O 36: Plasmonics and Nanooptics

Time: Tuesday 18:15–21:00 Location: Poster A

O 36.1 Tue 18:15 Poster A

Optical-tuning of surface phonon polaritons with a phase-change material — •Xiaosheng Yang, Peining Li, Tobias Mass, Angela De Rose, Ann-Katrin Michel, and Thomas Taubner — I. Institute of Physics (IA), RWTH Aachen University, Germany

As an alternative to metallic surface plasmon polaritons (SPPs), surface phonon polaritons (SPhPs) on polar dielectric crystals provide many opportunities in infrared and terahertz nanophotonic applications [1]. For example, localized SPhP modes have been experimentally demonstrated to show high quality factors on periodic nanopillar arrays (40-135) and single circular microcavities (around 60) [2][3]. However, such effects within SPhP structures can only be tunable by varying the size of nanostructure and resonances are fixed once fabricated. Here, we perform theoretical studies of active tuning of SPhPs by changing the phase of germanium antimony telluride (GST) thin film. Initial experiments are made with thermally and optically induced GST phase change [4][5].

[1] J. Caldwell et al., Nanophotonics (doi:10.1515/nanoph-2014-0003) (2014); [2] J. Caldwell et al., Nano Lett. 13, 3690-3697 (2013); [3] T. Wang et al., Nano Lett. 13, 5051-5055 (2013); [4] A. Michel et al., Nano Lett. 13, 3470-3475 (2013); [5] A. Michel et al., ACS Photonics 1 (9), 833-839 (2014).

O 36.2 Tue 18:15 Poster A

Phase-change induced switching of a SiC superlens — •Johannes Reindl, Peinning Li, Lena Jung, and Thomas Taubner — Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany

Conventional optics can only resolve structures larger than half of the used lightsource's wavelengths. The utilization of the superlensing phenomenon enables an improved extraction of near-field information and thus beats the diffraction limit[1-2]. Nearly a decade ago the functionality of SiC as a superlens in infrared optics was shown [3]. But it suffers, like all phonon-polariton based superlenses, from its predetermined, non-changeable structural properties. The use of Phase-Change Materials, materials that can be switched reversibly between a stable crystalline and amorphous state, would expand the existing application by circumventing the monochromatic nature of this kind of superlens. Therefore, theoretical calculations of a switchable superlens and initial experimental measurements with s-SNOM are done on a layer-system consisting of SiC and germanium antimony teluride (GST).

[1] Pendry, Phys. Rev. Letters 85, 3966 (2000)
[2] Fang et al., Science 308, 534 (2005)
[2] Taubner et al., Science 313, 1595 (2006)

O 36.3 Tue 18:15 Poster A

Sensitivity engineering in direct contact Au@Pd nanosandwich hydrogen sensors — •Nikolai Strohfeldt, Jun Zhao, Andreas Tittl, and Harald Giessen — 4. Physikalisches Institut, Universität Stuttgart

We demonstrate a hydrogen sensing scheme, using complex hybrid plasmonic nanostructures, with stacked gold and palladium nanodisks. So far plasmonics mostly focusses on studying influences of lateral coupling on hybrid plasmonic structures. However, for industry products it would be more feasible to use stacked nanostructures that can be fabricated in one step. We, for the first time, study the influence of stacking order and geometry, experimentally and numerically, to find an optimal arrangement for a hydrogen sensor device. With the best sensing geometry - a stack of gold as lower and palladium as upper disk - we obtain spectral shifts as large as 30 nm at about 4 vol.% H_2, which is a strong improvement compared to previous indirect designs. Our samples yield large absorption and scattering signals and are fabricated by low-cost hole-mask colloidal lithography and therefore yield sample sizes over areas of 1 cm^2.

O 36.4 Tue 18:15 Poster A

Nano-photonic computations of light propagation and absorption in nano-structured hybrid solar cells — •Thomas Kiel[1], Thomas Pfadler[2], Martin Stärk[2], Julia F. M. Werra[1], Christian Matyssek[1], Johannes Boneberg[2], Lukas Schmidt-Mende[2], and Kurt Busch[1,3] — [1]Humboldt-Universität zu Berlin, Institut für Physik, AG Theoretische Optik & Photonik, D-12489 Berlin, Germany — [2]Universität Konstanz, D-78457 Konstanz, Germany — [3]Max-Born-Institut, D-12489 Berlin, Germany

Nano-structured multilayer organic-inorganic solar cells are promising candidates for enhanced efficiency due to additional absorption features as compared to unstructured solar cells. We consider a common inverted solar cell material setup with a periodically nano-structured TiO_2 grating, covered by a P3HT-PCBM blend as the active material and followed by PEDOT-PSS, which are enclosed by ITO and silver contacts. In this setup resonant absorption enhancement outside of the main optical absorption band of P3HT-PCBM is observed experimentally.

We perform numerical calculations solving Maxwells equations using the Discontinuous-Galerkin Time-Domain Method to provide explanations of the experimentally observed behavior. Specifically, in order to obtain deeper insight into the mechanisms involved we compute spatially resolved absorption profiles and investigate the influence of the TiO_2 grating periodicity, which we compare to the experimental data.

O 36.5 Tue 18:15 Poster A

plasmonic based low emission coatings — Mehdi Keshavarz Hedayati, •Moheb Abdelaziz, and Mady Elbahri — Nanochemistry and Nanoengineering, Institute for Materials Science, Faculty of Engineering, Christian-Albrechts-Universität zu Kiel, Kiel, Germany

High energy consumption in the current century makes development of new efficient energy saving materials inevitable. One of the highly used energy saving material are "low emission coatings" (also known as low-e coating) which are generally fabricated by transparent conductors. In such a approach, the transmission of visible light is relatively high while the near infrared transmission is negligible. However, the typical transparent conductors are made of indium tin oxide which is a costly compound and hence the need of cheaper replacing system is critical. In this work, we make use the high reflection of metallic film in IR frequency to our benefit to develop a new highly efficient low-e material. There, a composite out of metal-dielectric which sustain plasmon resonance is used to suppress the reflection of thin metal film in visible while keeping the reflection at NIR very high. In that sense, the resulting structure is highly transparent in visible whereas it block the light passage at NIR (by reflection). Therefore the heat can be maintained in the house if such a film is being used as the windows coating in cold area (e.g. Germany). The simple fabrication of this two layers coating turn it a reasonable alternative for next generation of low-e materials.

O 36.6 Tue 18:15 Poster A

Development and construction of an aperturless Scanning Nearfield Optical Microscope — •Jonas Albert, Matthias Brandstätter, and Markus Lippitz — Experimentalphysik III, Universität Bayreuth

We are interested in mapping optical fields of nanoobjects such as plasmonic structures. For that purpose we built an aperturless Scanning Nearfield Optical Microscope (aSNOM), to combine spatial resolution of an AFM with optical information. In a first step we built an "open" AFM with optical access to the tip,while still keeping a high stability of the system in sight. Our AFM shows vertical sub-nanometer resolution with the possibility to illuminate sample and tip from the side and the bottom. In a second step the optical near field detection system is installed. With an Michelson-type interferometric detection we gain signal amplification plus optical phase information. For background suppression a cross-polarization scheme is implemented to get optimal signal-to-noise ratio.

O 36.7 Tue 18:15 Poster A

Phase-tagged PEEM for localized surface plasmons — •Soo Hoon Chew[1], Sebastian Nobis[1], Alexander Gliserin[1], Peter Geisler[2], Michael Förster[3], Yingying Yang[4], Seungchul Kim[5], Jürgen Schmidt[1], Matthias Kübel[1], Peter Hommelhoff[3], Bert Hecht[2] und Ulf Kleineberg[1] — [1]Faculty of Physics, Ludwig Maximilian University of Munich, 85748 Garching, Germany — [2]Institute of Physics, University of Würzburg, 97074 Würzburg, Germany — [3]Department of Physics, University of Erlangen-Nuremberg, 91058 Erlangen, Germany — [4]Institute of Semiconductors, Beijing 100083, P. R. China — [5]Max Planck Center for Attosecond Science, Pohang, 790-

784, South Korea

Strong carrier-envelope phase (CEP) effects have been shown to be crucial in controlling electron motion recently in solids. As a further step, it is also very interesting to extend the CEP control on novel photonic devices. We have developed the single-shot phase-tagged time-of-flight photoelectron emission microscope (ToF-PEEM) with the aim to study localized surface plasmons in tailored plasmonic nanostructures. First, we use a CEP-sensitive nanotip to test the proof of principle of our setup. We also show some theoretical calculations of CEP effects on bowtie and dipole nanostructures with various gap sizes. The next experiments will be performed on single-crystalline gold nanostructures with ultralow surface roughness based on the theoretical prediction. The phase-tagged ToF-PEEM setup provides a versatile tool for both spatial-resolved and energy-resolved studies of attosecond control of electrons in tailored plasmonic nanostructures.

O 36.8 Tue 18:15 Poster A

Long range coupling within an ensemble of quantum dots by plasmonic nanostructures — •Laura Meissner[1], Christian Dicken[1], Michael Jetter[2], and Markus Lippitz[1] — [1]Experimentalphysik III, Universität Bayreuth, 95440 Bayreuth, Germany — [2]Institut für Halbleiteroptik und Funktionelle Grenzflächen, Universität Stuttgart,70569 Stuttgart, Germany

The dipole-dipole interaction between quantum emitters leads to well known effects such Dicke super-radiance of J aggregates. In a solid-state system, this interaction is weak due to its short range nature and the inhomogeneity of the ensemble. We investigate how a long-range surface plasmon can help to couple an ensemble of quantum dots. In a first approach, we combine high-density InP quantum dots with a two-dimensional surface plasmon forming at a gold layer. In this poster, we compare luminescence intensities and lifetimes as well as spatial emission patterns for different coupling geometries.

O 36.9 Tue 18:15 Poster A

STM induced light emission from pristine and adsorbate covered surfaces — •Ebru Ekici, Maren C. Cottin, Rolf Möller, and Christian A. Bobisch — Faculty of Physics, Center for Nanointegration Duisburg-Essen, University of Duisburg-Essen, 47048 Duisburg, Germany

In scanning tunneling microscopy (STM) mostly elastic tunneling occurs, however, also a very small percentage of inelastic tunneling takes place. This may lead to a local excitation at the tip-sample junction and the following relaxation may be accompanied e.g. by emission of photons [1]. The spectral analysis of the emitted light from the tunneling junction in the STM experiment carries information about the involved radiative decay channels, e.g. within adsorbed organic molecules [2]. Here, we studied the STM induced light emission from (noble metal) substrates which are partially covered with the archetype organic molecules 3,4,9,10-tetracarboxylic dianhydride (PTCDA), copper-phthalocyanine (CuPc) and C_{60}. Spectra of the integral photon yield as a function of the tunneling energy and spatially resolved photon maps for the pristine and molecule covered surfaces will be discussed. Further perspectives for manipulating the light emission properties by adsorbate layers will be presented.

[1] G. Hoffmann, T. Maroutian, and R. Berndt, Phys. Rev. Lett. 93, 076102 (2004)

[2] C. Chen, P. Chu, C. A. Bobisch, D. L. Mills, and W. Ho, Phys. Rev. Lett. 105, 217402 (2010)

O 36.10 Tue 18:15 Poster A

Pump-probe infrared near-field nanospectroscopy on germanium and silicon — •Frederik Kuschewski[1], S.C. Kehr[1], B. Green[2], S. Kovalev[2], M. Gensch[2], and L.M. Eng[1] — [1]Institut für Angewandte Photophysik, TU Dresden, 01062 Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany

Scattering-type scanning near-field optical microscopy (s-SNOM) is a versatile method to map the optical properties on the nanoscale. In combination with novel pulsed THz radiation sources, ultra-short dynamics can be observed in materials of very high interest (e.g. graphene). However, these experiments use very high repetition rates. Here, we introduce a technique to detect minute pump effects in the near-field signal, capable of processing low pumping repetition rates and, hence, allowing for measurements of biological samples.
In s-SNOM, the optical is exctracted via the method of higher-harmonic demodulation, which is extended to a novel side-band technique that allows for the pure measurement of pump-induced effects. In a pilot experiment, we investigated pure Si, Ge and a SiGe thin-film sample under excitation by a Nd:YAG ps laser while near-field probing was carried out by a cw CO_2 laser or by the tunable free-electron laser FELBE at the Helmholtz-Zentrum Dresden-Rossendorf.
All three samples show a time-variable pump-effect in the near-field when being probed at $\sim$10 μm wavelength. Moreover, image scans proof the resolution far beyond the diffraction limit. The experiment provides a definite proof of the applicability of our approach for investigating ultra fast phenomena in the near-field.

O 36.11 Tue 18:15 Poster A

Imaging ring resonator plasmons using photoemission electron microscopy — •Deirdre Kilbane, Anna-Katharina Mahro, Pascal Melchior, Cristian González, Michael Hartelt, Philip Thielen, Markus Rollinger, Stefan Mathias, and Martin Aeschlimann — Physics Department and Research Centre OPTIMAS, University of Kaiserslautern, Germany

Understanding fundamental interactions of light and matter e.g. the dynamic response of a metal to incident light is essential for designing plasmonic devices such as biosensors. Ring resonators are ideal biosensors since the binding of a biomolecule alters the near-field response causing detectable changes in the resonance wavelength and intensity. Typically far-field optical detection techniques are used to determine the spectral properties of these nanoantennas. However the near field response is determined on a length scale that is intrinsically smaller than the optical diffraction limit. We therefore use electrons instead of photons for imaging the near-field distribution. We characterize arrays of ring resonators by combining photoemission electron microscopy (PEEM) with a tuneable excitation source, an optical parametric oscillator (OPO). These ultrahigh spatially and spectrally resolved measurements reveal resonance conditions for different ring radii and depths.

O 36.12 Tue 18:15 Poster A

Micro-scale Imaging Ellipsometry on Single-crystalline Gold Flakes for Plasmonic Applications — •Peter Richter[1], Ovidiu D. Gordan[1], Muhammad Y. Bashouti[2], Björn Hoffmann[2], Thorsten Feichtner[2], Ahmed M. Salaheldin[3], Mirza Mačković[4], Christel Dieker[4], Erdmann Spiecker[4], Silke Christiansen[2,5], and Dietrich R. T. Zahn[1] — [1]Semiconductor Physics, Technische Universität Chemnitz, D-09107 Chemnitz — [2]Max Planck Institute for the Science of Light, D-91058 Erlangen — [3]Universität Erlangen-Nürnberg, Institute of Particle Technology, D-91058 Erlangen — [4]Universität Erlangen-Nürnberg, Center for Nanoanalysis and Electron Microscopy (CENEM), D-91058 Erlangen — [5]Helmholtz Centre Berlin for Materials and Energy, D-14109 Berlin

Micro-scale single-crystalline gold flakes were drop casted onto a silicon surface intended to be used as substrate material for the fabrication of nanostructured plasmonic devices. Using an Accurion nanofilm ep4 imaging ellipsometer with a 1 μm lateral resolution, we demonstrate that spectroscopic micro-ellipsometry measurements on the gold flakes are prominently suitable to investigate their crystal and surface quality. The spectra were acquired under a 50x microscope objective in a spectral range from 1.55 to 3.25 eV at multiple angles of incidence. The ellipsometric parameters Ψ and Δ were extracted only from a small region of interest positioned in the middle of the gold flake. An optical model was applied to assure the Kramers-Kronig consistency of the experimental data and to deliver reliable results for the dielectric function, which agrees well with previous literature reports.

O 36.13 Tue 18:15 Poster A

Coupling of an organic cyanine dye with a plasmonic structure — •Jessica Koller[1], Thorsten Schumacher[1], Christian Dicken[1], Daniela Wolf[1], Anna Köhler[2], and Markus Lippitz[1] — [1]Experimentalphysik III, Universität Bayreuth — [2]Experimentalphysik II, Universität Bayreuth, Germany

By placing a multichromophoric system nearby a metal surface the optical properties of the system can be modified due to the interaction between the surface plasmon polariton and the molecular states. This can lead to an emission enhancement and energy transfer between different emitters on the surface.

In this context we want to examine the optical properties of a hybrid plasmon-emitter-system consisting of an organic cyanine dye and different plasmonic structures by means of spatially resolved fluorescence spectroscopy. Therefor we use a J-aggregate forming TDBC dye which shows a sharp resonance in absorbance and luminescence for high dye concentrations. At this juncture we start with the analysis of

thin TDBC-PVA-films with different dye concentrations and present TDBC luminescence spectra and measurements of photostability. Additionally, a method to reduce photoactived bleaching by oxygen is tested as well as first results for the coupling of TDBC with plasmonic structures are given and compared to numerical simulations.

O 36.14 Tue 18:15 Poster A

Optical emission and absorption characteristics of graphene on copper in a tunnel junction — •Hakki Tunç Çiftçi, Berk Zengin, Umut Kamber, Cem Kincal, Dilek Yildiz, and Oğuzhan Gürlü — Istanbul Technical University, Istanbul, Turkey

Graphene has a huge potential for applications in optoelectronic devices due to its relatively small but efficient absorption of photons in a broad range of energies. Still the structural properties of graphene needs to be investigated at the atomic scale in order to expand the applicability of this novel material further in the optics, plasmonics and other related fields. Photon Scanning Tunneling Microscopy (pSTM) is a very useful tool for the purposes of studying structural properties at the atomic level as well as optical properties of graphene with very high, simultaneous, spatial information. In this work Chemical Vapor Deposition (CVD) grown graphene on copper was investigated with ambient pSTM. We studied the photon emission properties of STM among tip and graphene/Cu junction as well as the structural response of the surface due to different optical excitations. Bias voltage dependent characteristic of the tunnel junction under different illuminations were also investigated both on flat terraces and on moiré zones forming on the graphene/Cu system.

O 36.15 Tue 18:15 Poster A

On the Importance of the Plasmonic Near-Field Spectrum for SEIRA — •Jochen Vogt[1], Christian Huck[1], Frank Neubrech[1,2], Andrea Toma[3], David Gerbert[1], and Annemarie Pucci[1] — [1]Kirchhoff-Institute for Physics, Heidelberg University, Germany — [2]4th Physics Institute and Research Center SCoPE, University of Stuttgart, Germany — [3]Istituto Italiano di Tecnologia, Genova, Italy

The near-field characteristics of plasmonic infrared (IR) nanoantennas are of great importance for molecular sensing, e.g., with surface-enhanced IR absorption (SEIRA). Recent studies investigated the spatial extend [1], lateral distribution, and Angstrom-scale surface-distance dependence [2]. In addition, the spectral near-field information is crucial to design optimum nanostructures for vibrational sensing. The red shift between the plasmonic near- and far-field intensity peaks that has to be considered in the design was theoretically described and then experimentally confirmed using scanning near-field optical microscopy [3] and, as shown in this contribution, by IR microspectroscopy. We investigated vibrational SEIRA signals of a thin molecular layer on IR nanoantenna substrates. Varying the spectral tuning of plasmonic resonance and molecular vibrations, we find the maximum SEIRA in accordance with the predicted near- and far-field resonance energy shift. Furthermore, depending on the detuning, we observe the enhanced vibrational signals as asymmetric lines that are described by the Fano model. [1] Neubrech et al., ACS Nano 2014 [2] Bochterle et al., ACS Nano 2012 [3] Alonso-Gonzalez et al., PRL 2013

O 36.16 Tue 18:15 Poster A

IR Microscopy: Spectra-Structure Correlations in Plasmonic Metamaterials and Hybrid Surfaces — •Timur Shaykhutdinov, Thomas W. H. Oates, Andreas Furchner, and Karsten Hinrichs — Leibniz-Institut für Analytische Wissenschaften - ISAS - e.V., Department Berlin, Schwarzschildstraße 8, 12489 Berlin, Germany

Anisotropic plasmonic metamaterials, organic-inorganic hybrid surfaces, and thin organic films and interfaces are of high importance for applications in the field of nanotechnology and in the design of structure-resolving biosensors, photonic and optoelectronic devices. A fundamental requirement to this end is a detailed characterization of their structural properties and fundamental interactions, which induce and control their unique macroscopic optical response.

For a comprehensive understanding of structure- and heterogeneity-induced effects of these novel materials in the fingerprint region, both far- and near-field optical measurement concepts with high sensitivity and lateral resolution are required. Current methods include generalized ellipsometric IR microscopy (developed at the ISAS Berlin) and nanoscale IR microscopy based on photothermal induced resonance (PTIR), a technique also referred to as AFM-IR.

In combination with new measurement concepts, optical calculations (e.g. using rigorous coupled-wave analysis (RCWA), finite-difference time-domain method (FDTD)) of both the electromagnetic far- and near-fields are essential to avoid incorrect spectral assignments and unphysical conclusions.

O 36.17 Tue 18:15 Poster A

Simulations of s-SNOM Systems — •Lisa Ortmann, A. Hille, S.C. Kehr, and L.M. Eng — Institut für Angewandte Physik, George-Bähr-Straße 1, 01069 Dresden

Scattering scanning near-field optical microscopy (s-SNOM) utilizes scattering of electromagnetic waves by a sharp probe that is coupled via near-field interaction to the sample of interest. For small tip-sample distances, the near-field optical resolution and contrast clearly depend on the tip radius and the different sample properties only. Such a scenario may be easily modelled by the analytical dipole-approximation. Nevertheless, this simplified model suffers from limitations such as neglected retardation or the non-point-like tip, and thus is inappropriate to be applied to more complex systems including e.g. anisotropic substrates or structured samples. Hence, a full numerical description is needed to gain a deeper understanding of experimental results.

We present here simulations of the tip-sample interaction in a typical s-SNOM configuration. Our systems consist of a perfect electrically conducting sphere as the scattering and scanning tip, and various samples ranging from perfect electric conductors over typical dielectrics to anisotropic substrates. All calculations are performed using a classical finite element method (COMSOL).

O 36.18 Tue 18:15 Poster A

Bistable nano-plasma formation and EUV light generation in plasmonic nanostructures — •Frederik Busse, Murat Sivis, and Claus Ropers — IV. Physical Institute, University of Göttingen, Göttingen, Germany

The enhancement of light in plasmonic nanostructures offers new means to study highly nonlinear optical phenomena using ultrashort low-energy laser pulses at MHz repetition rates. Specifically, the excitation of noble gas atoms in resonant bow-tie antennas and tapered hollow waveguides facilitates nanostructure-based extreme-ultraviolet (EUV) light generation at local intensities above 10 TW/cm^2. Contrary to initial reports [1, 2] which indicate the feasibility of plasmon-enhanced coherent high-harmonic generation, it was recently shown that incoherent fluorescence stemming from multiphoton and strong-field excitation dominates the EUV light generation process under such conditions [3, 4].

Here, we present a study of gas plasma processes in tapered hollow waveguides which can lead to a pronounced intensity-hysteresis in the fluorescence signal. In addition to the spectral analysis of the fluorescent EUV radiation, we measure intensity- and pressure-dependent electron and ion yields which give further insights into the ionization mechanisms.

[1] S. Kim *et al.*, Nature **453**, 757(2008),
[2] I.-Y. Park *et al.*, Nat. Photon. **5**, 677 (2011).
[3] M. Sivis *et al.*, Nature **485**, E1 (2012).
[4] M. Sivis and C. Ropers, Phys. Rev. Lett. **111**, 085001 (2013).

O 36.19 Tue 18:15 Poster A

Calculation of photothermal heating in DNA-gold nanoparticle networks due to irradiation with laser light — Malte Linn, •Alexander Nedilko, and Gero von Plessen — Institute of Physics (IA), RWTH Aachen, Germany

Molecule metal-nanoparticle hybrid systems, such as DNA-gold nanoparticle (AuNP) networks, have attracted great interest because of their unique optical properties and their versatile chemical functionalities. Since DNA dehybridization is temperature-sensitive, the DNA-AuNP networks can be dissociated by thermal and photothermal heating. In this work, we calculate the temperature increase in DNA-AuNP networks induced by irradiation with c.w. laser light. To this end, we use generalized Mie theory to calculate the optical power absorbed by the individual nanoparticles in AuNP aggregates in water. By inserting the absorbed powers into finite-element calculations, the temporal and spatial changes of the temperature distribution within the AuNP aggregates and in their vicinity are computed. The maximal temperature in the AuNP aggregate is found to grow with aggregate size due to heat accumulation. While the irradiated AuNPs serve as heat sources, their individual temperature increases are only a few percent higher than those of the water regions between them, resulting in a relatively smooth temperature distribution in each aggregate.

O 36.20 Tue 18:15 Poster A

Real space imaging of nanotip plasmons using electron energy-loss spectroscopy — •Benjamin Schröder[1], Sergey Yalunin[1], Thorsten Weber[2,3], Murat Sivis[1], Felix von Cube[2,3], Thomas Kiel[4], Christian Matyssek[4], Stephan Irsen[3], Kurt Busch[4], Claus Ropers[1], and Stefan Linden[2] — [1]IV. Physical Institute, University of Göttingen, Germany — [2]Physikalisches Institut, Rheinische Friedrich-Wilhelms-Universität Bonn, Germany — [3]Research center caesar, center of advanced european studies and research, Bonn, Germany — [4]Institut für Physik, Humbold-Universität zu Berlin, Germany

The excitation of surface plasmon polaritons (SPPs) on metallic nanotips results in a plasmonic confinement and enhancement of electromagnetic fields at the apex. This field concentration provides for novel means of imaging and spectroscopy. One key aspect for the understanding and optimization of such a plasmonic structure is the dispersive evolution of propagating SPPs. In this contribution, we present a study of SPP excitation on a gold tip by using a scanning transmission electron microscope in combination with electron energy-loss spectroscopy. This technique allows for a spatially and spectrally resolved mapping of standing wave patterns on the nanotip's shaft. The data clearly shows a wavelength compression towards the apex and also indicates a significant contribution of higher azimuthal modes with increasing radii. We provide a fully retarded theoretical analysis of the adiabatic phenomenon based on a modal expansion. The numerical results demonstrate an excellent agreement with the data.

O 36.21 Tue 18:15 Poster A

Simulation of the second harmonic response from hybrid plasmonic nanoantennas — •Yevgen Grynko[1], Jens Foerstner[1], Heiko Linnenbank[2], and Stefan Linden[2] — [1]University of Paderborn, Paderborn, Germany — [2]University of Bonn, Bonn, Germany

Experimental spectroscopy of hybrid metallic/dielectric nanogap-antennas shows twofold enchancement of the SHG signal in comparison to pure metallic nanoantennas. Here, we study numerically their linear optical properties and the origin of the SHG emitted from such structures. We use the Discontinous Galerkin Time domain method and Maxwell-Vlasov hydrodynamic approach to describe the nonlinear flow of the free electron gas in a metal [1].

[1] S. Linden, F. B. P. Niesler, J. Förstner, Y. Grynko, T. Meier, and M. Wegener, Collective Effects in Second-Harmonic Generation from Split-Ring-Resonator Arrays, Phys. Rev. Lett. 109, 015502, 2012.

O 36.22 Tue 18:15 Poster A

Comparing the emission quenching of electric dipole and magnetic dipole transitions near metal nanoparticles of different shapes — •Deepu Kumar[1], Dmitry Chigrin[1], Florian Hallermann[1], Alexander Sprafke[2], and Gero von Plessen[1] — [1]RWTH Aachen University, 52074 Aachen, Germany — [2]μMD Group, Institute of Physics, Martin-Luther University Halle-Wittenberg, 06120 Halle, Germany

Near-field coupling to metal nanoparticles (MNPs) can lead to an enhancement of excitation and emission rates of molecular or ionic emitters placed in the vicinity of the particle. Magnetic dipole (MD) transitions are usually neglected in the treatment of such coupling due to their lower radiative rates as compared to electric dipole (ED) transitions. However, MD transitions appreciably contribute to some of the intra-4f transitions in rare-earth ions such as trivalent erbium (Er^{3+}). We use Mie theory and the finite element method (FEM) to study the excitation and decay rates of purely ED and purely MD transitions in the close vicinity of MNPs of different shapes, such as spheres, ellipsoids and split rings acting as nanoantennas. We compare the emission quenching of ED and MD transitions in the extreme near-field regime, i.e. the close vicinity of the surface of the MNPs.

O 36.23 Tue 18:15 Poster A

Tip-Enhanced and Confocal Scanning Photocurrent Microscopy on Graphene. — •Nicolas Coca Lopez, Tobia Mancabelli, Harald Budde, and Achim Hartschuh — Department Chemie and CeNS, LMU München, Germany.

Scanning photocurrent microscopy (SPCM) is a powerful tool to investigate the electronic properties of nanoscale devices such as carbon nanotube- or graphene-based field-effect transistors [1, 2]. However, due to the diffraction limit of propagating light, most SPCM measurements on graphene reported so far have been restricted to a spatial resolution of few hundred nanometers, making it impossible to optically characterize a device on the nanoscale. Tip-enhanced near-field optical microscopy (TENOM) overcomes this limit [3]. Exploiting the strong electromagnetic field enhancement in the vicinity of an illuminated metallic nanoparticle, the absorption, and hence, charge carrier generation in nearby photoactive materials is locally increased [4]. Here, we report on our last advances on the combination of SPCM and TENOM and our results regarding charge carrier generation and transport in graphene.

[1] Freitag, M. et al., Nano Lett. Vol. 7, No. 7, 2007 [2] Müller T. et al., Phys. Rev. B 79, 245430, 2009 [3] Mauser, N. et al., Chem. Soc. Rev., Vol. 43, No. 4, 2014 [4] Rauhut, N. et al., ACS Nano, Vol. 6, No. 7, 2012

O 36.24 Tue 18:15 Poster A

Spectroscopic ellipsometry of anisotropic metal nanostructures on patterned diblock co-polymer thin film — •Johannes F. H. Risch Risch[1], Sarathlal Koyiloth Vayalil[1], Gonzalo Santoro[1], Shun Shun[1,2], Bastian Besner[3], Philipp Bremer[3], Dieter Rukser[3], Yuan Yao[4], Ezzeldin Metwalli[4], Peter Müller-Buschbaum[4], Michael A. Rübhausen[3], and Stephan V. Roth[1] — [1]DESY, Notkestr. 85, D-22607 Hamburg — [2]KTH, Teknikringen 56-58, SE-100 44 Stockholm — [3]UHH, INF CFEL APOG, Luruper Chaussee 149, D-22761 Hamburg — [4]TUM, Physik Department LS E13, James-Franck-Str. 1, D-85748 Garching

Hybrid materials play a crucial role in modern advanced material science. Nanostructures can exhibit plasmonic resonances based on the shape, size and ordering, which can be used for example for SERS. Nanostructured gold films were fabricated by oblique angle deposition on a patterned diblock co-polymer thin film. Due to selective wetting behavior hierarchical films were created. Furthermore the gold clusters on top of the polymer film show a shape anisotropy leading to optical birefringence. Using angular resolved spectroscopic ellipsometry we investigate the optical properties of these hybrid films at selected different growth stages below and above the percolation threshold.