O 35: Poster Tuesday: Plasmonics and Nanooptics 1

Time: Tuesday 11:00–13:00 Location: P3

O 35.1 Tue 11:00 P3

Positioning of DNA origami based nanostructures on surfaces by lithographic patterning — Zhe Liu[1], Zunhao Wang[2], Birka Lalkens[3], Daesung Park[2], Jannik Guckel[2], Juliane Breitfelder[3], and •Markus Etzkorn[1] — [1]Institute of Applied Physics, Technische Universität Braunschweig, 38106 Braunschweig, Germany — [2]Physikalisch Technische Bundesanstalt, 38116 Braunschweig, Germany — [3]Institute of Semiconductor Technology, Technische Universität Braunschweig, 38106 Braunschweig, Germany

Self-assembly protocols of functionalized DNA-origami structures can be used to create large amounts of identical hybrid nanostructures. We use this approach to create structures with tunable plasmonic properties. In our study, dimers of 15 nm gold nanoparticles with an average gap of 7 nm were self-assembled in solution. In order to control the positioning of such DNA-origami structures on surfaces, we created surface areas with hydrophobic/hydrophilic contrast by electron beam lithography and dry oxidative etching. This protocol offers positional control on the sub 10 nm scale. Here we will present results for hexamethyldisilazane (HDMS) covered silicon, but the approach can be utilized for various substrates and nanostructures. Our origami/dimer structure shows highly selective adsorption on different lithographically patterned structures. We achieve an efficiency in positioning, that is the ratio of origami in wanted to those in unwanted positions, of above 95%. Important parameters controlling the efficiency are discussed.

O 35.2 Tue 11:00 P3

Investigation of the plasmonic Phase-Change Materials $AgSnTe_2$ and In_3SbTe_2 for tuning nanoantenna resonances — •Kilian Wilden, Lukas Conrads, Andreas Hessler, Matthias Wuttig, and Thomas Taubner — I. Institute of Physics (IA), RWTH Aachen University

Providing a high optical contrast between their amorphous and crystalline phases, phase-change materials (PCMs) can serve for many applications in nanophotonics. [1] Optical pulses can be used for switching between those two states. This enables the tunability of antenna resonances by changing the surrounding medium. Currently, a novel material class of switchable infrared plasmonic PCMs is rising, which is characterized by a negative permittivity and therefore a Drude-like behaviour in the crystalline. This plasmonic PCM In_3SbTe_2 (IST) offers resonance tuning by reconfiguring the antenna shapes of rod antennas and even more complex ones with magnetic resonances.[2] $AgSnTe_2$ (AST) is another plasmonic PCM with a smaller plasma frequency and higher plasmonic losses than IST. Here, we investigate directly optically written antenna structures of crystalline AST. The quality of the plasmonic resonances is compared to IST antennas. Furthermore, the well-established concepts of reconfiguring antenna geometries are applied to inverse antenna structures, in which amorphous holes are created in a crystalline plasmonic surrounding. Their resonance behavior can be described by Babinet's principle. [1] M. Wuttig, H. Bhaskaran and T. Taubner, Nature Photonics 11, 465-476 (2017). [2] A. Heßler et al., Nature Communications 12, 924 (2021).

O 35.3 Tue 11:00 P3

Large area writing of reconfigurable metasurfaces with the plasmonic PCM In_3SbTe_2 — •Natalie Honné[1], Lukas Conrads[1], Andreas Ulm[2], Andreas Hessler[1], Matthias Wuttig[1], Robert Schmitt[2], and Thomas Taubner[1] — [1]I. Institute of Physics (IA), RWTH Aachen University — [2]Fraunhoferinstitut für Produktionstechnologie

Phase-change materials (PCMs) are optimal candidates for optical components being non-volatile and reversibly switchable. Their amorphous and crystalline phases differ tremendously in their properties. Conventional PCMs exhibit a large contrast in their refractive index and can be used to tune antenna resonances by influencing their surrounding.[1] Recently, plasmonic PCMs, like In_3SbTe_2, has been introduced. They switch between a dielectric (amorphous) and a metallic (crystalline) phase in the complete IR and enable optical writing of metallic nanoantennas directly in a dielectric surrounding.[2] Large area writing of reconfigurable metasurfaces is a key feature for tuneable nanophotonic devices. Here, the Nanoscribe Photonic Pofessional GT is used, a femtosecond laser writer with an infrared wavelength. Large area direct laser crystallization is investigated to fabricate antenna arrays of several hundred micrometers. Finally, a beam steering device is designed and fabricated. This work paves the way towards large area fabrication of functional metasurfaces in the IR with the ability of rapid prototyping for IR nanophotonic devices.

1. Wuttig et al., *Nature Photonics* **11**,465 (2017)
2. Heßler et al., *Nature Communications* **12**, 924 (2021)

O 35.4 Tue 11:00 P3

Direct Writing of Chiral and Nonlinear Plasmonic Devices — •Aleksei Tsarapkin[1], Victor Deinhart[1], Thorsten Feichtner[2], and Katja Höflich[1] — [1]Ferdinand-Braun-Institut gGmbH, 12489 Berlin, Germany — [2]University of Würzburg, 97074 Würzburg, Germany

The miniaturization of electrical and optical components allowed many technological and economic advancements over the last decades. Devices that permit control over the polarization of light are crucial in telecommunication and quantum optics but are usually realized as bulky optical systems and thus require further miniaturization. Here we aim at designing a uniquely compact converter and detector based on nanostructures. The device consists of a vertically oriented gold double helix coupled to a planar two-wire transmission line. The helix acts as a sensitive antenna for circularly polarized light, while the plasmonic transmission line guides plasmons on-chip. With numeric analysis we show that antisymmetric modes can be excited in both double helix and two-wire waveguide allowing spatial matching. Furthermore, one can match impedances of both components to maximize power transfer by adjusting their sizes. Finally, we developed fabrication protocols: while the helix can be directly written with an electron-induced deposition, the plasmonic waveguide can be cut from single-crystalline gold flake utilizing focused gallium-ion beam milling. We achieved high structuring resolution with both methods, allowing for efficient coupling to transform linear to circular polarization while retaining a device size of just a few microns.

O 35.5 Tue 11:00 P3

Transverse magnetic routing of light emission in hybrid plasmonic-semiconductor nanostructures: Grating period dependence — •Carolin Harkort[1], Lars Klompmaker[1], Alexander N. Poddubny[2], Leonid V. Litvin[3], Ralf Jede[3], Grzegorz Karczewski[4], Sergij Chusnutdinow[4], Tomasz Wojtowicz[5], Dmitri R Yakovlev[1,2], Manfred Bayer[1,2], and Ilya A. Akimov[1,2] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]St. Petersburg — [3]Raith GmbH, Konrad-Adenauer-Allee 8, 44263 Dortmund, Germany — [4]Institute of Physics, Polish Academy of Sciences, PL-02668 Warsaw, Poland — [5]International Research Centre MagTop, PL-02668 Warsaw, Poland

We use plasmonic gratings to achieve transverse magnetic routing of the light emission of a nearby quantum well exciton via an external magnetic field. In a hybrid plasmonic-semiconductor (Cd,Mn)Te/(Cd,Mg)Te quantum well (QW) structure the effect of the plasmonic grating period on the directional emission spectra is measured using a Fourier imaging setup to obtain angular and energy resolved photoluminescence spectra for opposite transverse magnetic fields. We achieve a strong directionality of the QW emission of up to 15% at low temperature of about 5 K and magnetic fields of 500 mT with a grating period of 240 nm and demonstrate the effect of the changing SPP dispersion on the directional emission characteristics.

O 35.6 Tue 11:00 P3

Mapping Lamb, Stark and Purcell effects at a chromophore-picocavity junction with hyper-resolved fluorescence microscopy — •Anna Rosławska[1], Tomáš Neuman[1,2,3], Benjamin Doppagne[1], Andrei G. Borisov[3], Michelangelo Romeo[1], Fabrice Scheurer[1], Javier Aizpurua[2], and Guillaume Schull[1] — [1]Université de Strasbourg, CNRS, IPCMS, UMR 7504, F-67000 Strasbourg, France — [2]Center for Materials Physics (CSIC-UPV/EHU) and DIPC, Paseo Manuel de Lardizabal 5, Donostia - San Sebastián 20018, Spain — [3]Institut des Sciences Moléculaires d'Orsay (ISMO), UMR 8214, CNRS, Université Paris-Saclay, 91405 Orsay Cedex, France

Light-matter interaction plays a crucial role in the properties of light emission from single molecules. Here, we show that it can be probed

with sub-molecular precision thanks to the atomically-confined electromagnetic field at the scanning tunneling microscope tip apex, which acts as a picocavity for localized plasmons. Such strong fields interact with the molecular exciton via Purcell, Lamb and Stark effects, which enable tuning the emission energy and line width. Hyper-resolved fluorescence maps of these two parameters can be understood as images of the static charge redistribution upon electronic excitation of the molecule, and the distribution of the dynamical charge oscillation associated with the molecular exciton, respectively [1].

[1] A. Rosławska *et al.*, Phys. Rev. X, 12, 011012, 2022.

O 35.7 Tue 11:00 P3

Steps towards fluorescence detected two-dimensional electronic spectroscopy of a single molecule — •Sanchayeeta Jana and Markus Lippitz — Chair for Experimental Physics III, University of Bayreuth, Bayreuth, Germany

Two-dimensional electronic spectroscopy (2DES) is an ultrafast spectroscopic technique which gives information about the coupling between molecular energy levels. As spectroscopy of a single molecule by fluorescence detection is a well established technique, we want to explore whether fluorescence-detected 2DES is possible at very low concentrations, ideally even on a single molecule. We use a sequence of four phase-modulated pulses to excite the molecules and collect the fluorescence by a high NA objective. The signal amplitude is demodulated at several mixing frequencies to extract the rephasing and non-rephasing contributions.

In this work, we study the 2D spectra measured from an ensemble of molecules in solution and discuss the challenges to experimentally measure 2D spectra from a single molecule.

O 35.8 Tue 11:00 P3

Coupling single epitaxial quantum dots to plasmonic waveguides — •Michael Seidel[1], Yuhui Yang[2], Saimon Covre da Silva[3], Thorsten Schumacher[1], Armando Rastelli[3], Stephan Reitzenstein[2], and Markus Lippitz[1] — [1]Experimental Physics III, University of Bayreuth, Germany — [2]Institute of Solid State Physics, TU Berlin, Germany — [3]Institute of Semiconductor and Solid State Physics, Johannes Kepler University Linz, Austria

Integrated plasmonic nanocircuits are highly promising building blocks for future quantum optical applications. In combination with self-assembled epitaxially grown GaAs quantum dots as stable, bright and narrow-band single-photon sources, ultra-compact nanocircuits operating below the diffraction limit can be designed [1]. A crucial aspect is the coupling of the quantum dot emission into plasmonic waveguide modes. In this work, we demonstrate the coupling of a single near-surface GaAs quantum dot to a silver nanowire by introducing a 100nm thick dielectric spacer layer. We characterize the nanostructure by comparing different imaging methods involving low-temperature cathodoluminescence and photoluminescence as well as confocal laser reflection mapping. Supported by 3D numerical simulations, we find that resonant plasmonic wires can enhance the waveguide coupling efficiency.

[1] Wu et al., Nano Lett. 2017, 17, 7, 4291-4296