O 71: Poster Plasmonics and Nanooptics: Fabrication, Characterization and Applications

Time: Wednesday 18:00–20:00 Location: P2

O 71.1 Wed 18:00 P2

Large area writing of In_3SbTe_2 metasurfaces for polarization optics and complex orbital angular momentum beams — •Maike Kreutz[1], Lukas Conrads[1], Andreas Mathwieser[2], Matthias Wuttig[1], Robert Schmitt[2], and Thomas Taubner[1] — [1]I. Institute of Physics (IA), RWTH Aachen — [2]Fraunhofer IPT

Optical metasurfaces enable tailoring light-matter interaction for miniaturized optical elements with customized functionalities.The nonvolatile reversible switching of phase-change materials (PCMs) has been applied for tunable optical metasurfaces [1]. The plasmonic PCM In_3SbTe_2 (IST) switches from an amorphous dielectric to a crystalline metallic state. IST has been exploited for the direct laser writing of metallic nanoantennas in a dielectric surrounding [2] and for geometric phase metasurfaces [3] including orbital angular momentum (OAM) beams with single singularities. Here, we investigate optical metasurfaces fabricated with the Nanoscribe Photonic Professional GT to shape OAM beams with multiple singularities. We show preliminary results regarding the optical programming of these OAM beams for possible applications in optical communications [4]. Additionally, metasurface polarization optics are explored, enabling plasmonic quarter-wave plates with large bandwidths in the infrared range. This work paves the way towards creating tailored reconfigurable metaoptics for the infrared without cumbersome fabrication techniques. [1] Wuttig et al., Nat. Photon. 11, 465 (2017), [2] Heßler et al., Nat. Commun. 12, 924 (2021), [3] Conrads et al. arXiv:2408.05044 (2024), [4] Shen, Y. et al. Light. Sci. Appl. 8, 90 (2019)

O 71.2 Wed 18:00 P2

Investigation of the plasmonic phase-change material In_3SbTe_2 in the near-infrared range — •Hristiyana Kyoseva, Lukas Conrads, Rebecca Rahmel, Gero von Plessen, and Thomas Taubner — I. Institute of Physics (IA), RWTH Aachen University

Phase-change materials (PCMs) provide a suitable platform for active nanophotonics and reconfigurable metasurfaces by enabling reversible switching between two phases with contrasting optical properties [1]. In_3SbTe_2 (IST) is a novel plasmonic PCM which can be switched between an amorphous (dielectric) and a crystalline phase (metallic in the whole infrared (IR) spectrum) with precise laser pulses [2]. The direct writing of micrometer-sized structures into a thin IST film with resonances in the mid-IR (above $5\,\mu$m) has been extensively demonstrated [3]; however, smaller structures have not been explored yet due to their challenging fabrication process. Here, we examine the smallest achievable sizes of structures written in IST by spatially overlapping crystallization and amorphization pulses. We investigate the resonances of sub-micrometer rod antenna arrays as they shift to shorter wavelengths (below $4\,\mu$m) with decreasing size. We also aim to identify its lower limit set by the refractive index of the surrounding media. Our work paves the way towards sophisticated antenna structures with resonances at shorter wavelengths, broadening the applications of IST as a versatile platform for active nanophotonics. [1] Wuttig et al. *Nat. Photon.* **11**, 465 (2017) [2] Heßler et al., *Nat. Com.* **12**, 924 (2021) [3] Heßler, Conrads et al., ACS Photon. **9**, 5 (2022).

O 71.3 Wed 18:00 P2

Laser pulse front tilt effects in the observation of SPPs using photoemission electron microscopy — •Hanno Christiansen[1], Tobias Eul[1], and Michael Bauer[2] — [1]Institute of Experimental and Applied Physics, Kiel University, 24098 Kiel, Germany — [2]Kiel Nano, Surface and Interface Science KiNSIS, Kiel University, 24118 Kiel, Germany

In recent years, PEEM has become an established technique for the investigation of surface plasmon polaritons (SPP). This technique allows, for example, the study of the propagation dynamics of these collective surface excitations with femtosecond resolution or the measurement of their dispersion relations with high spatial resolution. The characteristic signal measured in PEEM results from the coherent superposition of the exciting laser field and the emitted SPP. Based on simulations and experimental data we show in this contribution that the plasmonic PEEM signal is very sensitive to the pulse front tilt of the exciting laser pulse and thus represents a sensor for this often overlooked laser parameter.

O 71.4 Wed 18:00 P2

Surface plasmon polariton neuronal cell — •Emily Kruel[1], Christopher Weiss[1], Tobias Eul[2], Mario Pfeiffer[1], Benjamin Stadtmüller[3], and Martin Aeschlimann[1] — [1]Department of Physics and Research Center OPTIMAS, University of Kaiserslautern-Landau, Germany — [2]Institute of Experimental and Applied Physics, University of Kiel, Germany — [3]Institute of Physics, University of Augsburg, Germany

Today, the classical electronic computer architecture is one of the limiting factors for fast and energy-efficient data processing. This has triggered the search for alternative hardware architectures to overcome these limitations. For instance, neuromorphic photonics has emerged as a novel research field for new classes of information processing devices that incorporate photonically integrated neural networks [1].

The hybrid nature of surface plasmon polaritons (SPPs) offers a concept for integrating neuromorphic photonics by combining photonic advantages such as high bandwidth and speed with strong electronic interactions. Here, we present an experimental approach to constructing essential components of an artificial neuron based on SPP interactions. We optimized the dimensions of individual components through a combination of finite-difference time-domain (FDTD) simulations and iterative experimental adjustments. The resulting plasmonic responses are imaged using a photoemission electron microscope (PEEM).

[1] Shastri, B.J., Tait, A.N., Ferreira de Lima, T. et al., Nat. Photonics 15, 102-114 (2021)

O 71.5 Wed 18:00 P2

Investigating Gel Electrolyte Compositions for Enhanced Switching Speed in PEDOT:PSS Electrochromic Devices and Switchable Metasurfaces — •Hoorieh Fallah[1], Dominik Ludescher[1], Jonas Herbig[1], Mario Hentschel[1], Andy Steinmann[1], Klaus Dirnberger[2], Junqi Lu[2], Semi Kim[2], Aldilene Santos Franca[2], Sabine Ludwigs[2], and Harald Giessen[1] — [1]4th Physics Institute and Research Center SCoPE, University of Stuttgart — [2]Institute of Polymer Chemistry, University of Stuttgart

Switchable metasurfaces using the conductive polymer PEDOT:PSS have gained substantial interest over the last years. PEDOT:PSS can be switched from metallic to dielectric state for wavelengths > 1.3 μm using electrochemistry, with CMOS compatible voltages between -1V to +1V. Here, we report on the preparation and characterization of gel electrolytes for PEDOT switching with varying ratios based on polyethylene oxide (PEO), polyvinyl alcohol polymers (PVA), acetonitrile, and lithium perchlorate ($LiClO_4$). Our gel electrolytes are integrated with PEDOT:PSS, coated onto ITO substrates to evaluate their performance in electrochromic switching applications. By applying alternating voltage and laser light, we analyze the dynamic switching speed of the PEDOT layer as it transitions from a conductive to an insulating state. Our approach explores how PEO- and PVA-based electrolytes impact high-frequency, low-voltage switching in PEDOT:PSS systems. We have achieved switching rates up to 100 Hz. The results aim to enhance our understanding of the influence of the electrolyte composition on switching behavior.