O 21: Poster Monday: Plasmonics and Nanooptics

Time: Monday 17:45–20:00 Location: Poster F

O 21.1 Mon 17:45 Poster F

Comparing resonance tuning of infrared rod and slit antennas enabled by phase-change materials — •Lukas Voelkel, Achim Strauch, Andreas F. Hessler, Matthias Wuttig, and Thomas Taubner — Institute of Physics (IA) RWTH Aachen

Phase-change materials (PCMs) have been shown to be a useful tool to provide metasurfaces with an active functionality. Since they generally have large optical contrasts between their metastable amorphous and crystalline phases, a change in the phase of a thin film of PCM greatly influences the optical response of a metasurface [1]. This phase-change can be controlled very locally around individual nanostructures with a focussed pulsed laser by either using long, low-energy or short, high-energy pulses for crystallization or amorphization, respectively [2].
In our work, we investigate the switching of nanostructures with PCM $Ge_3Sb_2Te_6$. Because rod and slit antennas response to excitation with completely different near-field distributions, we compare their switching behavior and further demonstrate continuous tuning of the resonance frequency of the nanostructures.
A complete understanding of the switching process of the PCM is the basis for an efficient design of versatile metasurfaces suitable for nanophotonic applications.

[1] M. Wuttig et al., Nat. Photon. 11, 465 (2017)
[2] P. Li et al., Nat. Mater. 15, 870 (2016)

O 21.2 Mon 17:45 Poster F

Coupling of Quantum Dots to Plasmonic Slot Waveguides — •Lok-Yee Yan, Mike Prämassing, and Stefan Linden — Physikalisches Institut, University of Bonn, Nußallee 12, D-53115 Bonn, Germany

Quantum emitters coupled to plasmonic systems are considered as promising candidates for building blocks in quantum plasmonic circuits. So far, several plasmonic platforms such as silver nanowires and gold V-grooves have been exploited. These concepts rely on the tight electric field confinement, hence an enhanced coupling of quantum emitters to the mode, and the guided radiation in the form of plasmon modes. We report on the fabrication of a hybrid system consisting of colloidal CdSeTe-quantum dots (QDs) and a 100 nm wide slot waveguide milled into a thermally evaporated 50 nm thick gold film. We use standard electron beam lithography in combination with an alignment process to deposit the QDs into the slot. The colloidal QDs are provided with carboxyl surface groups which enable chemical bonding to the sample surface. The QDs can launch guided surface plasmons in the slot which induce scattered photons at the end of the slot. Moreover, QDs deposited in the slot region experience an increase of the local photonic density of states which leads to a lifetime reduction of excited states. We demonstrate the coupling of QDs to the slot mode by imaging the fluorescence of the QDs onto an EMCCD camera and showing a reduction of lifetime.

O 21.3 Mon 17:45 Poster F

Optical ratchet based on plasmonic waveguide arrays — •Zlata Cherpakova and Stefan Linden — Physikalisches Institut, Universität Bonn, Nußallee 12, 53115 Bonn, Germany

A ratchet is a spatially periodic system in which the directional transport of particles is achieved without a bias force. Based on the quantum-optical analogy, we propose a new design of a plasmonic ratchet and demonstrate directional transport of surface plasmon polaritons (SPPs). Our design resembles the time-dependent version of the Rice-Miele model: the couplings (i.e. the distances) between the adjacent waveguides and effective refractive indices (i.e. heights) are changing periodically. The plasmonic structures are fabricated by making use of negative-tone gray-scale electron beam lithography. SPPs are excited by shining a highly focused laser beam on the grating, deposited on top of the central waveguide. The spatial evolution of surface plasmon polaritons (SPPs) in the arrays is monitored by the leakage radiation microscopy. One observes an efficient directional transport of SPPs in such an array in a single preferred direction. Additional refractive index variation distinguishes our system from a simple combination of directional couplers. We show that even a very small height variation makes the SPP transport independent on the period of modulation. The role of the phase offset $\Delta\phi$ between the refractive index modulation and coupling modulation is investigated, the maximum transport efficiency is reached for $\Delta\phi = \pi/2$

O 21.4 Mon 17:45 Poster F

Switchable cavity-assisted energy transfer in the infrared via surface phonon polaritons — •Mohsen Janipour[1], Matthias Hensen[2], and Walter Pfeiffer[1] — [1]Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, Bielefeld 33615, Germany — [2]Physikalische Chemie, Universität Würzburg, Am Hubland, Würzburg, Germany

Devices providing switchable energy and/or signal transfer in the infrared frequency range are essential to realize novel integrated photonic circuits. In the infrared and terahertz regime, Silicon-Carbide (SiC) supports the low-loss surface phonon polaritons. Based on finite difference time domain simulations we investigate high-quality tunable photonic modes in an elliptical metal-SiC heterostructure cavity which serves as a low-loss transfer channel for efficient coupling between two spatially separated locations in the cavity. Tuning of such modes in the Reststrahlen band of SiC is achieved via the longitudinal optical phonon resonance that depends on the carrier concentration. We demonstrate photonic mode shifts larger than 20 times the mode line width and conclude that these cavity modes are well suited to realize optically switchable resonant energy transfer channels in the range between 24-29 THz.

O 21.5 Mon 17:45 Poster F

Investigations of angle-dependent reflection spectra of large-area, disordered perfect absorber structures with ultra-broad absorption — •Ramon Walter[1], Matthias Zilk[2], Izzatjon Allayarov[1], Rostyslav Semenyshyn[1], Gabriel Schnoering[3], Audrey Berrier[3], Thomas Pertsch[2], Thomas Weiss[1], and Harald Giessen[1] — [1]4th Physics Institute, University of Stuttgart — [2]Institute of Applied Physics, Friedrich-Schiller University Jena — [3]1st Physics Institute, University of Stuttgart

So-called perfect absorber devices have the potential for many applications, such as light trapping, photocatalysis, and gas sensing. Such systems show very high absorption at their plasmonic resonance wavelength by optimizing their system impedance to vacuum values. Such perfect absorbers can keep their high absorption over a wide range of the incident angle when gratings mode are suppressed by a disordered arrangement of the plasmonic nanostructures, nearly independent of the polarization of the incoming light.

In this work, we investigate the potential of such devices with a very high absorption over a wide wavelength range, fabricated by colloidal Lithography. To approaches are possible, using a metal with a very broad plasmonic resonance, or creating perfect absorber system with multiple resonances, by using nanospheres of different sizes. We compare these two approaches and investigate the optical properties of the resulting devices under a wide range of incident angles.

We believe that our investigation can lead to improved designs with the potential for many applications.

O 21.6 Mon 17:45 Poster F

Optical tweezers with high-efficiency dielectric metalenses — •Christian Schlickriede[1], Teanchai Chantakit[1], Basudeb Sain[1], Heinz-Siegfried Kitzerow[1], Thomas Zentgraf[1], and Nattaporn Chattham[2] — [1]Universität Paderborn, Paderborn, Germany — [2]Kasetsart University, Bangkok, Thailand

In this work, we present a highly efficient all-dielectric metalens, which is able to optically trap polystyrene microbeads by tightly focusing the incident near-infrared light. In order to achieve a suitable numerical aperture, we use the concept of a geometric phase emerging from the configuration of rotated silicon meta-atoms. This intuitive and flexible design allows various application possibilities, for example multidimensional particle control by complex light fields. Depending on the incident circular polarization of light, the phase profile can be switched between convex and concave which makes this lens also a suitable candidate for polarization dependent particle trapping and antitrapping. In the experiments, we determine the trapping force exerted on the particles and we demonstrate three dimensional particle manipulation. With these results, we demonstrate metasurface enhanced optical tweezers with a broad range of applications in a very compact lab-on-a-chip-ready design.

O 21.7 Mon 17:45 Poster F

Multichannel holographic display and encryption using all-dielectric metasurfaces — •Basudeb Sain[1], Lingling Huang[2], and Thomas Zentgraf[1] — [1]Department of Physics, University of Paderborn, Warburger Straße 100, 33098 Paderborn, Germany — [2]Laser Micro/Nano-Fabrication Laboratory, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China

Metasurface hologram has emerged as a promising candidate for applications in optical displays, storage and security by exhibiting unprecedented spatial resolution, enormous information capacity and large field of view compared to traditional methods. In order to explore the full capability of the information storage/display and enhance the encryption security of metasurface holograms, smart multiplexing techniques are highly demanded. Here, we integrate multiple polarization manipulation channels for various spatial phase profiles into a single birefringent vectorial hologram by completely avoiding unwanted cross talk. Multiple independent target phase profiles with quantified phase relations, processing significantly different information in different polarization states are realized within a single all-dielectric metasurface. We demonstrate high fidelity, large efficiency, broadband operation, and a total of twelve polarization channels with our metasurface holograms. Such multichannel polarization multiplexing can be used for dynamic vectorial holographic display and provide triple protection to the optical security. The concept is highly promising for applications of arbitrary spin to angular momentum conversion and various phase modulation/beam shaping elements.

O 21.8 Mon 17:45 Poster F

Magensium Nickel Alloy Thin Films for Electrochemical Switching — •Elinor Kath, Florian Sterl, Mario Hentschel, and Harald Giessen — 4. Physikalisches Institut, Universität Stuttgart

Hydrogen can be reversibly loaded in and unloaded from magnesium, which is why magnesium gained significant attention as a potential low-risk storage medium for Hydrogen. Concurrently, magnesium also has found applications in switchable and active plasmonics. While elementary magnesium is metallic, magnesium hydride (MgH_2) is a transparent dielectric which allows switching on and off the plasmonic resonances in individual nanoparticles. For many potential applications the loading and unloading times are impractically long. To increase this switching rate we introduce small amounts of nickel into magnesium films. We are able to fabricate magnesium-nickel alloy thin films with different and controllable nickel concentrations. In our experiments these films are switched gasochromically, that is, using a hydrogen-nitrogen atmosphere, to determine the ideal amount of nickel for the best switching properties. Our measurements show that the loading and unloading times can be significantly reduced in the alloyed systems. Future directions include the potential to switch the magnesium-nickel alloy films electrochemically by immersing them into a KOH electrolyte and applying a negative voltage to the magnesium.