O 64: Poster Wednesday: Plasmonics and Nanooptics

Time: Wednesday 17:45–20:00 Location: Poster B1

O 64.1 Wed 17:45 Poster B1

Photoemission electron microscopy using a 200 kHz high-order harmonic source — •Jan Vogelsang, Lukas Wittenbecher, Sara Mikaelsson, Chen Guo, Cord L Arnold, Anne L'Huillier, and Anders Mikkelsen — Department of Physics, Lund University, 221 00 Lund, Sweden

Ultrafast photoemission electron microscopy (PEEM) combines the high temporal resolution of short laser pulses with the high spatial resolution of electron microscopy. It elegantly circumvents the well-known problem of electron pulse dispersion by photoemitting and imaging electrons directly from a sample.

We developed an OPCPA laser system at 200 kHz repetition rate that drives the generation of high-order harmonics in an Ar gas jet. In combination with a spectral phase and amplitude pulse shaper, this system becomes a versatile tool to perform ultrafast PEEM experiments at a wide range of laser pulse energies and frequencies from the IR to the XUV.

We introduce the upgrade of the laser system driving high-order harmonic generation with a pulse energy of 10 to 15 uJ in the few-cycle regime. Additionally, first results of ultrafast PEEM experiments on both plasmonic and semiconductor nanostructures with varying dimensionality are shown.

O 64.2 Wed 17:45 Poster B1

Symmetry-induced coupling of plasmonic metasurfaces and WS_2 — •Florian Spreyer[1], Feng Shun[2], Yu Ting[2], and Thomas Zentgraf[1] — [1]Department of Physics, University of Paderborn, Warburger Straße 100, 33098 Paderborn, Germany — [2]Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore 637371, Singapore

Recent studies show great potential for transition metal dicholgenides (TMD) and their optical application. By downscaling TMD*s to a monolayer flake of atomical thickness, TMD*s become semiconductors with a direct band gap. These monolayer flakes can be used to fabricate hybrid metasurfaces combining plasmonic nanoantennas and a monolayer of TMD. Hybrid metasurfaces with TMD*s with a band gap in the visible regime show great potential for an enhanced light matter interaction for nonlinear applications. Here we, investigate the coupling between a metasurface made of plasmonic C3 gold nanoantennas and a monolayer of tungsten disulfide (WS_2). We present recent results of the characterization of WS_2 flakes transferred to different substrates. By using photoluminescence and nonlinear measurements, we locate monolayers of WS_2 and the orientation of the symmetry axis. On top of the WS_2, we fabricate the plasmonic nanoantennas with different orientations and study their influence on the nonlinear properties by SHG spectroscopy.

O 64.3 Wed 17:45 Poster B1

Electron-induced photon injection at single-mode glass fibres in transmission electron microscopy — •Vincent Hock, Christopher Rathje, Niklas Müller, Holger Koch, and Sascha Schäfer — University Oldenburg

Transmission electron microscopy (TEM) provides a versatile platform for the investigation of electron-light interaction at the nanoscale [1]. Utilizing femtosecond electron pulses and transient localized light fields, ultrafast TEM experiments have opened new avenues for the coherent optical control of free-electron wave packets [2-4]. Translating these developments to an optical control of continuous electron beams remains challenging. Here, we report on the current status of our investigations on high-energy electron beams interacting with guided modes in optical fibres. Utilizing a home-build TEM sample holder incorporating an on-axis tapered glass fibre, we demonstrate electron-induced light injection into the single-mode fibre with a spatially inhomogeneous injection efficiency. Photon count rates, light spectra and photon statistics are discussed considering different electron-light coupling mechanisms, including coherent transition radiation as well as cathodoluminescence processes.

[1] García de Abajo, Rev. Mod. Phys. 82, (2009)
[2] Barwick, Flannigan, Zewail, Nature 462, 902-906 (2009)
[3] Feist et al. Nature 521, 200-203 (2015)
[4] Priebe, Rathje et al., Nat. Photonics 11, 793-797 (2017)

O 64.4 Wed 17:45 Poster B1

Quantification of the chemical enhancement contribution to surface enhanced Raman scattering (SERS) — •Bonito Thielert[1,2], Bo Liu[1,2], Rainer Stosch[3], and Peter Lemmens[1,2] — [1]IPKM, TU-BS, Braunschweig, Germany — [2]LENA, TU-BS, Braunschweig, Germany — [3]Abt. 3.1, PTB, Braunschweig, Germany

In our aim to quantify chemical enhancement (CM) in SERS we study light-matter interactions of molecules on dedicated Au nanorod arrays. The latter are based on AAO substrates and allow tunable geometries and interaction parameters of the plasmonic array. Using Rhodamine 6G and Malachite Green we analyze the effect of light-induced degradation and mobility on the SERS intensity. Work supported by DFG-RTG 1952/2 "NanoMet" and Braunschweig-IGSM.

O 64.5 Wed 17:45 Poster B1

Excitation Pathways in Nonlinear Photoemission visualized through Photon-Plasmon Spin-Orbit Mixing — •Michael Hartelt[1], Grisha Spektor[2], Eva Prinz[1,3], Anna-Katharina Mahro[1], Deirdre Kilbane[1,4], Meir Orenstein[2], and Martin Aeschlimann[1] — [1]Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany — [2]Department of Electrical Engineering, Technion - Israel Institute of Technology, Haifa, Israel — [3]Graduate School for Excellence Materials Science in Mainz, Germany — [4]Telecommunications Software & Systems Group, Waterford Institute of Technology, Waterford, Ireland

Light carries spin angular momentum (SAM) in the form of its helicity, but it can also carry orbital angular momentum (OAM) in the form of vortex beams. This phenomenon was also shown for surface plasmon polaritons (SPP), where a phase vortex can be generated in 2D. We measured the interaction between light carrying axial SAM and plasmon vortices with high order transverse OAM.

The interaction is mediated via two-photon absorption on a gold surface, imprinting the resulting angular momentum mixing into matter by excitation of electrons that are photo-emitted into vacuum and detected by PEEM. We show that this interaction leads to both single and double photon-plasmon angular momentum mixing processes. The different mixing processes can be identified with specific quantum pathways of the electron excitation. In an interferometric pump-probe experiment, we isolate these pathways by frequency decomposition of the phase-resolved signal.

O 64.6 Wed 17:45 Poster B1

A compact optical-pump/THz-probe spectrometer based on sub-diffraction field confinement — •Michael Seidel and Georg Herink — Experimental Physics VIII, University of Bayreuth, Germany

Optical-pump/THz-probe spectroscopy presents a powerful scheme for contact-free detection of transient carrier mobilities and relaxation dynamics. In this contribution, we present a novel experimental approach to realize time-resolved time-domain THz spectroscopy (tr-THz-TDS) based on a compact mode-locked fiber laser, efficient frequency conversion and photoconductive detection. Specifically, this approach employs sub-diffraction confinement and optical mode-matching in order to enhance sample excitation and signal strength. The instrument is used to characterize transient carrier dynamics in organic electronic materials and devices.

O 64.7 Wed 17:45 Poster B1

Phase-resolved detection of strong terahertz nearfields — •Moritz Heindl and Georg Herink — Experimental Physics VIII, University of Bayreuth, Germany

Table-top schemes to generate ultrafast radiation in the terahertz spectral range enable access to strong sub-picosecond field transients at increasingly high repetition rates. This opens up novel schemes for ultrafast probing and control of quantum systems. Nanostructures, e.g., micro-antennas and micro-slits, can further enhance the electric fields by orders of magnitude. The exact knowledge of the absolute local field strengths is highly desirable and has been realized with electron nearfield streaking [1], electron microscopy [2] and electro-optical sampling [3]. Here, we present an all-optical widefield approach to de-

tect the absolute values of the THz electric fields on a subwavelength scale. This provides a defined platform to study THz field-driven dynamics in complex nanostructures.

[1] L. Wimmer et al., "Terahertz control of nanotip photoemission", Nature Physics 10, 432 (2014)
[2] A. Ryabov et al., "Electron microscopy of electromagnetic waveforms", Science 353, 374 (2016)
[3] F. Blanchard et al., "Improving time and space resolution in electro-optic sampling for near-field terahertz imaging", Opt. Lett. 41, 4645 (2016)

O 64.8 Wed 17:45 Poster B1

Influence of cesium adsorption on plasmoemission from gold surfaces — •Jan-Henrik Herrig[1,2], David Janoschka[1,2], Pascal Dreher[1,2], Michael Horn-von Hoegen[1,2], and Frank-J. Meyer zu Heringdorf[1,2] — [1]Faculty of Physics & CENIDE, Lotharstraße 1, 47048 Duisburg — [2]University of Duisburg-Essen, Duisburg, Germany

It is known that the superposition of a SPP-field and an incident light field leads to the non-linear emission of electrons. Recently, a photoemission electron microscopy (PEEM) experiment was used to show that the pump-probe contribution to the electron yield originates from the SPP's longitudinal component. Plasmoemisson, in which electrons are liberated from the metal surface by the SPP's electrical field alone, however, is dominated by the SPP's transverse component. To enable a second order emission process, the high work function of the used Au-surfaces is routinely decreased by the adsorption of sub-monolayer coverages of cesium. Until now, it was not known whether cesium adsorption changes which one of the field components dominates the plasmoemission yield. By careful analysis of the spatial modulation of the electron yield as function of cesium coverage in a plasmonic standing-wave experiment we can spatiotemporally separate the emission from different field components. Here we use light- and SPP-pulses to investigate whether there is a change in the spatial distribution of the electron yield induced by the cesium adsorption. We show evidence that sub-monolayer coverages of cesium do not have substantial influence on the character of the emission processes.

O 64.9 Wed 17:45 Poster B1

Ultrafast time-resolved photoemission electron microscopy of indium arsenide nanowires with variable crystal phase — •Lukas Wittenbecher[1,2], Jan Vogelsang[1], Sebastian Lehmann[1], Kimberly Dick Thelander[1], Donatas Zigmantas[2], and Anders Mikkelsen[1] — [1]Department of Physics, Lund University, Sweden — [2]Chemical Physics, Lund University, Sweden

The III-V nanowire (NW) technology platform has reached a level of advancement that allows atomic scale control as well as flexible device integration. In particular, controlled axial stacking of segments with Wurtzite (Wz) and Zinc blende (Zb) crystal phase is uniquely possible in the NWs. We have previously found that multiphoton electron excitations from indium arsenide (InAs) NWs with Wz and Zb segments can controllably varied across the crystal segments that also retain their electronic properties to the smallest possible scales. However, the effect of the crystal phase on the ultrafast dynamical behavior of photo-excited electrons in these NWs has so far not been explored.

In the present study we combine photoemission electron microscopy with ultrafast optical pump-probe techniques to investigate the photo-excitation dynamics in InAs NWs with alternating Wz and Zb segments with 50 nm spatial and 20 fs temporal resolution. We focus on the initial stages of the electron relaxation process, and we interpret the observed signals as signatures of the thermalization and cooling of photo-excited electrons. We find small differences in the observed dynamics between Wz and Zb segments phase depending on the excitation conditions.

O 64.10 Wed 17:45 Poster B1

Revealing the magneto-plasmonic enhancement in Bi:YIG/Au hybrid nanostructures — Spyridon Pappas and •Evangelos Papaioannou — Department of Physics, TU Kaiserslautern

Magnetoplasmonics allows to explore the influence of the strong localization of light, enabled by resonant plasmonic structures, on the response of magneto-optically active adjacent materials. In this work, we demonstrate experimentally the anomalous enhancement of the longitudinal magneto-optic Kerr effect of bismuth substituted yttrium iron garnet films, induced by localized surface plasmons in embedded gold nanoparticles. Additionally, we reveal the underlying mesoscopic nanoscopic near-field mechanism. In order to gain insight into the exact origin of the anomalous magneto-optic response of the hybrid metastructure, we performed far-field simulations, as well as near-field analysis. The far-field simulations reproduce very well the features of the magneto-optic response in the spectral vicinity of the relevant plasmonic resonances. The near-field studies reveal an enhancement of the purely magneto-optically induced field at a spectral position, which correlates with the lateral dimensions of the nanoparticles, and is different from the spectral position of the main plasmon resonance. The exact correlation of the origin of the plasmon-induced effects on the properties of the adjacent magneto-optic materials, as well as the near-field mapping of the enhanced polarization conversion efficiency, can have a high impact on the engineering of hybrid magneto-plasmonic metastructures.