different mechanisms, namely binding-energy-difference-induced and step-edge-induced growth. Molecules may prefer to nucleate on material with which molecules have larger binding energy from other area when diffuse on pre-patterned substrate. Fully uniform nucleation control at the predefined locations can be achieved by an appropriate selection of the growth parameters and template dimensions. Molecules can also be controlled to nucleate at the edge of the template first, and grow laterally due to strong interaction such as π-π interaction of aromatic molecules, resulting in area selective growth of molecules on topographically low area of substrate. The technique can be used to grow crack-free, crystalline films with large domain sizes, presenting significantly increased charge mobility in comparison with un-patterned substrates. Further more, the two mechanisms can be combined together to separate molecules at defined locations.

DS 46.7 Fri 15:30 H8

Coverage and Morphology Dependence of Dip Coated Organic Films on Withdrawal Velocity — •Tomás Corrales[1,2], Pía Homm[2], Piero Ferrari[2], María J. Retamal[2], Edgardo A. Cisternas[3,2], Valeria del Campo[4,2], and Ulrich G. Volkmann[2] — [1]Max-Planck-Institut für Polymerforschung, Mainz, Germany — [2]Dept. of Physics, P. Universidad Católica de Chile, Santiago de Chile — [3]Dept. of Research and Development, Tecnología Integral S.A., Santiago de Chile — [4]Dept. of Hydraulic and Environmental Engineering, P. Universidad Católica de Chile, Santiago de Chile

In this work we dip-coat *n*-dotriacontane onto silicon substrates, coated with their native oxide film (≈15 Å), from an *n*-heptane solution varying systematically the withdrawal velocity from 0.04 cm/min to 9.25 cm/min. After coating, we study the resulting films with AFM and SEM. We observe the formation of self-assembled monolayer structures with different coverage and morphologies, depending on the withdrawal velocity: For a pulling velocity of 1 cm/min we observe a minimum coverage of ≈11% while a maximum coverage of ≈54% is reached for the slowest velocity (0.04 cm/min). For velocities higher than 5 cm/min we observe a stabilization at a coverage of ≈35%. We relate this behavior to the transition from a gravity driven film growth to an entrained film regime, proposed by M. Ghosh et al. [1]. We also find that the morphology of these structures depends strongly on the withdrawal velocity.

[1] M. Ghosh, F. Fan, K.J. Stebe, Langmuir 23 (4), 2007.

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DS 46.8 Fri 15:45 H8

Thin films of new organic charge transfer systems — •Milan Rudloff and Michael Huth — Physikalisches Institut, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main

We deal with the preparation and characterization of thin films of organic charge transfer (CT) systems. These systems are made of donor and acceptor molecules that exhibit an additional electrostatic attraction due to Coulomb interaction between donor and acceptor. The electronic properties of the resulting new compound (depending on crystal structure, temperature and pressure) can be those of an insulator, a semiconductor, a metal or a superconductor.

The thin films are prepared by organic molecular beam deposition (OMBD). The OMBD process takes place inside an UHV chamber in which the source materials are (co-) sublimed and deposited onto a substrate. After that the samples are characterized by light and atomic force microscopy, X-ray diffractometry and (temperature dependent) transport measurements.

Our work focuses on new donor-acceptor combinations with the aim to prepare CT compounds that are yet unknown. The results presented here relate to experiments with some of these new donor(D)-acceptor(A) pairs, e.g. tetramethoxypyrene (D) + tetracyanoquinodimethane (A) and tetrathiafulvalene (D) + tetraketopyrene (A).

DS 46.9 Fri 16:00 H8

Direct Write 3-Dimensional Nanopatterning using Probes — •Felix Holzner[1], Armin Knoll[1], David Pires[1], Ute Drechsler[1], Michel Despont[1], Heiko Wolf[1], James Hedrick[2], Anuja DeSilva[3], and Urs Duerig[1] — [1]IBM Research - Zurich, Switzerland — [2]IBM Research - Almaden, USA — [3]IBM Research - Watson, USA

A high-resolution probe based patterning method is presented using organic resists, that respond to the presence of a hot tip by local material desorption. Thereby arbitrarily shaped patterns can be written in the organic films in the form of a topographic relief. Line gratings with a half-pitch of 15 nm have been fabricated.

Moreover, three dimensional patterns can be written by controlling the amount of material removal. The patterns can be readily transferred into silicon using standard RIE technology. The new technique offers a cost-effective and competitive alternative to high-resolution electron-beam lithography in terms of both resolution and speed.

DS 47: [O] Plasmonics and Nanooptics VII (Joint Session DS/O/HL)

Time: Friday 11:15–13:00 Location: H32

DS 47.1 Fri 11:15 H32

Metamaterial sensor for glucose and molecular monolayers using the plasmonic analog of EIT — •Martin Mesch[1], Na Liu[1], Thomas Weiss[1], Carsten Sönnichsen[2], and Harald Giessen[1] — [1]4th Physics Institute, University of Stuttgart, Germany — [2]Institute of Physical Chemistry, University of Mainz, Germany

We utilize the plasmonic analog[1] of electromagnetically induced transparency (EIT) to construct an optical LSPR (localized surface plasmon resonance) sensor. A combination of stacked gold dipole and quadrupole antennas exhibits a sharp spectral resonance, which shifts for changes in the structures' dielectric environment. To characterize the sensor, aqueous glucose solutions with concentrations between 0% and 25% have been measured in a custom flow cell by Fourier transform infrared spectroscopy. The results reveal a sensitivity of 374 nm per refractive index unit, corresponding to a figure of merit (sensitivity/linewidth) of 4.1. We compare our measurements to S-matrix simulations and give a recipe to determine the most sensitive structure geometry. To our knowledge, this is up to date the most sensitive lithographically manufactured LSPR sensor design. Additional experiments demonstrate the ability to detect a single molecular layer of biotin/streptavidin. [1] N. Liu et al., Nature Materials 8, 758 (2009)

DS 47.2 Fri 11:30 H32

Optical properties of a metallic meander Fabry-Perot cavity — •Liwei Fu[1], Heinz Schweizer[1], Thomas Weiss[2], Harald Giessen[1], Philipp Schau[3], Karsten Frenner[3], Steffen Maisch[3], and Wolfgang Osten[3] — [1]4th Physics Institute, University of Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany — [2]LASMEA, Université Blaise Pascal, F-63177 Aubière Cedex, France — [3]Institut für Technische Optik, University of Stuttgart, Pfaffenwaldring 9, 70550 Stuttgart, Germany

A single layer metallic meander structure is favorable to couple photons with surface plasmon polaritons and, as a result, a resonant enhanced transmission can be observed. A combination of two single-meander layers forms a Fabry-Perot cavity with frequency selective mirrors. In this contribution we investigate its optical properties. At the proper distance, the cavity behaves as a single layer meander, in which enhanced transmission and negative mode dispersion are present. In contrast to the single layer, however, the surface waves from the two mirrors are still coupled together, resulting in an amplified longitudinal E-field propagating backwards inside the cavity. The backward wave can be observed at visible frequencies with low loss and high transmittance for structural parameters that are well suited for nanofabrication. Such a compact realization of negative refraction is a promising approach for applications of subwavelength imaging, polarization beam splitting, and delay line approaches.

DS 47.3 Fri 11:45 H32

Dynamical response of split-ring molecules for metamaterials — •Stephan Bernadotte[1,2,3], Wim Klopper[1,2], and Ferdinand Evers[1,3] — [1]Institut für Nanotechnologie, Karlsruher Institut für Technologie — [2]Lehrstuhl für Theoretische Chemie, Institut für Physikalische Chemie, Karlsruher Institut für Technologie — [3]Institut für Theorie der Kondensierten Materie, Karlsruher Institut für Technologie

We investigate the dynamical properties of molecular crystals (matrices) built up from nanometer sized ring shaped, conjugated molecules,

which are candidate systems for negative index materials with frequencies in the optical regime. The response properties of such materials near their dynamical resonances can be understood in terms of an LRC circuit. In the conventional modeling of metamaterials, the circuit parameters enter (essentially) as phenomenological quantities. By contrast, in the present work they will be calculated from a microscopic tight binding model of a molecular Hamiltonian employing the Kubo approach.

We find that the LRC resonances of the molecular structures correspond to plasmonic excitations. By comparing to an analytical calculation, we can study in which way the plasmon resonances (and residues) depend on the molecule's electronic structure. On a qualitative level, our study also includes an investigation of the sensitivity of the dynamical response to the damping of the plasmons. Finally, we analyze the impact of cross-talk among the molecules within the matrix and the importance of birefringence terms.

DS 47.4 Fri 12:00 H32

Negative refraction in natural ferromagnetic metals — •Sebastian Engelbrecht, Alexey Shuvaev, and Andrei Pimenov — Experimentelle Physik 4, Universität Würzburg

It is generally believed that nature does not provide materials which show negative refraction. Up to now, the experiments with negative refraction have been realized with metamaterials or photonic crystals. As has been suggested recently, negative refraction in natural materials can be realized in ferromagnetic metals. Close to the ferromagnetic resonance (FMR) the real part of the magnetic permeability can reach negative values. This may lead to negative refraction as long as the dielectric permittivity is dominated by metallic response. This talk will provide experimental data of ferromagnetic metals (Fe,Co) which indeed show a range of negative refraction close to FMR in millimeter frequency range. In these materials the negative refractive index can be achieved even at room temperature.

DS 47.5 Fri 12:15 H32

Bragg Plasmonics — •Richard Taubert, Ralf Ameling, Lutz Langguth, Daniel Drégely, and Harald Giessen — University of Stuttgart, Germany

The investigation of plasmon-plasmon coupling has focused on near-field coupling until now. Only little work has been done on far-field interaction in plasmonic structures. We investigate a so-called 3D plasmonic crystal: four layers of nanowires are stacked in Bragg fashion, where the vertical distance matches half the resonance wavelength of the individual nanowire particle plasmon. The resonant far field coupling leads to the formation of a plasmonic band gap spanning almost one octave.

The structure was fabricated using layer-by-layer stacking. We investigate the dependence of the optical spectra on layer number and distance tuning. Scattering matrix calculations agree very well with our experimental findings.

DS 47.6 Fri 12:30 H32

Al nanostructures for metamaterials in visible region and biosensing — •Shankar K. Jha[1], Yogesh Jeyaram[1], Mario Agio[2], Jörg F. Löffler[1], and Yasin Ekinci[1,3] — [1]Laboratory of Metal Physics and Technology, ETH Zurich, 8093 Zurich, Switzerland — [2]Laboratory of Physical Chemistry, ETH Zurich, 8093 Zurich, Switzerland — [3]Paul Scherrer Institute, 5232 Villigen-PSI, Switzerland

Metamaterials are artificially engineered materials having electromagnetic material properties that are not readily found in nature. Owing to their potential applications like sub-wavelength imaging, negative refractive index, optical cloaking etc., these materials have been extensively studied in the microwave and optical regimes including in red wavelengths. We report development of metamaterials down to blue range. We studied optical properties of two-dimensional arrays of aluminum nanosandwiches. Strong magnetic response and negative permeability are observed down to 400 nm wavelength, paving the way towards metamaterials operating in the visible range. In addition we discuss the superior performance of such structures in biosensing.

DS 47.7 Fri 12:45 H32

Electromagnetic polarisation twisting mediated by plasmon / nanostructure interaction — •Brian Ashall[1], Brian Vohnsen[1], Stephan Schwieger[2], Erich Runge[2], Michael Berndt[3], and Dominic Zerulla[1] — [1]School of Physics, University College Dublin, Dublin 4, Ireland. — [2]Theoretical Physics I, Technische Universität Ilmenau, 98684 Ilmenau, Germany. — [3]Max Planck Institute of Molecular Cell Biology and Genetics, 01307 Dresden, Germany.

The design and architecture of nanostructures for the purpose of controlling and manipulating Surface Plasmon Polariton (SPP) dynamics is currently a focal point of research. Here, we present the first instance of plasmon mediated polarisation reorientation observed in the farfield with no associated reemission directional change [1]. Specifically, it is demonstrated that, as a result of the interaction between SPPs and tailor designed nanostructures of 3-fold symmetry characteristics [2], a polarisation twisting of the SPP mediated reradiated light is attained. It is shown that the dynamics of such an interaction can be controlled externally, enabling active control of the out-going polarisation orientation. In order to further understand the origin of the processes involved, Green's function based simulations of the interactions are presented and confirm that the origin of the polarisation twisting can be explained via asymmetrical in-plane SPP scattering.

[1] B. Ashall, B. Vohnsen, M. Berndt, D. Zerulla; Phys. Rev. B, 80(20) (2009)

[2] B. Ashall, M. Berndt, D. Zerulla; Appl. Phys. Lett. 91(20), 203109 (2007)

DS 48: [O] Organic Electronics and Photovoltaics III (Joint Session DS/CPP/HL/O)

Time: Friday 11:15–12:45 Location: H40

DS 48.1 Fri 11:15 H40

WO3 under, in and on CuPc - A doping mechanism for organic semiconductors — •Corinna Hein, Eric Mankel, Thomas Mayer, and Wolfram Jaegermann — TU Darmstadt, FG Oberflächenforschung, Petersenstraße 32, 64287 Darmstadt

Doping of organic semiconductors plays an important role for the development of organic devices like photovoltaic cells or organic light emitting diodes. P-doping of CuPc which is frequently used as hole conductor was performed successfully by coevaporation of the CuPc matrix and the WO3 dopant showing good doping efficiency and limit. The Fermi level determined by synchrotron induced photoemission shifts gradually with the concentration of dopant up to 690meV. To clarify the doping mechanism band alignment of both CuPc/WO3 and WO3/CuPc interfaces was determined. The work function difference of the two materials is overcome by band bending and an interface dipole. The dipole is 2eV for CuPc/WO3 and 1.4eV for WO3/CuPc lowering the amount of transferred charge and therefore limiting the doping efficiency. The sum of band bending at the interface adds up to 0.5eV for the CuPc/WO3 interface and 1.1eV for CuPc deposited on WO3. The Fermi level shift in the composites fits to this range in accord to a doping model assuming cluster growth of WO3 within CuPc. The model could be directly proofed by transmission electron microscopy distinguishing the two phases of CuPc and WO3 with a cluster size of approximately 5nm.

DS 48.2 Fri 11:30 H40

Mixed Self-Assembled Monolayers on Au(111): Understanding the Level Alignment and Work-Function Modification. — •Ferdinand Rissner[1], David A. Egger[1], Lorenz Romaner[2], Georg Heimel[3], and Egbert Zojer[1] — [1]Institute of Solid State Physics, Graz University of Technology, Austria — [2]Chair of Atomistic Modelling and Design of Materials, University of Leoben, Austria — [3]Institut für Physik, Humboldt-Universität zu Berlin, Germany

In organic electronics, coverage of electrodes with appropriate self-assembled monolayers (SAMs) is a well-known technique for enhancing the performance of devices; by modification of the electrode work function, Φ, charge-carrier injection barriers can be optimized. Mixing molecules which show a work-function increasing effect ($\Delta\Phi > 0$) with molecules decreasing Φ was experimentally found to allow for tuning of Φ over a wide range (as a function of the mixing ratio). [1]

For "pure" SAMs of π-conjugated oligophenylene derivatives, the