O 23: Plasmonics and Nanooptics: Light-Matter Interaction, Spectroscopy

Time: Monday 18:15–20:30 Location: Poster E

O 23.1 Mon 18:15 Poster E

Time of flight momentum microscopy of plasmon assisted photoemission — •Martin Lehr[1], Karina Bley[2], Nicolas Vogel[2], Gerd Schönhense[1], and Hans Joachim Elmers[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55122 Mainz — [2]Friedrich-Alexander University Erlangen-Nürnberg, 91058 Erlangen

The photoemission properties of a Au nano triangular array have been investigated using a time-of-flight-momentum microscope (ToF-PEEM), equipped with a state-of-the-art Surface Concept delay line detector (DLD). The nano triangular array has been fabricated by deposition of a gold film on a self-assembled colloidal sphere structure. The triangles can be resonantly excited by Ti:sapphire femtosecond laser pulses. The sample is illuminated from the backside at normal incidence. We have studied the photoemission intensity as a function of kinetic energy and parallel momentum. Both dependencies deviate from results obtained for flat surfaces.

O 23.2 Mon 18:15 Poster E

Excitation of Surface Phonon Polaritons using an Infrared Free-Electron Laser — •Nikolai Passler, Ilya Razdolski, Martin Wolf, and Alexander Paarmann — Fritz-Haber-Institut der Max-Planck-Gesellschaft

Similar to surface plasmon polaritons (SPPs) at metal surfaces, polar dielectrics can support surface polaritons. These surface phonon polaritons (SPhPs) [1] emerge due to negative permittivity between transverse and longitudinal optical phonon frequencies, the so-called Reststrahl region. As for SPPs, these excitations are non-radiative due to a wave vector mismatch, which is why they can only be excited in sub-wavelength nanostructures or via prism coupling. SPhPs have, however, much longer lifetimes than SPPs, promising low-loss optical modes below the diffraction limit.

Here, we employ the Otto geometry [2] for prism coupling to excite SPhPs at the SiC-air interface, using a tunable mid-infrared Free-Electron Laser (FEL). In this configuration, the necessary momentum for SPhP excitation is provided by the evanescent wave leaking into the air gap between prism and sample for incident angles of total internal reflection inside the prism. The optimal coupling conditions for the phase-matched SPhP excitation are studied using reflectance spectroscopy. Additionally, the resonant nonlinear response of the excited SPhPs is probed by second harmonic generation spectroscopy.

[1] Neuner et al., Opt. Lett. 34, 2667 (2009)
[2] Otto, Zeitschrift für Physik 216, 398 (1968)

O 23.3 Mon 18:15 Poster E

Upconversion of infrared free-electron laser light in gallium selenide — •Riko Kiessling, Sandy Gewinner, Wieland Schöllkopf, Martin Wolf, and Alexander Paarmann — Fritz-Haber-Institut der MPG, Berlin

For absolute timing synchronization with sub-picosecond accuracy between table-top and accelerator-based free-electron lasers (FELs), it is essential to develop efficient schemes for relative timing measurements [1]. Specifically, for the synchronization between an FEL tunable throughout the mid-infrared frequency region [2] and a near-infrared table-top laser, light upconversion by sum-frequency generation could provide sufficient sensitivity for online-timing measurements.

As a first step, we have investigated the sum-frequency generation in gallium selenide by mixing the picosecond FEL pulses with near-infrared nanosecond pulses from a Nd:YAG laser. The conversion process is explored in terms of phase-matching and azimuthal angle dependence, polarization orientations and intensity scaling over a broad spectral range, utilizing the tunability of the FEL. Gallium selenide presents itself as an efficient nonlinear medium in the infrared, allowing its application to determine the absolute timing between the FEL and femtosecond table-top laser pulses.

[1] S. Schulz et al., Nat. Commun. 6, 5938 (2015)
[2] W. Schöllkopf et al., Proc. SPIE 9512, 95121L (2015)

O 23.4 Mon 18:15 Poster E

Incident Angle-Tuning of Infrared Antenna Array Resonances for Molecular Sensing — •Andreas Hessler, Tobias W.W. Mass, and Thomas Taubner — Institute of Physics (IA) RWTH Aachen

Metallic structures can efficiently couple light into a region of subwavelength size. In these regions, large local field enhancements can occur and enable an increased absorption of molecules which are placed in these so called "hot spots". Arrays of metallic structures which are designed for surface enhanced infrared absorption spectroscopy (SEIRA) enable the detection of molecular vibrations with high sensitivity [1,2].

In recent work [3], we apply incident angle-tuning to antenna array resonances in order to optimize the enhancement of two adjacent vibrational bands of a self-assembled thiol-monolayer. Varying the incident angle shifts the spectral positions at which collective excitation and peak field enhancement of the antennas occur. This allows a spectral tuning of the array resonance without changing geometry or surrounding material of the antennas.

Additionally, we now investigate the enhancement of vibrational modes of different numbers of CH_2-bonds by varying the chain lengths of the surface molecules.

[1] R.Adato et al., P. Natl. Acad. Sci. USA, **106**, 19227, 2009
[2] F.Neubrech et al., Phys. Rev. Lett, **101**, 157403, 2008
[3] T.W.W.Maß and T.Taubner, ACS Photonics, **2**, 1498, 2015

O 23.5 Mon 18:15 Poster E

Efficiency of Fano resonance in arrangements of nanorods: a comparison study — •Madeleine Nilsen[1], Manuel Gonçalves[1], Armen Melikyan[2], Hayk Minassian[3], Taron Makaryan[4], and Othmar Marti[1] — [1]Ulm University - Institute of Experimental Physics, Ulm, Germany — [2]Russian-Armenian (Slavonic) University, Yerevan, Armenia — [3]Yerevan Physics Institute, Yerevan, Armenia — [4]Drexel Nanomaterials Group, Drexel University, Philadelphia, USA

Nanorods allow easy tuning of optical resonances by varying the rod length and aspect ratio. Multipole resonances in rod-like nanoparticles are well separated and have relatively small bandwidths. Thus, assemblies of nanorods have been successfully used for generating Fano resonances.

In rods arranged in dolmen configuration, the dark mode necessary for the destructive interference of the Fano resonance is excited in both parallel rods simultaneously, with anti-symmetric surface charge density. In a H-like configuration of rods, quadrupole dark modes are excited independently in each long rods, resulting although in a mirror anti-symmetric surface charge density. Moreover, the near-field coupling of the H-like structure leads to a more pronounced Fano resonance than in the dolmen. H-like structures assembled in linear arrays with short separation comparing to the wavelength produce further attenuation of the scattering cross-section at the Fano dip.

The optical properties of the coupled nanorods were investigated by finite-element method (FEM). Nanorod structures were fabricated by e-beam lithography (EBL) and focused ion beam milling (FIB).

O 23.6 Mon 18:15 Poster E

Higher Harmonics Generation in Single Extended Gold Nanostructures — •Julian Obermeier, Thorsten Schumacher, Daniela Wolf, and Markus Lippitz — Experimental Physics III, University of Bayreuth

Higher harmonics generation in single gold nanostructures is a commonly known effect. Many fascinating experiments showed, that the nonlinear emission is strongly influenced and shaped by the particle plasmon resonance. However, when the structure dimension exceeds the diffraction limited excitation area, the higher order modes of the structure and even propagation of the fundamental and nonlinear field becomes important. In our experiments we investigate the spectrally dependent local nonlinear response of single gold nanostructures ranging from a few hundreds of nanometers to several micrometers in size. After excitation with pulsed infrared light, the locally generated second and third harmonic field is emitted in the near ultraviolet and visible spectrum and collected by a high NA oil immersion objective. This configuration allows a high spatial resolution of the origin of the nonlinear emission far below the diffraction limit of the excitation wavelength. In addition, the back focal plane pattern of the nonlinear emission carries information of its phase and directivity. On this poster, we present our method and first experimental results to determine the local emission properties of extended gold nanostructures.

O 23.7 Mon 18:15 Poster E

Ultrafast thermionic injection currents in metal-insulator-metal junctions — •Felix Becker[1], Detlef Diesing[2], Dominik Differt[1], Matthias Hensen[1], Walter Pfeiffer[1], and Christian Strüber[3] — [1]Molekül- und Oberflächenphysik, Fakultät für Physik, Universität Bielefeld, 33615 Bielefeld, Germany — [2]Surface Dynamics Group, Fakultät für Chemie, Universität Duisburg-Essen, 45141 Essen, Germany — [3]Quantum Optics and Laser Science Research Group, Imperial College London, SW7 2AZ London, GB

Recently, it has been shown that plasmonic resonances at structural defects on the top electrode of the heterosystem facilitate the injection of charge carriers above the tunnel barrier of the oxide [1]. Here, we exploit the enhanced excitation in the vicinity of gold nanoparticle antennas deposited on the top electrode of a metal-insulator-metal junction to inject charge carriers in the counter electrode. Instead of multi-photon processes or strong field effects, we identify highly localized thermionic emission as the dominating process for current injection. Here the theoretical model describing the experimental observations is presented. It is based on the calculated electromagnetic field distribution, simulated excited electron relaxation cascades and solutions of the three-dimensional heat diffusion equation. The large temperature gradients in the electron gas and the corresponding ultrafast temperature transients give rise to highly localized and ultrafast thermionic injection currents. An injection current pulse duration of about 20 fs is obtained although the thermionic emission is dominating.

[1] D. Differt et al., Appl. Phys. Lett. 101, 111608 (2012)

O 23.8 Mon 18:15 Poster E

Femtosecond pump-probe transmission measurements of spatially inhomogenous electron heating caused by plasmonic excitation in gold gratings — •Jonas Vondran[1], Felix Spitzer[1], Ilya Akimov[1], Boris Glavin[2], Vladimir Belotelov[3], Sachin Kasture[4], Arvind S. Vengurlekar[4], Achanta V. Gopal[4], and Manfred Bayer[1] — [1]Technische Universität Dortmund, Dortmund, Germany — [2]V.E. Lashkaryov Institute of Semiconductor Physics, Kiev, Ukraine — [3]Lomonosov Moscow State University, Moscow, Russia — [4]Tata Institute of Fundamental Research, Mumbai, India

Periodically perforated gold films are subject to femtosecond resolved pump-probe transmission measurements which show ultrafast relaxation dynamics of optically excited electrons. Differential transmission is measured with varying incident angles and different polarisation configurations. Using biexponential fitting functions two distinct decay times can be observed in the transient data: A decay with a relaxation time of about 1 ps is attributed to electron-lattice energy transfer which is also present in unstructured gold films. A second, shorter relaxation is observed which shows a characteristic decay time of 200 to 300 fs. This decay is due to spatially inhomogeneous heat distribution inside the gold grating's slabs which causes an additional thermal diffusion process. Depending on the exciting pump polarisation this decay shows a changing sign which indicates an opposing direction of heat gradients with plasmonic compared to non-plasmonic excitation.

O 23.9 Mon 18:15 Poster E

Plasmonic metasurface enhanced non-linear optical effects in LiNbO3 optical waveguides — •Felicitas Walter[1], Andre Hildebrandt[2], Nils Weber[1], Jens Förstner[2], Cedric Meier[1], and Thomas Zentgraf[1] — [1]Department of Physics, University of Paderborn, Warburgerstr. 100, D-33098, Germany — [2]Department of Electrical Engineering, University of Paderborn, Warburger Str. 100, D-33098, Germany

In this project we exploring the possibilities to enhance the frequency conversion of light in LiNbO3 waveguides by utilizing plasmonic metasurfaces. In particular, we are investigating the effects of gold plasmonic nanoantennas arrays on Titanium undiffused Lithium Niobate (Ti:LiNbO3) waveguides. Two different kind of nanoanteannas were fabricated on top of the waveguides in a two-step electron-beam lithography and lift-off process. The metasurfaces are designed for a resonance wavelength of 1500 nm. As these antennas enhance the light field locally, they serve as an enhancement for nonlinear optical effects, e.g., second harmonic generation. To guaranty a phase matching as well as the coupling into the waveguide for light incident perpendicular to the surface, we tested various periodicities and arrangements of the antennas. Furthermore, an additional layer of TiO2 on top of the metasurfaces can further increase the coupling to the optical waveguide mode by lifting the mode profile more to the surface.

O 23.10 Mon 18:15 Poster E

strong coupling of surface plasmons and whispering gallery cavity — •qi ai, domenico paone, nikolai strohfeldt, simon ristok, and harald giessen — 4th Physics Institute and Research Center SCoPE, University of Stuttgart, 70569 Stuttgart, Germany

A lot of research has focused on spectrally narrowing the plasmon resonance of metal nanoparticles, which could benefit the application of the localized surface plasmon resonance (LSPR) for sensing and nonlinear conversion. Here we demonstrate substantial reduction in the LSPR linewidth of an Au nanorod by depositing it onto the surface of a tapered fiber. When the taper diameter is reduced to about 1-3 μm, we observe signatures of strong coupling between the LSPR modes and the whispering gallery modes of the tapered fiber. This results in a very narrow hybrid plasmon-fiber resonance of the single Au nanorod, with a much higher quality factor (up to 300) when compared with that of an Au nanorod or an uncoated fiber with the same diameter. The strong coupling leads to a significant enhancement of the peak scattering intensity at plasmon resonance when compared to an uncoupled Au nanorod.

O 23.11 Mon 18:15 Poster E

Simulation of electric field patterns modified by metallic nanoantennas — •Richard Kerber, Doris E. Reiter, and Tilmann Kuhn — Institut für Festkörpertheorie, Universität Münster, Wilhelm-Klemm-Straße 10, 48149 Münster, Germany

Metallic nanoantennas are known to greatly enhance light fields and the geometry of nanoantennas influences the polarization properties of the electric field. When a nanoantenna is coupled to a semiconductor nanostructure, e.g., a quantum dot, the polarization plays an important role in the creation of electron-hole pairs. Focussing on linear and circular polarization, we perform a systematic study of nanoantennas, revealing effects of geometry on the electric field polarization. For the simulation we use the boundary element method. We consider nanoantennas consisting of gold nanostripes, which are arranged in a circle around a gap region. Different geometries are studied by varying length and number of the stripes. The impact of symmetry in a dimer nanoantenna is analyzed by changing the angle between the two nanostripes. The results show a strong dependence of the electric field on the excitation polarization and the antenna geometry.

O 23.12 Mon 18:15 Poster E

Real-space imaging of nanotip plasmons using electron energy loss spectroscopy — •Benjamin Schröder[1], Thorsten Weber[2,3], Sergey V. Yalunin[1], Thomas Kiel[4], Christian Matyssek[4], Murat Sivis[1], Sascha Schäfer[1], Felix von Cube[2,3], Stephan Irsen[3], Kurt Busch[4,5], Sefan Linden[2], and Claus Ropers[1] — [1]4th Physical Institute - Solids and Nanostructures, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Physikalisches Institut, Rheinische Friedrich-Wilhelms-Universität Bonn, Nußallee 12, 53115 Bonn — [3]Electron Microscopy and Analytics, center of advanced european studies and research, Ludwig-Erhard-Allee 2, 53175 Bonn — [4]Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin — [5]Max-Born-Institut, Max-Born-Straße 2A, 12489 Berlin

Surface plasmon polaritons (SPPs) excited on the shaft of sharp metal tips provide electromagnetic field confinement and enhancement at the apex. Here, we study gold nanotips by scanning transmission electron microscopy combined with electron energy loss spectroscopy (STEM-EELS). Using this technique, we observe standing waves of plasmonic modes formed by SPP reflection at the tip apex. We provide a fully retarded model and numerical computations based on a discontinuous Galerkin time domain approach showing excellent agreement with the experimental data. Our results demonstrate a high reflectivity of the apex to the fundamental mode, with negligible contributions of higher order azimuthal SPP modes in the apex-near region[1].

[1] B. Schröder et al., Phys. Rev. B 92, 085411 (2015).

O 23.13 Mon 18:15 Poster E

Investigation of carrier concentrations in doped InAs using SNOM measurements to quantify and improve signal modelling — •Maximilian Sauer, Lena Jung, and Thomas Taubner — I. Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany

The scattering-type scanning near-field optical microscope (s-SNOM) consists of an AFM where the tip is illuminated by an infrared laser to create near-fields at the tips apex, which has a radius of typically 25nm.

With SNOM it is possible to investigate the optical and electrical properties, including the dielectric function, of doped semiconductors with a spatial resolution that can be below the diffraction limit because it is given by the tip's radius. Hereby, the so called Finite Dipole Model (FDM) in combination with the Drude model is used to calculate SNOM signals to compare with actual measurement data. Within these models, the carrier concentration of a material can be extracted from the signals amplitude and phase at different wavelengths.

Doped bulk InAs samples with known electrical properties like carrier concentration due to investigation via other measurement techniques like Hall measurements are investigated with SNOM. The model's predictions based on our SNOM measurements can be compared with the known properties. The results of this comparison are used to examine if the models need to be improved in order to correctly describe the data. The next step is the expansion of the investigation to nanostructures, for example determining and imaging the electrial properties of nanowires, to make use of SNOM's high spatial resolution.

O 23.14 Mon 18:15 Poster E

Ideas on aSNOM using fiber optics — •Marco Klement, Jonas Albert, and Markus Lippitz — Universität Bayreuth, Bayreuth, Deutschland

Apertureless scanning near-field optical microscopy (aSNOM) is a tool to measure the electric fields of optical excitations on nano-particles with deep subwavelength resolution.

We will present our progress in implementing this method into an existing SNOM experiment and present ideas on how stability and signal to noise ratio could be improved using fiber optics instead of free space optics.

O 23.15 Mon 18:15 Poster E

Tip modified spectroscopy of nanowires — •Jonas Albert and Markus Lippitz — Universität Bayreuth

We are investigating 1D structures such as CdSe nanowires and wire-like molecular aggregates with an apertureless Scanning Near-field Optical Microscope (aSNOM). The optical fields at the near-field probe, a metal coated AFM-tip, are confined in a space much smaller than the wavelength and therefore showing a high field gradient on the nanometer scale. Utilising this near-field interaction we aim for modification of fluorescence emission by the presence of the near-field probe. Next to simple quenching we expect the optical field gradients to enhance dipole forbidden higher-order transitions.

O 23.16 Mon 18:15 Poster E

Long-lived coherence in the metal-organic hybrid Cobalt/Alq3 — Martin Aeschlimann[1], Tobias Brixner[2], Mirko Cinchetti[1], Norman Haag[1], Matthias Hensen[3], •Bernhard Huber[2], Christian Kramer[2], Walter Pfeiffer[3], Martin Piecuch[1], Christian Schneider[1], Benjamin Stadtmüller[1], and Philip Thielen[1] — [1]Fachbereich Physik and Research Center OPTIMAS, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern, Germany — [2]Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [3]Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany

The coherent electron dynamics of optically pumped (400 nm) molecular states of the metal-organic complex tris(8-hydroxyquinolinato)aluminium (Alq3) deposited on Cobalt are investigated with time-resolved photoemission microscopy (PEEM). We observe a coherence signal in interferometric autocorrelation traces when probing the excited-state manifold of Alq3 with 800 nm laser pulses. In two-dimensional (2D) nanoscopy spectra, two excited states are identified with an energy spacing of about 77 meV with respective linewidths of 11 meV and 48 meV. Measuring the kinetic energy of the photoelectrons, these features prevail over the entire accessible energy range of about 1 eV. The observed signal can be explained by long-lived coherent excited states of the adsorbate that decay among others via coupling to excited electrons in the substrate giving rise to a photoemission signal that depends linearly on the laser intensity.

O 23.17 Mon 18:15 Poster E

Fine-tuning and individual addressing of mid-IR nanoantenna resonances by reversible optical switching of Ge3Sb2Te6 thin-films — •Ann-Katrin U. Michel, Dmitry N. Chigrin, Thomas Kalix, Angela De Rose, Matthias Wuttig, and Thomas Taubner — RWTH Aachen University, 1. Institute of Physics A, Otto-Blumenthal-Straße, 52074 Aachen

Metallic nanostructures with well-defined resonances are a key building block for nanoscale photonic "meta-devices". The post-fabrication control over the nanostructures resonances is fundamental for enabling reconfigurable devices based on metamaterials, which allow for all-optical switchable nanophotonic imaging and sensors [1].

We present the tuning of the spectral position of the nanostructure resonance frequency by locally addressing phase-change material (PCM) thin-films with single nanosecond laser pulses. PCMs offer a huge contrast in the refractive index n due to a phase transition from their amorphous to their crystalline state. By optically induced local phase transitions, the effective n of the PCM medium, which affects the resonant structures resonance, can be tuned over a broad range.

The variation of the PCM area switched by a laser pulse allows us to reversibly alter the nanostructure resonance frequency of a 600 nm long rod-shaped antenna stepwise in the mid-infrared spectral range [2]. The local addressing enables a multi-step tuning of single nanostructures pointing towards actively controllable metasurfaces.

[1] Zheludev, N. I. et al. Nat. Mater. 11 (2012).
[2] Michel, A. U. et al. in preparation

O 23.18 Mon 18:15 Poster E

Single Molecule Spectroscopy in a tunable cavity system — •Oliver Schneider[1], Ulrich Müller[1], and Jens Pflaum[1,2] — [1]Experimental Physics VI, Julius-Maximilian-Universität, 97074 Würzburg — [2]Bavarian Center for Applied Energy Research (ZAE Bayern), 97074 Würzburg

Organic molecules are suitable quantum systems for single photon sources (SPS) as their high exciton binding energies allow for room temperature operation in contrast to inorganic semiconductors [1].

For the implementation of an electrically driven SPS, control of the triplet lifetime is desirable. Drexhage [2] already showed how ensemble lifetimes can be tuned with varying the distance between quantum emitters and a metallic surface. This type of experiment has been advanced for single molecules by using piezo controlled mirrors [3].

Here we report on a novel approach for electrically tuning the molecule-mirror distance by means of an Al-covered support embedded directly within the sample layout. As demonstrated by interferometric measurements, a displacement of about 70 nm, corresponding to about $\lambda/4$, is feasible by this arrangement.

Measuring photon statistics on selected single molecules while simultaneously varying the distance to the reflecting Al-interface, we demonstrate the voltage-driven control of radiative lifetimes of individual quantum emitters located within the device.

[1] M. Nothaft et al., *Nature Comm.* **3**, 628 (2012)
[2] K. H. Drexhage, *Prog. Opt.* **12**, 165 (1974)
[3] B. C. Buchler et al., *Phys. Rev. Lett.* **95**, 063003 (2005)

O 23.19 Mon 18:15 Poster E

Coherent energy transfer between widely separated nanoantennas coupled via an elliptic cavity — Martin Aeschlimann[1], Tobias Brixner[2], •Benjamin Frisch[1], Bert Hecht[3], Bernhard Huber[2], Matthias Hensen[4], Christian Kramer[2], Enno Krauss[3], Thomas Löber[5], Walter Pfeiffer[4], Martin Piecuch[1], and Philip Thielen[1] — [1]Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Physical and Theoretical Chemistry, Würzburg University, 97074 Würzburg, Germany — [3]Experimental Physics 5, Würzburg University, 97074 Würzburg, Germany — [4]Faculty of Physics, Bielefeld University, 33615 Bielefeld, Germany — [5]Nano-Structuring-Centre, TU Kaiserslautern, 67663 Kaiserslautern, Germany

We present experimental and theoretical results on a system that allows long-distance coupling between two plasmonic nanoantennas mediated by an extended SPP mode in an elliptic cavity. The system is the first to demonstrate a prearranged hybridization of two seperated LSPs and a propagating surface plasmon. It is prepared on atomically flat single crystalline gold flakes and temporal dynamics of plasmonic excitations are investigated by time-resolved photoelectron emission microscopy (PEEM). The observed coherent back and forth transfer of energy between the nanoantennas is well explained by a model of three coupled oscillators. Spectrally-resolved PEEM experiments support the demonstration of hybridization.

O 23.20 Mon 18:15 Poster E

Tuning the plasmon-exciton resonance of Gold-TDBC core-shell particles via the surrounding medium — •Felix Stete[1,2],

Wouter Koopman[1], and Matias Bargheer[1,3] — [1]Universität Potsdam, Institut für Physik und Astronomie, 14476 Potsdam, Germany — [2]Humboldt-Universität zu Berlin, School of Analytical Sciences Adlershof (SALSA), 10099 Berlin, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Wilhelm-Conrad-Röntgen Campus, BESSY II, 12489 Berlin, Germany

We present a method to tune the resonance frequencies of a plasmon-exciton system leading to an anti-crossing of the resonance peaks. The investigated plasmon-exciton system is given by gold nanospheres coated with the cyanine dye TDBC. The surrounding medium is gradually changed by a layer-by-layer deposition of polyelectrolytes with alternating charge forming well-defined double layers. We explain the dependence of the core-shell particles' spectrum on the surrounding medium by the shift of the uncoupled plasmon resonance given by the effective dielectric function of the composite particle-air-polyelectrolyte medium. The uncoupled exciton resonance is approximately unchanged by the changing environment. The strong coupling characteristics of the plasmon-exciton system are demonstrated by an anti-crossing behaviour of the resonance peaks.

O 23.21 Mon 18:15 Poster E

Radiation patterns of semiconductor nanocrystals coupled to optical dimer antennas — •Nicolas Coca Lopez[1], Annick Hemmerling[1], Harald Budde[1], Francesca Nicoli[2], Tao Zhang[2], Mauricio Pilo-Pais[2], Tim Liedl[2], and Achim Hartschuh[1] — [1]Department of Chemistry, and Center for NanoScience (CeNS), LMU München, Germany — [2]Department of Physics, and Center for NanoScience (CeNS), LMU München, Germany

Optical antennas can be used to manipulate the coupling between emitters and the radiation field leading to changes in the rate and direction of spontaneous emission [1,2]. Here we study single semiconductor nanocrystals (NC) enclosed at the feed-point of plasmonic dimer antennas formed by DNA-based self-assembly [3]. Radiation patterns recorded by back-focal plane (BFP) imaging of the photoluminescence (PL) emission of single NC-antenna systems show the antenna directivity and the spontaneous emission rate enhancement. Quantitative model calculations of the BFP patterns are carried out to determine the coupling strength of the different transition dipole moment orientations in the NC to the antenna resonance.

[1] Bharadwaj, P. et al., Adv. Opt. Photon. 1, 438 - 483, (2009).
[2] Curto, A. G. et al., Science 329, 930 - 933, (2010).
[3] Kuzyk, A. et al., Nature 483, 311 - 314, (2012).

O 23.22 Mon 18:15 Poster E

Electrodynamics of Gold Nano-Sponges — •Felix Schwarz, David Leipold, and Erich Runge — Institut für Physik und Institut für Mikro- und Nanotechnologien, TU Ilmenau

Taylored disorder can prove most beneficial in nanophotonics: Not only are systems inherently unaffected by perturbations caused by, e.g., temperature, but also disorder-induced localization can appear and symmetry-breaking causes light-trapping in otherwise dark modes. Recently, irregular nanoporous gold sponges with a diameter of around 200nm and features on the 20nm scale made by clever metallurgy were presented [1]. Our numeric calculations of plasmonic resonances show that surprisingly long-lived modes with greatly enhanced near-field intensities can be excited. The results reproduce important aspects of scattering and nonlinear photoemission spectra found in recent experimental studies [1,2]. These are intuitively explained in terms of interacting near-field modes and their coupling to the far-field. Furthermore, we discuss the impact of our findings on future practical applications, e.g. in chemical sensing.

[1] C. Vidal et al., ACS Photonics, 2, 1436 (2015)
[2] G. Hegert, C. Lienau, private communication