O 46: Poster Tuesday: Plasmonics and Nanooptics

Time: Tuesday 18:00–20:00 Location: Poster D

O 46.1 Tue 18:00 Poster D

Multi-color holographic metasurfaces — •Bernhard Reineke[1], Basudeb Sain[1], Lingling Huang[1,2], and Thomas Zentgraf[1] — [1]Universität Paderborn Department Physik, Warburger Str. 100, 33098 Paderborn — [2]Beijing Institute of Technology School of Optoelectronics, Side Rd of N. 3rd Ring Rd W, Haidian Qu, Beijing Shi, China

A phase only hologram is the recording of the phase distribution of an object. This phase distribution can be used to reconstruct an image of the encoded object. Several approaches exist to encode the phase information onto a physical hologram. One way is to use specially designed silicon nanophotonic metasurfaces. Here, we use a metasurface made of silicon nanostructures that are rotated against each other to encode a phase information. In most cases, there is a certain need to extend the principles of holographic metasurfaces to a multi wavelength regime. In our work, we demonstrate a holographic Metasurface that consists of different silicon nanostructures optimized for two different wavelengths in the visible spectral range. We show how this metasurface behaves in transmission, if it is illuminated with different wavelengths from a coherent light source. Furthermore, we retrieve a color image when the metasurface is illuminated with light of different wavelengths. Our approach opens new ways for improved multi-color anticounterfeit measures or new ways of color display systems.

O 46.2 Tue 18:00 Poster D

Accurate positioning of quantum dots by means of dielectrophoresis — •Patrick Pertsch[1], René Kullock[1], Monika Emmerling[1], Noga Meir[2], Dan Oron[2], and Bert Hecht[1] — [1]NanoOptics & Biophotonics Group, Experimental Physics 5, University of Würzburg, Germany — [2]Nanophotonics Laboratory, Weizmann Institute of Science, Israel

Semiconductor quantum dots (QDs) attract a lot of interest due to their tunable light emission, high efficiency and single-photon characteristics. Combining them with optical antennas can not only lead to strong coupling [1] but further enhance the emission and directionality of the radiation. To achieve that the QDs have to be positioned accurately which, in the past, has been realized by complex and time consuming processes [2,3].

Here we report on a much simpler process, utilizing dielectrophoresis, to load the gap of an electrically connected antenna with colloidal QDs. The dot-in-rod QDs align along the 30-nm gaps of the dimer antennas, show strong photoluminescence and are promising for electro-optical applications. This method is not restricted to the dimer antennas and allows accurate preparation of QD-antenna systems within a few minutes.

[1] H. Groß et al., Science Advances 4, eaar4906 (2018)
[2] A. G. Curto et al., Science 329, 930-933 (2010)
[3] E. Tranvouez et al., Nanotechnology 20, 165304 (2009)

O 46.3 Tue 18:00 Poster D

First steps towards strong coupling between emitters and plasmonic lattices — •Christoph Schnupfhagn, Simon Durst, Thorsten Schumacher, and Markus Lippitz — Experimental Physics III, University of Bayreuth, Germany

Plasmonic nanostructures allow to increase the interaction with light by resonant oscillations of the conduction electrons. When arranged in a lattice with a periodicity comparable to the optical wavelength, plasmonic nanoparticles can diffractively couple in the far-field, giving rise to surface lattice resonances. Consequently, the lattice structure generates a spatially extended mode while the plasmonic hotspots boost the light-matter interaction locally. It has already been shown that systems where emitters are coupled to these hybrid modes can serve as plasmonic nanolasers [1]. Furthermore, the small mode volume of the field hotspots allows to reach the strong coupling regime [2]. Here we present our first measurements on the dispersion relations of surface lattice resonances in gold nanoparticle arrays and their interaction with emitters.

[1] A. Yang et al., ACS Nano 2015, 9 (12), 11582-8
[2] L. Shi et al., Phys. Rev. Lett. 2014, 112 (15), 153002

O 46.4 Tue 18:00 Poster D

Enhanced Confinement of Surface Plasmon Polaritons on InAs with a High Index Medium — •Konstantin G. Wirth, Lena Jung, Yixi Zhou, Andreas F. Hessler, and Thomas Taubner — Institute of Physics (IA), RWTH Aachen

The semiconductor InAs offers promising properties for applications in the field of plasmonics due to its low damping and easy tunabilty compared to metals and other semiconductors. Recently, on InAs-Nanowires 1D surface plasmons (SP) with a high confinement of $\lambda_0/\lambda_p = 34$ and low damping rate have been observed by using infrared nearfield microscopy (s-SNOM)[1]. Simulations suggest that by depositing a thin layer of a high index material on the InAs an enhanced confinement of the SP can be achieved. In our work we use the phase change material (PCM) $Ge_3Sb_2Te_6$ as high index medium, which is switchable between an amorphous and a crystalline phase accompanied by a large refractive index change and low dielectric loss in the IR[2]. Switching the PCM between its amorphous and crystalline phase would further enable us to control the wavelength of the SP as well as its damping.

[1] Y. Zhou et al., Adv. Mater. 2018, 1802551
[2] A.-K. U. Michel et al., Adv. Optical Mater. 5, 1700261 (2017)

O 46.5 Tue 18:00 Poster D

Extracting the electronic properties of an oxide two-dimensional electron gas by scanning near-field optical microscopy — •Julian Barnett[1], Martin Lewin[1], Marc Rose[2], Felix Gunkel[2], Regina Dittmann[2], and Thomas Taubner[1] — [1]Institute of Physics (IA), RWTH Aachen — [2]Peter Grünberg Institut, Forschungszentrum Jülich GmbH

In the family of functional oxide materials one interesting system is the interface between bulk insulators $SrTiO_3$ and $LaAlO_3$ (LAO/STO), which gives rise to a confined and highly conductive two-dimensional electron gas (2DEG) [1]. This 2DEG exhibits remarkable properties such as superconductivity and gate tunability, while displaying the possibility for future transistor applications. Infrared spectroscopy can be employed for the characterization of 2DEG structural and electronic properties, such as confinement dimensions, carrier density and mobility, but is diffraction-limited in its lateral resolution.

Here, scanning near-field optical microscopy (SNOM) is used to overcome this limitation and obtain nanoscale IR spectra of buried LAO/STO interfaces in the range of the near-field phonon resonance, as the local electronic properties of STO can be quantified by exploiting plasmon-phonon coupling [2]. We will investigate the impact of variations in local topography and interface termination on 2DEG formation to better understand the underlying principles and enable controlled manipulation of its electronic properties.

[1] A. Ohtomo et al., Nature 427, 423 (2004).
[2] M. Lewin et al., Adv. Funct. Mater. 28, 1802834 (2018).

O 46.6 Tue 18:00 Poster D

Localization of photonic modes in optimised disordered amorphous silicon thin films — •Felix Becker[2], Martin Aeschlimann[1], Tobias Brixner[3], Benjamin Frisch[1], Michael Hartelt[1], Matthias Hensen[3], Thomas H Loeber[4], Walter Pfeiffer[2], Sebastian Pres[3], Bernd Stannowski[5], and Helmut Stiebig[2] — [1]Fachbereich Physik and Research Center OPTIMAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 46, 67663 Kaiserslautern — [2]Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld — [3]Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg — [4]Nano-Structuring-Center, Erwin-Schrödinger-Str. 13, 67663 Kaiserslautern — [5]Helmholtz-Zentrum Berlin, PVcomB, Schwarzschildstr. 3, 12489 Berlin

Tailored disordered nanostructures that feature long-living photonic modes are employed to enhance local light scattering, light localization, and absorption. We demonstrate the controlled fabrication of nanotextured a-Si:H absorber layers using focused ion beam milling of planar ZnO_x substrates and PECVD. This allows studying the light absorption in nanotextured absorber layers with custom designed topographies. Light trapping and absorption in these samples is investigated by time- and energy-resolved PEEM. The obtained map of photonic modes and absorption patterns agrees well with FTDT simulations. We demonstrate enhanced light localization in tailored disordered absorbers and demonstrate a new strategy to further optimize light trapping.

O 46.7 Tue 18:00 Poster D

Femtosecond pulse compression for nonlinear spectroscopy
— •Johannes Klier, Christoph Schnupfhagn, Julian Obermeier, and Markus Lippitz — Experimentalphysik III, University of Bayreuth, Germany

A pulse shaper makes it possible to manipulate arbitrarily the phase and amplitude of a femtosecond laser pulse. This is very useful for nonlinear spectroscopy since electric fields for multi-photon processes can be generated very accurately. Therefore, it is important that the pulse does not experience any broadening in time domain when coupled into a high-NA microscope. This compensation of the pulse chirp can be done with different nonlinear processes. Two photon absorbtion or the FWM-signal of samples with a large third-order nonlinear susceptibility $\chi^{(3)}$ in combination with phase-resolved interferometric spectral modulation (PRISM) are well suited for achieving this task. Here we present our experimental setup and results on pulse compression in the focal plane. Moreover, we give an overview how multi-photon excitation of dyes and graphene can be implemented in future experiments.

O 46.8 Tue 18:00 Poster D

Combining fluorescence and photoemission electron microscopy for the investigation of ultrafast surface phenomena
— •Daniel Fersch[1], Sebastian Pres[1], Bernhard Huber[1], Victor Lisinetskii[1], Matthias Hensen[1], Enno Krauss[2], Bert Hecht[2], Heiko Lokstein[3], and Tobias Brixner[1] — [1]Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]NanoOptics & Biophotonics Group, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [3]Department of Chemical Physics and Optics, Charles University Prague, 121 16 Praha 2, Czech Republic

To learn something about individual quantum systems and their interaction with the environment it is advantageous to look beyond the optical diffraction limit on ultrashort timescales. For this purpose, we use a scanning fluorescence microscope as well as an aberration-corrected photoemission electron microscope combined with a NOPA-based laser source, giving us an effective temporal and spatial resolution of sub-20 fs and sub-10 nm, respectively. Here, we present results on the polarization-dependent fluorescence enhancement of cyanobacterial Photosystem I thin films by gold nanorods, as well as first photoemission images of the protein dropcasted on monocrystalline gold flakes. We further show fluorescence and time-resolved photoemission from low-dimensional nanostructures performed with our pulse shaper. Finally, we want to use our microscopes to compare fluorescence-based multidimensional spectroscopy and coherent two-dimensional nanoscopy on the same samples.