O 69: Plasmonics and Nanooptics VI: Light-Matter Interactions and Characterisation

Time: Wednesday 10:30–12:30 Location: TRE Ma

O 69.1 Wed 10:30 TRE Ma

Remote excitation and detection of surface-enhanced Raman scattering from graphene — •Nicolas Coca Lopez, Nina Gordon, Tobia Mancabelli, Nicolai Hartmann, and Achim Hartschuh — Department of Chemistry and Center for Nanoscience, Ludwig-Maximilian-University Munich

In this contribution, we show the remote excitation and detection of surface enhanced Raman scattering (SERS) from graphene. Surface plasmon polaritons (SPPs) were launched by focused laser illumination at the termination of a metallic nanowire (NW) which served as a plasmonic waveguide. An SPP excited by the laser travels to the other end of the waveguide that is placed on top of single layer graphene, resulting in the remote excitation of Raman scattering. In the reversed direction, locally excited Raman scattering from graphene is coupled to an SPP traveling along the NW and scattering out at its end. By projecting the sample scattered light onto a CCD camera mounted on a spectrometer we quantified the SPP contributions at different wavelengths in combination with polarization dependent measurements.

O 69.2 Wed 10:45 TRE Ma

Helicity Sorting of Photons: A Spin Optical Device — •Enno Krauss[1], Gary Razinskas[1], Dominik Koeck[1], Swen Grossmann[1], and Bert Hecht[1,2] — [1]NanoOptics & Biophotonics Group, Experimentelle Physik 5, Physikalisches Institut, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]Röntgen Research Center for Complex Material Systems (RCCM), Am Hubland, 97074 Würzburg, Germany

Spin optics adds an additional degree of freedom and therefore promises new functionalities in optical nanocircuits in analogy to spintronics. Here we study experimentally and theoretically spin-optical devices, so-called photon helicity sorters, based on "birefractive" propagation in a plasmonic two-wire transmission line. We study the mechanism that leads to spin-orbit coupling in these devices including the role of a geometrical phase.

O 69.3 Wed 11:00 TRE Ma

Optical properties of hybrid chiral plasmonic systems — •Martin Schäferling, Maxim L. Nesterov, Xinghui Yin, Harald Giessen, and Thomas Weiss — 4th Physics Institute and Research Center SCoPE, University of Stuttgart, Germany

Chiroptical spectroscopy is a vital technique in the life sciences. The combination of chiral media with plasmonic nanostructures offers a possibility to enhance the tiny chiroptical responses. Theoretical studies of such hybrid systems are necessary to understand the occurring interactions. A well-established method to investigate the potential interaction strength between plasmonic nanostructures and a chiral molecule is the analysis of chiral near-fields [1]. This method works for the presence of a few molecules in the limit of weak coupling. However, in systems where a sizeable amount of a chiral medium is present, additional effects beyond the capabilities of this model can occur.

In this contribution, we analyze the full hybrid system combining plasmonic nanostructures with chiral media. In one approach, we use numerical full-wave simulations where we introduced an effective chiral medium via its constitutive equations. Our results reveal the importance of coplanarity of the incident field with the generated near-field in addition to strong field enhancement [2]. Additionally, we show first results of a semi-analytical approach using perturbation theory [3] to analyze the influence of a chiral medium on plasmonic resonances.

[1] M. Schäferling et al., Phys. Rev. X **2**, 031010 (2012).

[2] M. L. Nesterov et al., ACS Photonics **3**, 578 (2016).

[3] T. Weiss et al., Phys. Rev. Lett **116**, 237401 (2016).

O 69.4 Wed 11:15 TRE Ma

Colloid-defined Scattering Interfaces with Tailored Disorder for PV Applications — Peter Michael Piechulla[1], •Lutz Mühlenbein[1], Alexander Sprafke[1], Ralf B. Wehrspohn[1], Stefan Nanz[2], Aimi Abass[2], and Carsten Rockstuhl[2] — [1]FG Mikrostrukturbasiertes Materialdesign, MLU Halle-Wittenberg — [2]Institut für Theoretische Festkörperphysik, KIT, Karlruhe

Optical interfaces with tailored scattering properties are of interest for numerous applications, such as light management in photonic devices. In particular, thin film solar cell absorber materials exhibit long absorption lengths in the long wavelength range compared to the absorber thickness, which makes effective light trapping structures indispensable. Numerical studies reveal that interfaces with a certain degree of disorder outperform strictly periodic structures due to their improved broadband response. However, the proposed design in these studies are mostly either hypothetical in nature or rely on expensive top down fabrication methods. In our approach, we deposite a monolayer of colloidal particles onto a substrate using self-organization effects. Colloidal size distribution and manipulation of interaction potentials between particles and substrate provide effective levers to obtain desired surface profiles. The structure is then stabilized by conformal coating using atomic layer deposition and can be used as back side structure for solar cells. In this contribution, we will identify relevant fabrication parameters of these structures and present experimental data for their scattering properties. The presented experimental work is motivated by optical simulations that are specific to colloidal structures.

O 69.5 Wed 11:30 TRE Ma

Characterization of thin-load polymethyl-methacrylate plasmonic waveguides using PEEM — •Malte Grossmann[1], Martin Thomaschewski[1], Alwin Klick[1], Elzbieta Sobolewska[2], Arkadiusz Jaroslaw Goszczak[2], Till Leissner[2], Jacek Fiutowski[2], Horst-Günter Rubahn[2], and Michael Bauer[1] — [1]Institute of Experimental and Applied Physics, University of Kiel, Leibnizstraße 19, D-24118 Kiel, Germany — [2]Mads-Clausen-Institute, NanoSYD, University of Southern Denmark, Alsion 2, DK-6400 Sønderborg, Denmark

Surface plasmon-polaritons (SPPs) are promising candidates for future signal transport applications due to their capability of bypassing the diffraction limit of light. However, for applications such as on-chip communications SPPs have to be confined laterally. This can be achieved using plasmonic waveguides. Here we present work on dielectric-loaded SPP waveguides (DLSPPW) using a thin load (30 to 50 nm) of polymethyl-methacrylate (PMMA).

PMMA DLSPPW of variable width are fabricated on gold substrates using electron-beam lithography. We investigate the waveguides using photoemission electron microscopy supported by a wavelength-tunable near-infrared laser. The dispersive characteristics of the waveguides are compared to finite-element-method calculations. We are able to determine waveguide mode effective index with quantitative agreement and mode confinement with qualitative agreement to expectations set by the finite-element-method calculations for both singlemode and multimode waveguiding.

O 69.6 Wed 11:45 TRE Ma

Design and fabrication of metasurfaces with high polarization sensitivity on top of crystalline gold plates — •Manuel Gonçalves[1], Vaishnavi Rao[1], Gregor Neusser[2], Christine Kranz[2], Boris Mizaikoff[2], and Othmar Marti[1] — [1]Institute of Experimental Physics, Ulm University, Albert-Einstein-Allee 11, 89081 Ulm, Germany — [2]Institute of Analytical and Bioanalytical Chemistry, Ulm University, Albert-Einstein-Allee 11, 89081 Ulm, Germany

Metasurfaces emerged in the last 10 years as one of the most successful realizations of plasmonic metamaterials. The two-dimensional geometrical arrangement of sub-wavelength plasmonic and dielectric nanostructures permits to use metasurfaces in a variety of ways: transformation of the polarization of light beams, beam focusing, holography, generation of structural colors. The units constituting plasmonic metasurfaces are tailored based on the plasmonic properties of single, or coupled particles. Among the several lithography techniques used for fabrication, focused ion-beam (FIB) is best indicated for milling crystalline films and particles, due to the accuracy achieved.

We have investigated the optical properties of grooves milled in crystalline gold plates and have designed a metasurface to be used in reflection using several groove elements. Due to the large sensitivity of the plasmonic absorption on the polarization of the light irradiating the grooves, the metasurface can be used as a polarization sensitive optical filter for specific bands in the visible and NIR spectrum.

O 69.7 Wed 12:00 TRE Ma

Imaging with SNOM and EELS in plasmonics — •Vlastimil Křápek[1,2], Petr Dvořák[1,2], Ai Leen Koh[3], Zoltán Édes[1,2], Michal Horák[1,2], Michal Kvapil[1,2], Lukáš Břínek[1,2], Tomáš

Šamořil[1,2], Martin Hrtoň[1,2], and Tomáš Šikola[1,2] — [1]Central European Institute of Technology, Brno University of Technology, Purkyňova 123, CZ-612 00 Brno, Czech Republic — [2]Institute of Physical Engineering, Brno University of Technology, Technická 2, CZ-616 69 Brno, Czech Republic — [3]Stanford Nano Shared Facilities, Stanford University, Stanford, California 94305, USA

Scanning near-field optical microscopy (SNOM) is a powerful tool for imaging and analysis of surface plasmon polaritons (SPPs) [1]. However, the correct interpretation of SNOM images requires profound understanding of principles behind their formation. To study fundamental principles of SNOM imaging in detail, we performed spectroscopic measurements of plasmon interference patterns by an aperture-type SNOM setup equipped with a supercontinuum laser and a polarizer. The series of wavelength- and polarization-resolved measurements, together with results of numerical simulations, then allowed us to identify the role of individual near-field components in formation of SNOM images.

Electron energy loss spectroscopy (EELS) is a technique for imaging of localized plasmon resonances with unprecedented spatial resolution. We present our EELS imaging of gold plasmonic particles suitable for the enhancement of optical processes [2].

[1] P. Dvořák *et al.*, Nano Lett **13**, 2558 (2013).
[2] V. Křápek *et al.*, Opt. Express **23**, 11855 (2015).

O 69.8 Wed 12:15 TRE Ma

Multimodal Tip-Enhanced Microscopy — Kai Braun, •Otto Hauler, Dai Zhang, and Alfred J. Meixner — Institut für Physikalische und Theoretische Chemie, Auf der Morgenstelle 18, 72076 Tübingen

Electromagnetic coupling between plasmonic resonances of two closely spaced metal particles can lead to a strongly enhanced optical near field in the gap between. It is the leading amplification mechanism for surface- and tip-enhanced Raman scattering (SERS/TERS) or enhanced molecular luminescence and has widespread applications in nanoplasmonics. Collecting correlated signals of photoluminescence (PL) and Raman as well as topography, tip-enhanced hyperspectral imaging is able to provide a thorough map of the chemical and morphology-related optical properties in multi-component material systems. Introducing new microscope functions offer us insights into various aspects, such as morphology related photophysical and photochemical processes. Despite its attractive capabilities, developing a tip-enhanced near-field microscope providing reliable and reproducible performance is demanding. In the last years great efforts have been made in our lab to develop stable, reproducible and reliable near-field optical microscopes, which largely meet the above requirements. They successfully demonstrated their capability in high-resolution optical imaging and spectral mapping, or using the tip as local probe for enhanced coupled fields. Furthermore we demonstrate the direct manipulation and measurement of surface properties via electrical charging or injection of charge carriers