O 56: Plasmonics and nanooptics: Light-matter interaction, spectroscopy IV

Time: Wednesday 10:30–11:45 Location: MA 041

O 56.1 Wed 10:30 MA 041

Coupling of IR140 dye molecules to a plasmonic two-wire waveguide — •Christian Schörner, Subhasis Adhikari, and Markus Lippitz — University of Bayreuth, Germany

Plasmonic waveguides offer the possibility to guide light with a subwavelength confinement. For thin metal wires it is well established that they support a single fundamental waveguide mode, called TM0 mode. A combination of two such metal wires with a nanoscale gap in between results in two hybridized modes with a symmetric or antisymmetric surface charge distribution. Recent studies have been able to selectively excite these modes and detect them in the far field be means of a mode detector. Here we investigate the coupling of a near-infrared laser dye, IR140, embedded in a photoresist to such multimode plasmonic two-wire transmission lines by spatially resolved photoluminescence spectroscopy. We show that the photoluminescence of the dye molecules acts as a local source that couples simultaneously to the symmetric and antisymmetric plasmonic waveguide mode. Propagation lengths and position dependent incoupling profiles are obtained by spatially resolved excitation. We further investigate the polarization dependency of the outcoupled emission.

O 56.2 Wed 10:45 MA 041

Second harmonic generation in fully symmetric gold nanostructures — •Julian Obermeier[1], Tzu-Yu Chen[2,3], Fan-Chen Lin[4], Jer-Shing Huang[5], Chen-Bin Huang[2,3], and Markus Lippitz[1] — [1]Experimental Physics III, University of Bayreuth — [2]Institute of Photonics Technologies, National Tsing Hua University — [3]International Intercollegiate PhD Program, National Tsing Hua University — [4]Department of Chemistry, National Tsing Hua University — [5]Leibniz Institute of Photonic Technology

Higher harmonics generation in single plasmonic nanostructures is widely observed. While the third harmonic can always be generated, second harmonic generation underlies special symmetry restrictions. For common plasmonic materials as gold and silver the centosymmetric crystal structure forbids second harmonic generation in the electric dipole approximation for bulk material. Inversion symmetry can be broken by the shape of the nanostructure itself, i.e., L or V shapes. Until now this is the only known way to generate strong second harmonic signal from symmetric materials. We demonstrate an entirely new way to break the overall symmetry in structural and material fully symmetric nanostructures. The key idea is to offer an optical mode of broken symmetry in which the symmetric structure can emit. We will illustrate this effect and demonstrate experimental as well as numerical realizations.

O 56.3 Wed 11:00 MA 041

Plasmon enhanced nano-chemistry with gold nanostars — •Christian Mühlbauer[1], Wolf Knöller[1], Christioph Maier[1], Lakshmi Polavarapu[1], Theo Lohmüller[1], Jochen Feldmann[1], and Ana Huergo[2] — [1]LMU, München, Deutschland — [2]Instituto de Investigaciones Fisicoquímicas Teóricas y Aplicadas (INIFTA), La Plata, Argentina

Plasmonic gold nanostars with radially distributed spikes display strong field enhancement at the sharptips upon excitation with light [1]. Non-radiative decay of the highly localized surface plasmons in thetip region can lead to the generation of hot-electrons that can transfer to, for example, nearbymolecules or semiconductor particles.

Here, we report on the use of gold nanostars for controlling hot-carrier induced nano-chemicalreactions. Bare gold nanostars with a core size of approximately 30 nm are synthesized in a surfactant-free approach. The stars are covered with a self-assembled monolayer of molecules that undergo areduction by electron uptake upon plasmon excitation. The efficiency and localization of this hot-carrier driven reaction is monitored and characterized by Surface Enhanced Raman Scattering (SERS).

[1] Hrelescu, T.K. Sau, A.L. Rogach, F. Jäckel, J. Feldmann; Appl. Phys. Lett. 94 (15), 153113 (2009)

O 56.4 Wed 11:15 MA 041

Two-dimensional properties of thin single-crystalline gold films — Swen Grossmann[1], •Daniel Friedrich[1], Michael Karolak[2], René Kullock[1], Enno Krauss[1], Monika Emmerling[1], Giorgio Sangiovanni[2], and Bert Hecht[1] — [1]NanoOptics & Biophotonics Group, Experimental Physics 5, University of Würzburg, Germany — [2]Theoretical Physics 1, University of Würzburg, Germany

Gold nanostructures such as nanowires can strongly enhance and confine optical fields while also providing excellent electronic contacts to functional elements.[1] Films of single-crystaline gold ensure well-defined experimental conditions for precision metrology and sensing.[2] In all these cases the electronic properties of gold either affect the functionality or the interpretation of experimental findings.

Here, we report notable changes in the electronic structure of gold occurring already for film thicknesses of 30nm by studying atomically flat 2D single-crystal gold platelets of variable thickness. When the gold thickness reduces below 30nm deviations from bulk electronic properties reveal themselves in a 100-fold increase of the nonlinear two-photon photoluminescence signal. Our findings are supported by density functional theory calculations and also allow us to optically resolve single-unit-cell steps.

[1] J. Kern et al., Nat Photon 9, 9 (2015)
[2] J.-S. Huang et al., Nat Comm 1, 150 (2010)

O 56.5 Wed 11:30 MA 041

Limits of Babinet principle for plasmonic antennas — •Vlastimil Křápek[1], Michal Horák[1], Martin Hrtoň[1], Andrea Konečná[2], Filip Ligmajer[1], Michael Stöger-Pollach[3], and Tomáš Šikola[2] — [1]CEITEC, Brno University of Technology, Purkyňova 123, CZ-61200 Brno, Czech Republic — [2]CIC nanoGUNE, Tolosa Hiribidea 76, E-20018 Donostia – San Sebastián, Spain — [3]USTEM, TU Vienna, Wiedner Hauptstr. 8-10, A-1040 Wien, Austria

Babinet principle relates the properties of a planar plasmonic antenna (particle) and a complemetary aperture in a thin metal film of the same size and shape. In particular, the energies of localized surface plasmon (LSP) resonances in both antennas shall be identical and the corresponding near fields shall be complementary with the electric-field distribution of the solid antenna corresponding to the magnetic-field distribution of the complementary aperture.

We investigate the limits of the Babinet principle for gold plasmonic antennas (discs and disc-shaped apertures) using electron energy loss spectroscopy, cathodoluminescence, and theoretical modeling. We show that Babinet priciple qualitatively holds but quantitative differences are found. The energies of LSP resonances in apertures are red-shifted and the near fields are less localized. Plasmonic breathing mode is observed only for particles. Observed response of apertures is stronger than that of particles, which is attributed to better heat drain and sharper edges of apertures. Finally, we discuss the possibility to employ Babinet principle for a design of electric and magnetic hot spots.