DS 57: Plasmonics and Nanophotonics O-VII (jointly with HL and O)

Time: Thursday 15:00–16:15 Location: WIL A317

DS 57.1 Thu 15:00 WIL A317

Optical and electronic properties of Ag clusters on SiO_2 — •Sabrina Hoffmann[1], Kamil Latussek[1], Stefanie Duffe[1], Christian Sternemann[1], Ralph Wagner[2], and Heinz Hövel[1] — [1]TU Dortmund, Experimentelle Physik I, Otto-Hahn-Str. 4, 44221 Dortmund, Germany — [2]BU Wuppertal, Fachbereich C - Fachgruppe Physik - Materialwissenschaften, Gaußstraße 20, 42097 Wuppertal, Germany

Clusters assembled materials are of great impact for future applications in science and nanotechnology. In particular, advances in metal cluster-beam technology allow experiments on free and supported or embedded clusters resembling nanostructures in realistic, technical relevant environments. Optical properties of noble metal clusters and nanostructures such as their UV-VIS absorption band alter significantly with size, shape and interparticle spacing as well as with the properties of the local environment. The plasmon resonance of Ag clusters on SiO_2 before and after exposure to air is examined using optical spectroscopy [1]. Then the same clusters are examined with XANES at the Ag L_3 edge. With this method changes in the uDOS of clusters can be investigated which occur either due to the cluster size or a change in their chemical environment. After exposing the Ag clusters to H_2S the plasmon resonance disappears and the XANES spectra show that the clusters are transformed to silver sulfide.

[1] U. Kreibig et al., Optical Investigations of Surfaces and Interfaces of Metal Clusters, In: Advances in Metal and Semiconductor Clusters Vol. 4, (ed. M.A. Duncan), JAI press Inc., 345 (1998).

DS 57.2 Thu 15:15 WIL A317

Quantifying Chirality in 2D and 3D Metallic Metamaterials — •Martin Schäferling, Daniel Drégely, Thomas Weiss, and Harald Giessen — 4th Physics Institute and Research Center SCoPE, University of Stuttgart, Germany

Chirality on the nanoscale is an emerging field for metamaterials. Circular dichroism in metallic spirals can exceed the best liquid crystals or helical molecules by many orders of magnitude. Broadband quarter-wave plates can be assembled by 3D spirals that are fabricated by direct laser writing [1]. Bichiral metallic photonic crystals exhibit phases and optical properties that are unattainable in nature [2,3].

In this contribution, we investigate numerically various planar and three-dimensional metallic metamaterials with respect to their degrees of circular dichroism and optical chirality. The latter is a measure for the local chirality of electromagnetic fields [4]. Chiral metamaterials can lead to local superchiral fields, which exhibit extremely high optical chirality. We discuss the structural, spectral and spatial dependence of these values. This provides a comparison of the chiroptical properties of different practical geometries.

[1] J. K. Gansel et al., Science **325**, 1513 (2009).
[2] M. Thiel et al., Adv. Mat. **21**, 4680 (2009).
[3] A. Radke, P. V. Braun, and H. Giessen, to be published.
[4] Y. Tang and A. E. Cohen, Phys. Rev. Lett. **104**, 163901 (2010).

DS 57.3 Thu 15:30 WIL A317

Weak localization of light in ZnO nanorods in space and time — •Manfred Mascheck[1], Slawa Schmidt[1], Martin Silies[1], David Leipold[2], Erich Runge[2], Takashi Yatsui[3], Kokoro Kitamura[3], Motoichi Ohtsu[3], and Christoph Lienau[1] — [1]Carl von Ossietzky Universität Oldenburg — [2]Technische Universität Ilmenau — [3]University of Tokyo

An array of ZnO nanorods is used to directly visualize the weak localization of light in both space and time. Ultrashort laser pulses from a Ti:Sapphire oscillator with a pulse duration of 6 fs are focused to their diffraction-limit of 1 μm^2 onto the ZnO nanorod array using an all-reflective Cassegrain objective. The generated SH emission is collected in reflection geometry and detected as a function of the lateral position of the laser focus. Pronounced intensity fluctuations on a sub-μm scale due to the multiple random scattering inside the nanoneedle array are taken as the spatial hallmark of weak the localization of light. By varying the delay between the phase-stabilized pair of laser pulses from a dispersion-balanced Michelson interferometer, interferometric frequency-resolved autocorrelation (IFRAC) traces are measured. By analyzing these traces in the frequency domain, the dephasing time and therewith the temporal evolution of the electric field within the ZnO array could be deduced.

DS 57.4 Thu 15:45 WIL A317

Octave-wide Photonic Band Gap in Three-Dimensional Plasmonic Bragg Structures — •Richard Taubert and Harald Giessen — University of Stuttgart, 4th Physics Institute and Research Center SCoPE, Pfaffenwaldring 57, 70550 Stuttgart

We investigate radiative coupling of particle plasmons in various three-dimensional, stacked geometries of plasmonic oscillators. The arrays of gold nanowires with fixed dimensions and lateral periodicity are stacked on top of each other, separated by a dielectric spacer layer. The vertical distance as well as the number of layers is varied.

The dependence of the optical spectra on spacing distance is investigated in a system consisting of two layers. We show that the coupled system exhibits a superradiant mode when the vertical distance of the oscillators matches half their emission wavelength. This means that the Bragg criterion for the particle plasmonic resonance wavelength is fulfilled.

Upon increase of the number of radiatively coupled oscillators, the spectral width of the superradiant mode increases alongside with a change of the spectral shape from Lorentzian to stop-gap like. Eventually the superradiant mode evolves into a very broad photonic band gap which spans almost over one octave.

By changing the dimensions of the gold nanowires, keeping their aspect ratio constant, the oscillator strength is modified, and therefore the radiative damping rate can be tuned. This allows for a convenient tailoring of very broad photonic band gaps.

DS 57.5 Thu 16:00 WIL A317

Palladium-based perfect plasmonic absorber in the visible and its application to hydrogen sensing — •Andreas Tittl[1], Patrick Mai[1], Richard Taubert[1], Thomas Weiss[1], Na Liu[2], and Harald Giessen[1] — [1]4th Physics Institute and Research Center SCoPE, University of Stuttgart, 70569 Stuttgart, Germany — [2]Department of Chemistry, University of California, Berkeley, and Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California, 94720, USA

We report on the first experimental realization of a palladium-based perfect plasmonic absorber at visible wavelengths and its application to hydrogen sensing.

Our design utilizes palladium wires on top of a MgF_2 spacer layer on a 200 nm thick gold mirror and exhibits an absorbance $> 99\%$ at the given design wavelength in the red part of the visible spectrum.

Exposure to hydrogen causes a change in the complex refractive index of palladium, resulting in reduced absorption and hence enhanced reflection at the interrogation wavelength[1]. Our sensor has a very fast reaction time of less than 1 second, a recovery time of about 10 seconds, and a lower detection limit of less than 0.5% hydrogen in air.

This pronounced response and background-free operation should enable extremely sensitive optical gas detection schemes down to the ppm range in the future.

[1] N. Liu, et al., Nano Lett. **10**, 2342 (2010)