O 27: Plasmonics and nanooptics: Light-matter interaction, spectroscopy – Poster

Time: Monday 18:00–20:00 Location: P2

O 27.1 Mon 18:00 P2

Charge reservoir as a design concept for plasmonic antennas — •Rostislav Řepa, Michal Horák, Tomáš Šikola, and Vlastimil Křápek — Brno University of Technology, Brno, Czechia

Plasmonic antennas exploit localized surface plasmons to shape, confine, and enhance electromagnetic fields with subwavelength resolution. The field enhancement is contributed to by various effects, such as the inherent surface localization of plasmons or the plasmonic lightning-rod effect [1]. Inspired by nanofocusing observed for propagating plasmons [2], we test the hypothesis that plasmonic antennas with a large crosssection represent a large charge reservoir, enabling large induced charge and field enhancement. Our study reveals that a large charge reservoir is accompanied by large radiative losses, which are the dominant factor, resulting in a low field enhancement.

[1] Křápek et al., arXiv:2407.09454.
[2] Babadjanyan et al., J. Appl. Phys. **87**, 3785-3788 (2000).

O 27.2 Mon 18:00 P2

Distinct Multiphoton Orders in Photoelectron Spectra of Individual Silver Nanoparticles — Waqas Pervez[1], •Frithjof Harmsen[1], Kevin Oldenburg[2], Moha Naeimi[1], Sylvia Speller[1], and Ingo Barke[1] — [1]Institute of Physics, University of Rostock, Germany — [2]Department of Life, Light & Matter, University of Rostock, Germany

We investigate how the multiphoton photoemission process of individual metal clusters deposited on a non-metallic substrate is affected by the particle shape and its local environment. Here we present photoelectron spectra acquired by time-of-flight spectroscopy using a photoemission electron microscope (PEEM). Size-selected particles produced in a magnetron cluster source are deposited in-situ onto silicon substrates. The cluster source can produce single particles as well as agglomerates with characteristic plasmon modes [1], as revealed by transmission electron microscopy (TEM). Photoelectron spectra are obtained using illumination by a femtosecond laser at wavelengths around 800 nm, where at least 3 photons are required to overcome the work function. In addition, we observe well-separated above-threshold processes (ATP / ATI) of 4th order and up to 7th order for agglomerates. No noticeable resonances are observed across the spectral range, in contrast to illumination around 400 nm [2], i.e., at the plasmon energy. Mechanisms are discussed in view of symmetry properties and dipole selection rules.

[1] K. Oldenburg et al., Phys. Rev. Research 7, 023267 (2025)
[2] K. Oldenburg et al., J. Phys. Chem. C 123, 1379 (2019)

O 27.3 Mon 18:00 P2

Plasma-assisted defect modification in hBN studied with cathodoluminescence spectroscopy — •Bharti Garg, Masoud Taleb, and Nahid Talebi — Institute of Experimental and Applied Physics, Kiel University, Germany

In this work, we study exfoliated hexagonal boron nitride (hBN) flakes treated with argon plasma for different durations and compare their optical response using cathodoluminescence (CL) spectroscopy. Emission spectra collected before and after plasma exposure allow us to isolate the effects of the treatment. hBN is known for defect-dependent optical emission, and plasma processing is a commonly used method to introduce or modify the density and the atomic structure of defects. We observe that longer plasma exposure leads to stronger defect-related emission and broader CL features, indicating an increase in defect density. The emission though occurs at the same wavelength before and after the plasma treatment, allowing us to conclude that the atomic structure of the defects remains similar even after the plasma interaction with the surface of hBN. These results clarify the influence of plasma treatment on defect formation in hBN and highlight the role of exposure time in tuning its optical properties.

O 27.4 Mon 18:00 P2

Tunable Stokes-shifted photoluminescence and defect emission from hBN excited with a supercontinuum laser — •Prabhdeep Singh, Bharti Garg, Maximilian Black, Masoud Taleb, and Nahid Talebi — Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany

We investigate the photoluminescence (PL) of hexagonal boron nitride (hBN) flakes placed on holey carbon grids under tunable supercontinuum excitation from 460 to 650 nm. The spectra consistently show a fixed defect emission around 537 nm together with a stokes-shifted peak that moves linearly with the excitation wavelength. The excitation emission energy differences cluster around 0.17 eV and 0.20 eV, matching the in-plane E_1u and E_2g phonon modes of hBN. Cathodoluminescence measurements on the same flakes exhibit only the defect line, along with phonon sidebands. On a gold substrate, we additionally observe a weak third moving peak at the sum of the two phonon energies, arising from surface enhanced Raman spectroscopy scattering (SERS). Spatial PL maps, intensity variations, and measurements with different optical density filters further allow us to evaluate the local emission characteristics and estimate the down-conversion efficiency. The results provide a consistent picture of phonon-mediated optical processes in hBN. Using tunable supercontinuum excitation, we reveal phonon-assisted stokes emission in hBN and a SERS phonon-combination peak on gold an excitation scheme not previously explored for Raman-type processes in this material.

O 27.5 Mon 18:00 P2

Energy and momentum distribution of surface plasmon-induced hot carriers — •Ellen Brennfleck[1], Christopher Weiss[1], Jannis Lessmeister[1], Laurenz Rettig[1], Tobias Eul[2], and Martin Aeschlimann[1] — [1]Department of Physics and Research Center OPTIMAS, RPTU University Kaiserslautern-Landau, Germany — [2]Institute of Physics, University of Augsburg, Germany

Are the spectroscopic properties of plasmon- and photon-induced carriers fundamentally different? This question is crucial for advancing plasmonic energy conversion. Initial studies have suggested characteristic energy and momentum distributions for the photoemission of both bulk plasmon resonances and surface plasmons. For surface plasmons, however, the separation of plasmon and photon-induced emission patterns by their inherent spatial and temporal dynamics remains challenging [1].

To further characterize the electron emission pattern of surface plasmons, we combine a femtosecond laser system with a spatial light modulator to generate a vector vortex beam to excite surface plasmon polaritons at an annular structure. Our photoemission electron microscope enables us to compare the spectroscopic properties of photoemitted electrons and those generated by plasmonic emission at the center of the structure, providing valuable insights into the distinct emission mechanisms.

[1] Hartelt et al., ACS Nano 15, 12 (2021), 19559–19569

O 27.6 Mon 18:00 P2

Hot electron generation in tapered plasmonic waveguides — •Ferdinand Bauer, Valentin Dichtl, Marcell Schalling, Thorsten Schumacher, and Markus Lippitz — University of Bayreuth, Germany

The efficient generation of hot electrons is important for applications such as photochemical catalysis. Hot electron-hole pairs are created by Landau damping of surface plasmon polariton (SPP) and decay through electron-electron scattering.

A symmetric taper in a waveguide enhances the generation of hot electrons. At one end the waveguide is excited by a laser pulse. The emission at the other end is then used as a metric for the transmission and thus the creation of hot electrons.

Numerical simulations (COMSOL) are used to find a high energy density at the hot spot. Within the simulations, Beer's law holds for a broad range of taper lengths and can be used to make geometry optimisation more efficient.

We demonstrate how to maximize energy density in the waveguide hot spot by using numerical simulations and experimental data, thereby optimising the production of hot electrons.

O 27.7 Mon 18:00 P2

Optical Response of Noble Metals based on Metal Boltzmann-Bloch Equations — •Robert Lemke, Andreas Knorr, and Jonas Grumm — Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Berlin, Germany

The optical response of plasmonic noble metals can be attributed to the interplay of electronic intra- and interband processes. These processes are addressed by coupled metal Boltzmann-Bloch equations derived from microscopic many-body theory. The specific properties of noble metals are caused by an anisotropic band structure in the vicinities of the X and L high symmetry points.

In order to analyse the line broadening of intra- and interband excitations we consider linearised electron-phonon and electron-electron scattering. Our approach allows to connect spectroscopic signatures directly to microscopic processes, not possible with phenomenological Drude-Lorentz models.