DS 17: Poster Session I

Time: Tuesday 18:15–20:15 Location: Poster B

DS 17.1 Tue 18:15 Poster B

Coherent manipulation of a single electron surfing on a sound wave — Shintaro Takada[1,2], •Hermann Edlbauer[1], Arne Ludwig[3], Andreas D. Wieck[3], Tristan Meunier[1], and Christopher Bäuerle[1] — [1]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, 38000, Grenoble, France — [2]National Institute of Advanced Industrial Science and Technology (AIST), National Metrology Institute of Japan (NMIJ), 1-1-1 Umezono, Tsukuba, Ibaraki, 305-8563, Japan — [3]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstraße 150, 44780, Bochum, Germany

Surface acoustic waves (SAW) provide a promising platform to realize quantum optics experiments with electrons at the single particle level. Earlier experiments have shown SAW-assisted single electron transport between spatially separated quantum dots over a distance of 4 mm with an efficiency of about 92 % [1]. Here we go an important step further. We couple two quantum channels by a tunnel barrier along a region of 2 μm and demonstrate transport over a distance of 22 μm with extremely high efficiency above 99 %. Changing energy detuning in the coupling region we can partition the electron on-demand into the two paths. Lowering the barrier height we additionally observe tunnel oscillations of the probability that the electron ends up at the upper or the lower channel. This finding demonstrates coherent manipulation of the electron quantum state on the fly. Our results pave the way for the implementation of a solid state flying qubit having high relevance in fundamental research and quantum information technology.

[1] Hermelin et al., Nature 477, 435 (2011)

DS 17.2 Tue 18:15 Poster B

Silicon Acousto-Electronics: Requirements for Ultrahigh-Frequencies — •Robert Ukropec[1], Boris Vratzov[2], Daan Kooij[1], Paulo V. Santos[3], and Wilfred G. van der Wiel[1] — [1]NanoElectronics Group (NE), MESA+ Institute for Nanotechnology, University of Twente, Enschede, The Netherlands. — [2]NT&D - Nanotechnology & Devices, Aachen, Germany. — [3]Department of Semiconductor Spectroscopy, Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany.

Acousto-electronic transport and phonon cavities generated by surface acoustic waves (SAWs) are playing a central role in the rapidly emerging field of quantum acoustics, a phonon analogue of quantum optics on a chip. To enter the quantum regime, both ultrahigh-frequency (UHF, >10 GHz) SAWs and suitable host materials are indispensable. So far, research in this field has mainly concentrated on GaAs-based substrates. We investigate silicon, which is attractive for its long spin lifetimes and thus, for the interconnectivity of qubits via SAWs generated by piezoelectric multilayers. Integration of UHF-SAW technology with these structures for carrier and spin transport is our motivation. UHFs are achieved via small SAW wavelength (down to 260 nm) transducers fabricated by nano-imprint lithography. We compare numerical simulations and experimental network analysis of piezoelectric multilayers on Si to evaluate these material systems for application in quantum acousto-electronic transport.

DS 17.3 Tue 18:15 Poster B

Coupled surface acoustic waves cavities — •André Luiz O. Bilobran[1], Mauricio M. de Lima Jr.[1], and Paulo V. Santos[2] — [1]University of Valencia - Institute of Materials Sciences, 46890 Paterna, Valencia (Spain) — [2]Paul-Drude-Institut für Festkrperelektronik, Hausvogteiplatz 57, D-10117 Berlin (Germany)

A few years ago it was demonstrated that fundamental effects of quantum-wave transport (Bloch oscillations, Wannier-Stark ladders and Landau-Zener tunneling) can be studied with surface acoustic waves (SAWs) propagating in 1D coupled acoustic cavities. Posteriorly, it was shown that the cavities - a periodic arrangement of metal stripes within a surface acoustic delay line on piezoelectric substrate - can be electrically tuned by controlling the potential of the cavities' electrodes. Changing from floating stripes, i. e., electrically isolated, to short circuited ones, the acoustic field changes due to the screening of the piezoelectric potential underneath the stripes. Here, we discuss the two dimensional finite element model that we have developed. The model describes fairly well the behavior of such devices without any adjustment parameters. In it, the mechanics and electrostatics models are coupled to simulate the piezoelectricity. Using a frequency domain study the eigenfrequencies can be predicted with an accuracy of less then 1%. The transmission around them, in dB, is estimated with an error smaller than 10% for the short circuited devices, whereas for the floating ones the accuracy decreases. Moreover we calculate the variation of parameters such as the stress, the strain and the displacement throughout the structures.

DS 17.4 Tue 18:15 Poster B

Generation of surface acoustic waves on doped semiconductor substrates — •Mingyun Yuan[1], Colin Hubert[1], Sander Rauwerdink[1], Abbes Tahraoui[1], Bob van Someren[2], Klaus Biermann[1], and Paulo Santos[1] — [1]Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany — [2]Elf Software B.V., Rotterdam, Netherlands

We report on the electrical generation of surface acoustic waves (SAWs) on doped semiconductor substrates. This is implemented by using interdigital transducers (IDTs) placed on piezoelectric ZnO films sputtered onto evaporated thin metal layers. Two material systems are investigated, namely ZnO/Au/GaAs and ZnO/Ni/InP. The rf-field applied to the transducer is electrically screened by the highly conductive metal film underneath the ZnO film without any extra ohmic losses. As a result, absorption of the rf-field by the mobile carriers in the lossy doped region underneath the IDT is avoided, ensuring efficient SAW generation. We find that the growth temperature of the ZnO film on the metal layer affects its structure and, thus, the efficiency of SAW generation. With this technique, the SAW active layers can be placed close to doped layers, expanding the application range of SAWs in semiconductor devices.

DS 17.5 Tue 18:15 Poster B

Acoustic transport of charge carriers and electron spins in quantum wires — •Paul L. J. Helgers[1,2], Klaus Biermann[1], Haruki Sanada[2], Yoji Kunihashi[2], and Paulo V. Santos[1] — [1]Paul-Drude-Institut für Festkörperelektronik Berlin, Germany — [2]NTT Basic Research Laboratories, NTT Corporation, Atsugi, Japan

We investigate a concept for acoustically driven single-photon-sources (SPS), based on planar GaAs quantum wires (QWRs) embedded in an optical microcavity. The QWRs are fabricated by photolithography, wet chemical etching and anisotropic MBE overgrowth. In this concept, spin-polarized carriers are optically injected at one end of the quantum wire and then acoustically transported to a QD-like recombination center at the other QWR end where they recombine, emitting single photons. The one-dimensionality of the QWR reduces Dyakonov-Perel spin dephasing during acoustic transport, thereby correlating the excitation polarization with the emission polarization. The SPS properties are improved by a microcavity.

In this contribution, we observe line-edge-roughness (LER), leading to QWR width variations up to several tens of nm, which complicate acoustic transport. We show that LER is mainly caused by the photolithography process. Secondly, we observe charge transport in GaAs(113)A QWRs and in cavity-embedded GaAs(001) QWRs on lengths of several tens of microns. Furthermore, spin lifetimes in the GaAs(001) QWRs approach the nanosecond timescale, promising spin transport lengths of several microns. We will evaluate the potential of these structures to be used as efficient acoustically driven SPSs.

DS 17.6 Tue 18:15 Poster B

Solid-state magnetic traps and lattices — •Johannes Knörzer[1], Martin J. A. Schuetz[2], Géza Giedke[3,4], Hans Huebl[5], Mathias Weiler[5], Peter Zoller[6,7], Mikhail D. Lukin[2], and J. Ignacio Cirac[1] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany — [2]Physics Department, Harvard University, Cambridge, MA 02318, USA — [3]Donostia International Physics Center, Paseo Manuel de Lardizabal 4, E-20018 San Sebastián, Spain — [4]Ikerbasque Foundation for Science, Maria Diaz de Haro 3, E-48013 Bilbao, Spain — [5]Walther-Meissner-Institut, Walther-Meißner-Str. 8, 85748 Garching, Germany — [6]Institute for Theoretical Physics, University of Innsbruck, A-6020 Innsbruck, Austria — [7]Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, A-6020 Innsbruck, Austria

We investigate platforms which realize AC Stark-shift induced traps

and lattices for (pseudo-)spins in semiconductors. In close analogy to optical lattices, we discuss tunable magnetic lattices for probing quantum many-body phenomena and quantum simulation. Realistic parameters, imperfections and readout schemes are discussed along with a detailed case study for two implementations, one based on surface acoustic waves and another based on a resonating LC circuit.

DS 17.7 Tue 18:15 Poster B

Complex-Oxide Acousto-Electronics — •Yigitcan Uzun[1], Boris Vratzov[2], Alexander E. M. Smink[1], and Wilfred G. van der Wiel[1] — [1]NanoElectronics Group, MESA+ Institute for Nanotechnology, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands — [2]NT&D - Nanotechnology and Devices, Aachen, Germany

Surface acoustic waves (SAWs) are capable of capturing free charge carriers and transporting them along their propagation path, resulting in an acoustoelectric current. So far, acoustoelectric transport has been realized mainly in AlGaAs/GaAs based structures. Here, we intend to realize acoustoelectric transport in the two-dimensional electron system at the LaAlO3/SrTiO3 (LAO/STO) interface. This has been shown to have extraordinary low-temperature properties, such as a high carrier mobility, superconductivity and magnetism. Experiments were carried out in a Pb[ZrxTi1-x]O3(PZT)/LAO/STO tri-layer heterostructure. Initially, a 10 unit cell thick layer of LAO was grown on a TiO2-terminated STO substrate and was patterned in a Hall-bar shape in order to define the SAW path. A 200 nm thick top piezoelectric PZT layer was deposited. SAWs were generated by using interdigital transducers. The SAW resonance frequency was measured by S-parameters analysis and the dependency of the acoustoelectric current on the SAW power was analyzed.

DS 17.8 Tue 18:15 Poster B

Quantum optics with electrons using surface acoustic waves — •Hugo V. Lepage, Chris J. B. Ford, and Crispin H. W. Barnes — Cavendish Laboratory, Department of Physics, University of Cambridge, Cambridge CB3 0HE, United Kingdom

The time evolution of a quantum particle can be described by the time dependent Schrödinger equation (TDSE). An analytical solution to this problem can only be found in a few very simple cases and numerical solutions are hard in general. We use a GPU-accelerated code to parallelize the computation of the TDSE and obtain accurate simulations of a wave function evolving through an arbitrary dynamic underlying potential. The focus of these simulations is to investigate single electron transport driven by surface acoustic waves (SAWs). SAW-driven transport is particularly interesting since it adds a new level of confinement to the electrons, suppressing their dispersion. Through non-dispersive control of single electrons, we propose a framework to implement a positive-operator-valued measure (POVM) using experimentally realistic potentials.[1] Furthermore, we simulate the coherent transport of single electrons across a tunnel-coupled wire. Our simulation results are compared to experimental observations by a collaborating group at the CNRS in Grenoble, France. In this presentation, we provide insight into the various phenomena related to single electron transport and put forward experimentally realizable designs for future optics-like protocols. [1] Arvidsson-Shukur, D.R.M., Lepage, H.V., Owen, E.T., Ferrus, T. and Barnes, C.H.W., 2017. Protocol for fermionic positive-operator-valued measures. Physical Review A, 96(5), p.052305.

DS 17.9 Tue 18:15 Poster B

The Giant Atom Regime of Quantum Acoustics — •Gustav Andersson[1], Baladitya Suri[1], Lingzhen Guo[2], Thomas Aref[1], Göran Johansson[1], and Per Delsing[1] — [1]Chalmers University of Technology, Gothenburg, Sweden — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

We investigate the dynamics of a superconducting transmon qubit interacting with surface acoustic waves (SAWs) on a piezoelectric substrate through interdigitial transducers. This "quantum acoustic" platform allows us to perform experiments analogous to quantum optics with a crucial difference - the artificial atom has characteristic dimensions much larger than the wavelength of the slow-propagating acoustic field. We engineered artificial atoms that couple to the propagating field at two distant points such that the time of flight of phonons between them introduces a significant, deterministic time delay. This allows us to probe the unexplored "giant atom" regime of quantum optics, with characteristic signatures of non-Markovianity. Phonons emitted into the acoustic channel by such a "giant atom" from one coupling point interact with the atom again through the other point, leading to revivals in the excited state population. A dispersively coupled microwave resonator allows us to read-out the excited state population of the qubit, thereby enabling us to perform its time-domain characterisation. We observe the non-exponential energy relaxation as well as the phonon scattering properties of giant atoms with a resonance frequency in the 2-2.5 GHz range.

DS 17.10 Tue 18:15 Poster B

Acoustically tuned dynamic wavelength division multiplexing — •Dominik D. Bühler[1], Antonio Crespo-Poveda[1], Klaus Biermann[2], Andrés Cantarero[1], Paulo V. Santos[2], and Mauricio M. de Lima[1] — [1]Materials Science Institute, University of Valencia, Spain — [2]Paul-Drude Institute for Solid State Electronics, Berlin, Germany

Phasar multiplexers based on arrayed waveguide grating (AWG) devices are key components in modern integrated photonic systems. Acoustically tuning these multiplexers enables robust, compact and fast responding devices improving on recently demonstrated technology. Different concepts will be presented in each of which a surface acoustic wave (SAW) is induced in such a way that its propagation direction coincides perpendicularly with the AWG. The WGs of this grating introduce dispersion and connect two multimode interference (MMI) couplers of distinct lengths that are employed as a power splitter and combiner, respectively. By tuning the SAW amplitude this setup allows us to alter the refractive index in each arm discretely and, thus, introduce specific phase shifts resulting in wavelength depended constructive interference at each of the outputs of the combiner MMI. This mechanism can be readily applied for wavelength routing and circuit switching in optical networking systems of essentially any material platform. The devices here are presented for operation at the telecommunication wavelengths around 1.55 μm, working on a (Al,Ga)As platform and tuned by a SAW in the low GHz range.

DS 17.11 Tue 18:15 Poster B

VO2-SnO2 nanocomposite films for smart windows applications — Alexandr Belenchuk[1], Oleg Shapoval[1], Sergiu Vatavu[2], Arcadi Chirita[2], and •Vasily Moshnyaga[3] — [1]IIEN, Academy of Sciences, Chisinau, Republic of Moldova — [2]Moldovan State University, Republic of Moldova — [3]Erstes Physikalisches Institut, Georg-August-Universität Göttingen, Germany

Vanadium dioxide, VO2, is a promising thermochromic material due to a drastic change of the infrared transmittance at the metal-insulator transition. However, a high transition temperature, Tmi=68C, and low transmittance impede industrial applications of VO2-based smart windows. To address these challenges, we employed a nanocomposite approach, which allows one to increase the transmittance and to generate a strain between nanocrystals to reduce Tmi. Nanocomposite VO2-SnO2 thin films were grown by a metalorganic aerosol deposition (MAD) technique on amorphous SiO2 substrates under reduced oxygen conditions. A single solution containing metalorganic precursors of vanadium and tin was used. Atomic-force (AFM) and scanning-electron (SEM) microscopy revealed dense films, composed of homogeneous nanocrystals with irregular shape. X-ray diffraction evidences a V1-xSnxO2 solid solution in spite of huge lattice mismatch between the oxides. A low temperature annealing [1] was used to achieve the VO2/SnO2 phase separation by means of a spinodal decomposition. Financial support from the STCU Project and DFG via SFB 1073 (TP A02) is acknowledged. [1] Zenji Hiroi et al., Chem. Mater. 25, 2202 (2013)

DS 17.12 Tue 18:15 Poster B

Depletion layer spectroscopy on (010) and (-201) β-Ga_2O_3 single crystals — •Holger von Wenckstern, Rainer Pickenhain, and Marius Grundmann — Universität Leipzig , Felix-Bloch-Institut für Festkörperphysik, Halbleiterphysik, Leipzig

The properties of β-Ga_2O_3 and the possibility of bulk crystal growth by e.g. edge-defined film-fed growth, float-zone and Czochralski method render the material interesting for high-power applications and deep-UV photo detection[1]. The performance of devices is typically limited by defects incorporated during growth and processing. We present a comprehensive investigation of unintentionally doped (-201)- and (010)-oriented β-Ga_2O_3 bulk single crystals grown by edge-defined film-fed growth (*Tamura coporation*) by thermal admittance spectroscopy TAS and deep-level transient spectroscopy (DLTS). For that coplanar Ohmic and Schottky barrier diodes were fabricated and characterized at room temperature by current-voltage measurements.

Comparing the differently oriented crystals revealed differences in the appearance and concentration of deep-level defects and different effective mass-like donors in the freeze-out regime.

[1] H. von Wenckstern, Adv. Electron. Mater. **3**, 1600350 (2017).

DS 17.13 Tue 18:15 Poster B

Investigations of Ge-doped $(Al,Ga)_2O_3$ thin films — •A. Werner, H. von Wenckstern, and M. Grundmann — Halbleiterphysik, Universität Leipzig, Leipzig, Germany

Since deep-ultraviolet photo-diodes find wide use in technical applications like flame detection, solar-blind materials like semiconducting Ga_2O_3 are of peculiar interest. Ga_2O_3 has a large bandgap of 4.4-4.9 eV which can be enlarged by alloying with Al_2O_3[1].
The investigated $(Al,Ga)_2O_3$ thin films were grown by pulsed laser deposition (PLD) on (00.1) Al_2O_3. We investigated the influence of the growth parameters such as growth temperature (T_g) and oxygen partial pressures ($p(O_2)$) on the structural, optical and electrical properties of the samples by X-ray diffraction, energy-dispersive X-ray spectroscopy, atomic force microscopy, transmission, and Hall effect measurements, respectively.
The thin films have $(\bar{2}01)$ orientation and the cation incorporation strongly depends on the deposition parameters. At a given T_g, the incorporation of Al is favored for lower $p(O_2)$ due to higher dissociation energy of the Al-O bond compared to the Ga-O bond. At a given $p(O_2)$, the incorporation of Al is favored for higher T_g due to desorption of gallium sub-oxides during growth[2]. Furthermore, we show the influence of Ge-doping on the conductivity.

[1] H. von Wenckstern, Adv. Electron. Mater 3, 1600350 (2017).
[2] P. Vogt and O. Bierwagen, APL Mater. 4, 086112 (2016).

DS 17.14 Tue 18:15 Poster B

Occurence of the ϵ-phase in $(In_xGa_{1-x})_2O_3$ and $(Ga_xAl_{1-x})_2O_3$ thin films — •A. Werner[1], H. von Wenckstern[1], C. Sturm[1], D. Splith[1], V. Prozheeva[2], R. Hoelldobler[1], and M. Grundmann[1] — [1]Halbleiterphysik, Universität Leipzig, Leipzig, Germany — [2]Department of Applied Physics, Aalto University, Espoo, Finland

The wide bandgap semiconductor Ga_2O_3 appears in five polymorphs of which only the so-called ϵ-phase has a high spontaneous polarization P along its c-axis[1]. Within heterostructures, a discontinuous change of P at the heterointerface occurs, resulting in charge accumulation. Therefore, stabilization of the ϵ-phase within the ternary alloys $(In,Ga)_2O_3$ or $(Ga,Al)_2O_3$ is required in order to utilize the two-dimensional charge carrier gases within electronic devices. We present studies of the occurrence of the ϵ-phase in ternary alloys of Ga_2O_3 with In_2O_3 and Al_2O_3. Samples with continuous composition spread[2] were grown by pulsed laser deposition on (00.1) Al_2O_3. As target segments we used Ga_2O_3/In_2O_3 or Ga_2O_3/Al_2O_3. Each segment was additionally doped with tin to facilitate the formation of the ϵ-phase[3]. Resulting thin films were investigated by means of X-ray diffraction, transmission, energy-dispersive X-ray spectroscopy, Raman spectroscopy, and atomic force microscopy. We observed a monotonic shift of the ϵ-reflexion in dependency of In-/Al-content; for example the (002)-reflex shifts to lower angles with increasing In-content.

[1] M. B. Maccioni *et al.*, Appl. Phys. Express 9, 04102 (2016).
[2] H. v. Wenckstern *et al.*, CrystEngComm 15, 10020 (2013).
[3] M. Kracht *et al.*, Phys. Rev. Applied 8, 054002 (2017).

DS 17.15 Tue 18:15 Poster B

Optical and Magnetic Properties of Spinel Type Ferrites in Relation to their Crystallographic Order — •Vitaly Zviagin[1], Paula Huth[2], Chris Sturm[1], Daniel Spemann[3], Stephan Mändl[3], Jörg Lenzner[1], Annette Setzer[1], Jan Meijer[1], Reinhard Denecke[2], Pablo Esquinazi[1], Marius Grundmann[1], and Rüdiger Schmidt-Grund[1] — [1]Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, Linnéstr. 5, Germany — [2]Universität Leipzig, Wilhelm-Ostwald-Institut für Physikalische und Theoretische Chemie, Linnéstr. 2, Leipzig — [3]Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstr. 15, Leipzig

$ZnFe_2O_4$ (ZFO) and composite $Zn_xFe_{3-x}O_4$ thin films were fabricated on $SrTiO_3$ (100) and TiN/MgO (100) substrates by pulsed laser deposition. Assigned electronic transitions in the dielectric function show a clear dependence on temperature as well as pressure during deposition and annealing processes. A decrease in the octahedral Fe^{2+} site occupancy with an increase in Zn concentration in composite films was observed in the band to band transition as well as the valence specific elemental composition, determined by spectroscopic ellipsometry and analysis of Fe 3p and 2p XPS core levels, respectively. Change in the ferrimagnetic response and electronic structure was examined after annealing ZFO films in argon and oxygen atmospheres at different temperatures as well as after irradiation by Ne^+ ions with different fluences. Along with complementary methods such as Raman, AFM and SEM, we show the influence of crystallographic order on magnetic properties of normal, disordered and inverse spinel ferrite thin films.

DS 17.16 Tue 18:15 Poster B

Characterization of transport properties of thin β-GaO layers — •Johannes Boy[1], Martin Handwerg[1], Robin Ahrling[1], Rüdiger Mitdank[1], Günter Wagner[2], Zbigniew Galazka[2], and Saskia F. Fischer[1] — [1]AG Neue Materialien, Humboldt-Universität zu Berlin, Institut für Physik, Newtonstrasse 15, D-12489 Berlin, Germany — [2]Leibniz Institute for Crystal Growth, Max-Born-Strasse 2, D-12489 Berlin, Germany

Gallium oxide has been of great interest as a functional material for high power applications, due to its wide band gap and high breakthrough field. Knowledge about the transport properties of the material is a requirement for the design and production of gallium oxide based electric devices. In this work, homoepitaxially MOVPE-grown Si-doped β-GaO films have been investigated with regard to electric and thermoelectric transport over a wide temperature range. We have designed a measurement platform, which allows us to carry out van-der-Pauw-, Hall- and Seebeck-measurements on the same sample. The Seebeck coefficient S, conductivity σ, Hall carrier density n and Hall mobility μ have been measured in thin films, which have to be distinguished in terms of film thickness, doping concentration and mobility of the charge carrier. Seebeck coefficients in the range of a few hundreds μV/K have been measured at room temperature and below. The measurement of the Seebeck coefficient and Hall carrier density allows a discussion of the temperature-dependent Hall scattering factor r_{sc} in various β-GaO thin films.

DS 17.17 Tue 18:15 Poster B

Influence of Ga incorporation into bixbyite In_2O_3 thin films on the performance of Schottky barrier diodes thereon — •Daniel Splith, Steffen Lanzinger, Sophie Müller, Holger von Wenckstern, and Marius Grundmann — Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, Leipzig, Germany

Oxide semiconductors like In_2O_3 are promising materials for a new generation of transparent electronic devices. Although first Schottky contacts on In_2O_3 were realized recently using a reactive sputtering process [1], rectification of such contacts remained poor. Incorporation of Mg, acting as an acceptor in In_2O_3, improves the rectification [2]. Further improvement can be expected from Ga incorporation into the bixbyite In_2O_3 phase, since In incorporation into the monoclinic β-Ga_2O_3 phase decreases the barrier height of Schottky contacts on β-Ga_2O_3 thin films significantly [3].

In this contribution we investigate the influence of Ga incorporation into the bixbyite In_2O_3 phase on the rectifying behavior of Schottky contacts. In_2O_3 thin films with and without Ga admixture were grown by pulsed laser deposition. Schottky contacts were realized by sputtering of Pt. In the IV-characteristics, a significantly smaller reverse current can be observed for the samples having a Ga admixture, leading to an improved rectification. Additionally, first thermal admittance spectroscopy measurements were performed on such thin films.

[1] H. von Wenckstern *et al.*, APL Mat. **2**(4), 046104 (2014)
[2] F. Schmidt *et al.*, Phys. Status Solidi B, **252**(10), 2304-2308 (2015)
[3] H. von Wenckstern *et al.*, ACS Comb. Sci. **17**(12), 710-715 (2015)

DS 17.18 Tue 18:15 Poster B

A pulsed laser deposition technique to control the composition of ternary thin films in growth direction demonstrated on the $(Al_x,Ga_{1-x})_2O_3$ alloy — •Max Kneisz, Holger von Wenckstern, and Marius Grundmann — Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, Leipzig, Germany

In conventional pulsed laser deposition (PLD) a continuous variation of the composition of ternary thin films in growth direction is not possible since the number of discrete alloy combinations is limited by the amount of targets which can be mounted in the setup. We therefore propose a technique using only a single elliptically-segmented target with two regions of different composition. We control the Al/Ga ratio of the thin films by varying the radial position of the PLD laser spot on the target and thereby changing the ratio of the path lengths of the laser spot in the different regions. In analogy to our approach for lateral

continuous composition spreads [1] (lateral CCS), we call this method vertical CCS. We will show that we are able to control the composition of $(Al_x,Ga_{1-x})_2O_3$ thin films in growth direction quasi continuously or stepwise. Therefore films with varying single Al-contents are grown using the new technique on c-sapphire substrates. The Al-content in the films is determined by transmission spectroscopy. The structural and optical quality is similar to films grown via conventional PLD.
[1] H. von Wenckstern *et al.*, CrystEngComm **15**, 10020 (2013)

DS 17.19 Tue 18:15 Poster B

Electrical properties of unipolar devices based on amorphous zinc oxynitride — •Anna Reinhardt, Holger von Wenckstern, and Marius Grundmann — Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, Semiconductor Physics Group

Amorphous zinc oxynitride (a-ZnON) was demonstrated to be a promising high-mobility semiconductor for low-temperature fabricated, high-performance thin-film transistors [1–3]. Up to now, only metal-insulator-semiconductor field-effect transistors based on a-ZnON were reported.

Here, we present our results on metal-semiconductor field-effect transistors (MESFETs) using reactively sputtered platinum gate-contacts to control the current flow in the sputter deposited a-ZnON channel. On/off ratios of 10^5 and saturation mobilities of about $50\,cm^2V^{-1}s^{-1}$ are achieved. Furthermore, the electrical properties of the Schottky gate diode were analyzed by means of temperature-dependent current-voltage measurements.

[1] Y. Ye *et al.*, J. Appl. Phys. 106, 074512 (2009)
[2] H.-S. Kim *et al.*, Sci. rep. 3, 1459 (2013)
[3] A. Reinhardt *et al.*, Phys. Status Solidi A 213 (7), 1767 (2016)

DS 17.20 Tue 18:15 Poster B

Influence of pre-growth conditions on the interface formation in $SrTiO_3$ homoepitaxial thin films grown with pulsed laser deposition (PLD) — •Laura Bogula, Toni Markurt, Martin Albrecht, and Jutta Schwarzkopf — Max-Born-Str. 2, 12489 Berlin, Germany

In this poster a systematic study on the pre-growth conditions of a model perovskite system, namely homoepitaxial $SrTiO_3$ thin films grown by pulsed laser deposition (PLD) will be presented. In order to understand the origin of its functional properties and the correlation to defects the interface between substrate and film is of utmost importance. Therefore, we investigated the influence of different pre-growth conditions like oxygen partial pressure and substrate temperature on the surface reconstruction and the resulting interface. On as prepared $SrTiO_3$ substrates we observed a $(\sqrt{13} \times \sqrt{13}) - R33.7°$ reconstruction causing a non-stoichiometric interface measured both with transmission electron microscopy and x-ray diffraction. However, with vacuum annealing the surface structure can be altered to more favourable reconstructions for homoepitaxial thin film growth.

DS 17.21 Tue 18:15 Poster B

Electrical charcterization of thin monocrystalline homoepitaxial β-Ga_2O_3 films — •Robin Ahrling[1], Johannes Boy[1], Martin Handwerg[1], Rüdiger Mitdank[1], Zbigniew Galazka[2], Günter Wagner[2], and Saskia F. Fischer[1] — [1]Novel Materials Group, Humboldt-Universität zu Berlin, 12489 Berlin, Germany — [2]Leibniz Institute for Crystal Growth, 12489 Germany

As a wide band gap semiconductor with a high breakthrough field, gallium oxide (Ga_2O_3) has shown to be a promising material for applications in high power electronics. However, it is not yet clear how its electrical properties may change with a variation of crystal thickness. These changes may be caused by a change in scattering mechanisms or an inhomogeneity in crystal growth.

Here, homoepitaxially MOVPE-grown monocrystalline Si-doped β-Ga_2O_3 films of thicknesses between 28 nm and 225 nm were electrically characterized in a temperature range from 300 K down to 10 K. Van-der-Pauw and Hall-measurements have been performed to determine conductivity, Hall density and carrier mobility in those films. It was found that above 150 nm thickness the films show a behavior similar to the bulk. Below 100 nm a drastic drop of the mobility with decreasing thickness was seen. The Bergmann model, based on surface scattering of electrons due to their wavelength, was used to describe this dependence and showed an overall good agreement with the data. An alternative explanation is inhomogeneity in the sample growth process. In any case, this reduction in mobility for thin films has to be considered for future applications in devices.

DS 17.22 Tue 18:15 Poster B

growth mode evolution during (100)-oriented β-ga2o3 homoepitaxy — •zongzhe cheng[1], michael hanke[1], zbigniew galazka[2], and achim trampert[1] — [1]Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7 10117 Berlin, Germany — [2]Leibniz-Institut für Kristallzüchtung, Max-Born-Straße 2, 12489 Berlin, Germany

our work focuses on the analytics of (100)-oriented beta-Ga2O3 homoepitaxy as grown by MBE. In-situ reflection high-energy electron diffraction (RHEED) reveals sharp strike patterns that are indicative for a 2D layer-by-layer mode accompanied by a (1*1) surface reconstruction. The crystal structure of the thin film shows a high quality and matches coherently with the substrate underneath, as probed by in-situ synchrotron-based high resolution x-ray diffraction (HRXRD) and azimuthal RHEED maps. In contrast to the substrate, there is a high density of stacking faults and twin domains in the layers found by ex-situ transmission electron microscopy (TEM), which serve as a mark of the layers. The twins form from the coalescence of nucleated islands, which are elongated along b-direction. As monitored by the RHEED oscillations, the layer thickness can be controlled very precisely, therefore making it a good candidate for research and design of 2D electronics.

DS 17.23 Tue 18:15 Poster B

Resistive switching in memristive CBRAM devices — •Sven Dirkmann[1] and Thomas Mussenbrock[2] — [1]Ruhr-Universität Bochum, Lehrstuhl für Theoretische Elektrotechnik, 44780 Bochum, Germany — [2]BTU Cottbus-Senftenberg, Lehrstuhl für Theoretische Elektrotechnik, 03046 Cottbus, Germany

We report on resistive switching of memristive electrochemical metallization devices (CBRAM) using 3D kinetic Monte Carlo simulations describing the transport of ions through a solid state electrolyte of an Ag/TiOx/Pt thin layer system. The ion transport model is consistently coupled with solvers for the electric field and thermal diffusion. We show that the model is able to describe not only the formation of conducting filaments but also its dissolution. Furthermore, we calculate realistic current-voltage characteristics and resistive switching kinetics. Finally, we discuss in detail the influence of both the electric field and the local heat on the switching processes of the device. Furthermore, the reset process is discussed in detail.

This work is funded by the German Research Foundation DFG in the frame of Research Unit FOR2093.

DS 17.24 Tue 18:15 Poster B

Devices and Integrated Circuits Based on Amorphous Zinc-Tin-Oxide — •O. Lahr, S. Vogt, Z. Zhang, H. von Wenckstern, and M. Grundmann — Universität Leipzig, Semiconductor Physics Group, Leipzig, Germany

Currently there exists an increasing demand for low cost electronics and novel devices based on sustainable materials. Amorphous zinc-tin-oxide (ZTO) as a promising candidate paves the way for such technology since it only consists of abundant, non-toxic elements and can be deposited at room temperature with tunable charge carrier densities between 10^{16} cm^{-3} and 10^{19} cm^{-3} as well as mobilities up to 32 cm^2/Vs [1].
We present metal-semiconductor field effect transistors (MESFETs) and inverters based on amorphous n-type ZTO channels. The thin films were deposited at room temperature via long throw magnetron sputtering using a target with a 67 % ZnO and 33 % SnO_2 composition. On/Off ratios greater than 8 orders of magnitude are achieved for reactively sputtered Pt gate contacts with an 5-10 nm thick insulating i-ZTO layer in-between for rectification ratio enhancement [2]. Corresponding MESFET-based inverters show a peak gain maximum (pgm) up to 330 at V_{DD} = 3 V, thus ZTO is a suitable candidate towards more advanced circuits as for instance ring oscillators [3].

[1] Bitter *et al.*, ACS Appl. Materials & Interfaces, **9**, 31, 2017.
[2] Schlupp *et al.*, Physica Status Solidi (a), **214**, 10, 2017.
[3] Klüpfel *et al.*, Advanced Electronic Materials, **2**, 7, 2016.

DS 17.25 Tue 18:15 Poster B

A Variable Gas Injection System for Rapid Precursor Testing in Focused Electron Beam Induced Deposition — •Robert Winkler[1,2], Georg Arnold[1,2], Juergen Sattelkow[1,2], Andrew Smith[3], and Harald Plank[1,2] — [1]Institute for Electron Microscopy and Nanoanalysis Graz University of Technology, 8010 Graz, Austria — [2]Graz Centre for Electron Microscopy, 8010 Graz, Austria —

[3]Kleindiek Nanotechnik GmbH, Aspenhaustrasse 25, 72770 Reutlingen, Germany

Focused electron beam induced deposition (FEBID) is an additive, direct-write technology for the controlled on-demand fabrication of functional nano-structures on virtually any given material and surface morphology. Beside the strong current trend towards true 3D nano-fabrication with yet unpreceded flexibility, the material aspect is gaining increasing importance as the functionality finally decides about the applicability in research and development. From a chemical point of view, there was very strong progress during the last 3 years in the frame of the EU COST action CELINA, which brought essential insights and introduced new precursors. Those, however, need to be tested in an iterative fashion where technical flexibility is one of the highest demands. In this contribution we focus on a versatile and flexible gas injection system for rapid precursor testing of new materials. We also discuss how the system can be used for other exposure experiments such as purification or sensor applications. As we will show, the system provides unique advantages and an uncomplicated handling as essential element for further progress in the field of FEBID.

DS 17.26 Tue 18:15 Poster B

Investigation and utilization of catalytic processes in FEBIP techniques for nanofabrication — •Elif Bilgilisoy, Christian Preischl, Florian Vollnhals, and Hubertus Marbach — Lehrstuhl für Physikalische Chemie II, Friedrich-Alexander University Erlangen-Nürnberg, Egerlandstr. 3, 91058 Erlangen

In our group, we use and investigate Focused Electron Beam Induced Processing (FEBIP) techniques ultra-high vacuum (UHV) to fabricate arbitrary shaped nanostructures. Therefore, we use the highly focused electron beam of a scanning electron microscope in UHV to either directly modify adsorbed precursor molecules (electron beam induced deposition, EBID) or to locally modify the substrate such that it becomes active towards the decomposition of subsequently dosed precursor molecules (electron beam induced surface activation, EBISA) [1]. In the corresponding experiments with the precursors $Fe(CO)_5$ and $Co(CO)_3NO$ we observed diverse catalytic processes, like precursor decomposition at the pristine substrate, autocatalytic growth and decomposition on deposits of the other precursor. We will present and discuss the corresponding observations, e.g., the partially very different chemical sensitivities of the two precursors, the possibility to quench the catalytic activity of a surface by the preparation of organic layers and in particular how to exploit the findings for the improvement of FEBIP [2].

[1]H. Marbach, Appl. Phys. A 117 (2014), 987
[2]Drost et al., Small Methods, 1 (2017) 1700095

DS 17.27 Tue 18:15 Poster B

Evaluation of critical electron doses for surface activation in electron beam induced surface activation (EBISA) — •Florian Vollnhals, Christian Preischl, Martin Drost, Fan Tu, and Hubertus Marbach — Lehrstuhl für Physikalische Chemie II, Universität Erlangen-Nürnberg, Egerlandstr. 3, D-91058, Erlangen

The world of focussed electron beam induced processing encompasses not only electron beam induced deposition (EBID) and etching (EBIE), but also techniques like electron beam induced surface activation (EBISA).[1] In EBISA, an surface is locally modified by a electron beam such that it becomes active towards the decomposition of a subsequently dosed precursor, here $Fe(CO)_5$. The deposit can grow autocatalytically, i.e. via the local decomposition of further $Fe(CO)_5$ molecules, to form clean, polycrystalline iron deposits on the surface. Susceptible surfaces include oxides (TiO_2, SiO_2) as well as molecular layers (Porphyrins on various substrates).

In order to better understand the activation mechanisms and their dependence on the experimental parameters, we exploit the backscattering behavior of electrons commonly observed as BSE proximity effect to fabricate deposits and compare these to Monte-Carlo simulations. This allows to evaluate critical activation parameters and asses their implications for the EBISA process.

[1] Walz et al., Angew. Chem. Int. Ed. 49 (2010), 4669; Marbach, Appl. Phys. A 117 (2014), 987; Drost et al., Small Methods, 1 (2017) 1700095

DS 17.28 Tue 18:15 Poster B

Reduction and annihilation of wrinkles in graphene by He^+ ion bombardment at elevated temperatures — •Alexander Herman, Philipp Valerius, and Thomas Michely — II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany

Due to thermal mismatch of substrate and graphene, wrinkles form in CVD grown graphene upon cooling from the growth temperature to ambient. Wrinkles typically form a network with a characteristic lateral scale of micrometers. Wrinkles affect graphene's electrical and thermal properties through scattering processes in an unfavorable way. Therefore, methods to avoid wrinkle formation or to eliminate wrinkles are highly desirable.

Using a high CVD growth temperature of 1400°C for graphene on Ir(111) we force a large amount of wrinkles to result in the absence of any additional treatment. By additional low fluence, low energy noble gas ion irradiation at temperatures around the CVD growth temperature we show through scanning tunneling microscopy, that the height and length of the resulting wrinkles can be reduced until they are eventually completely eliminated. However, as side effects blisters and small vacancy clusters pinned to the moiré of graphene with Ir(111) show up.

DS 17.29 Tue 18:15 Poster B

Controllable p-doping of wafer-scale few-layer MoxNb1-xS2 — •Tien Tung Luong[1], Yen-Teng Ho[1], Peng Lu[2], Yung-Ching Chu[1], Chao An Jong[3], Edward Yi Chang[1], and Jason C.S. Woo[2] — [1]National Chiao Tung University, Hsinchu, China, Republic of (ROC) — [2]University of California, Los Angeles, Los Angeles, United States — [3]National Nano Device Laboratories, National Applied Research Laboratories, Hsinchu, China, Republic of (ROC)

Exfoliated monolayer MoS2 shows a great possibility FET for next generation due to the ultra-high carrier confinement. Nevertheless, exfoliation method is not suitable for practical applications on a large scale and disadvantages in controlling layer number and doping. 2D MoS2 can be used in many kinds of application fields, such as low power logic circuits, flexible electronics, sensors, memories and photovoltaic. etc. For integration circuit application, it is important to form p-type channels, Nb is the promising candidate for p-type dopant in MoS2. In this works, a very thin MoOx:Nb film was deposited on a commercial 2-inch sapphire wafer using a co-sputtering and then was sulfurized in H2S ambient at 750 oC to form few-layer MoxNb1-xS2. The effective mobility and effective hole concentration examined by Hall measurement and inferred from a field-effect measurement are strongly dependent both on the Nb power of co-sputtering and on the sulfurization conditions. Within some conditions, the effective mobility drastically increases as increasing the Nb incorporation and consequent the hole concentration in MoxNb1-xS2. The results present a feasible synthesis method for controllable p-doping of wafer-scale few-layer MoxNb1-xS2.

DS 17.30 Tue 18:15 Poster B

Utrafast dynamics in MoS2 probed by transient Raman spectroscopy — •Christoph Boguschewski, Jingyi Zhu, and Paul H.M. van Loosdrecht — II. Physikalisches Institut der Universität zu Köln

Mono-layer transition metal dichalcogenides (TMDs) form the most important materials platform for the emerging field of valleytronics. In order to further develop this field, it is crucial that one understands the dynamical aspects of valley excitations, including both population and polarization dynamics. Here we present a study of these dynamics in MoS2 using picosecond time resolved spontaneous Raman scattering. Apart from an insight into the phonon population dynamics, this technique yields a detailed insight in the population and polarization dynamics of valley excitations through the transient behavior of a doubly resonant Raman response in TMDs.

DS 17.31 Tue 18:15 Poster B

Epitaxially grown h-BN on Ir(111) under He ion irradiation: A route to form one atom thick membranes with an ordered array of nanometer sized holes — •Philipp Valerius, Carsten Speckmann, Alexander Herman, and Thomas Michely — II. physikalisches Institut, Universität zu Köln, Germany

Chemical vapor deposition of borazine molecules on Ir(111) results in a well aligned monolayer of hexagonal boron nitride (h-BN) which forms an incommensurate moiré with (11.7x11.7) h-BN on (10.7x10.7) Ir unit cells. The large h-BN super cell consists of a flat physisorbed mesa with small chemisorbed valleys which form a 2D hexagonal lattice with a pitch of about 3 nm. Here we demonstrate that single vacancies created in the h-BN monolayer on Ir(111) by low fluence 500 eV He ion irradiation at elevated temperatures order to vacancy clusters that are located in the initial valley regions. Consequently, a

2D antidot lattice of small holes with diameters of 0.5-1 nm is formed. The vacancy cluster formation is traced back to single vacancy mobility and preferential bonding of vacancy cluster edges to Ir(111) in the valley regions. Moreover, similar irradiation experiments for an h-BN monolayer on Pt(111) show that our observations represent a general principle of irradiation induced antidot lattice formation, rather than a unique case. Possible uses of such nanomesh membranes based on low energy irradiation are outlined.

DS 17.32 Tue 18:15 Poster B

Local stacking order in few-layer graphene — Fabian Rudolf Geisenhof[1], •Felix Winterer[1], and Ralf Thomas Weitz[1,2] — [1]Physics of Nanosystems, Physics Department, Ludwig Maximilians Universität, München, Germany — [2]NanoSystems Initiative Munich (NIM) and Center for NanoScience (CeNS), München, Germany

The electronic bandstructure of few-layer graphene depends strongly on the local stacking order. For example, it was shown that in contrast to Bernal stacking, ABC stacking exhibits flat conduction bands. These flat bands could possibly lead to exchange-interaction driven novel states [1,2]. It is, therefore, essential to understand and characterize the local stacking order of few-layer graphene samples.

Here, we investigate the local stacking order of few-layer graphene using Atomic Force Microscopy, Raman Spectroscopy and SNOM Measurements. We discuss the surprising observation that wet processing can transform the local stacking from ABC to ABA stacking order and induce further stacking boundaries while others are straightened out.

[1] R.T. Weitz, M.T. Allen, B.E. Feldman, J. Martin, and A. Yacoby, Broken-symmetry states in doubly gated suspended bilayer graphene, Science 330, 812 (2010)

[2] Y. Nam, D.-K. Ki, M. Koshino, E. McCann and A.F Morpurgo, Interaction-induced insulating state in thick multilayer graphene, 2D Mater. 3 045014 (2016)

DS 17.33 Tue 18:15 Poster B

Magnetic-Field-Induced Rotation of Polarized Light Emission from Monolayer WS_2 — •Robert Schmidt[1], Ashish Arora[1], Gerd Plechinger[2], Philipp Nagler[2], Andrés Granados del Águila[3], Mariana V. Ballottin[3], Peter C. M. Christianen[3], Steffen Michaelis de Vasconcellos[1], Christian Schüller[2], Tobias Korn[2], and Rudolf Bratschitsch[1] — [1]Institute of Physics and Center for Nanotechnology, University of Münster, 48149 Münster, Germany — [2]Department of Physics, University of Regensburg, 93040 Regensburg, Germany — [3]High Field Magnet Laboratory (HFML-EMFL), Radboud University, 6525 ED Nijmegen, The Netherlands

Atomically thin transition metal dichalcogenides (TMDCs) are potential building blocks of future applications in the field of "valleytronics". Valley polarization and valley coherence are two important physical mechanisms observed in monolayer TMDCs, such as MoS_2, WS_2, and WSe_2. We investigate the effect of valley coherence in a WS_2 monolayer by measuring the linear polarization of the photoluminescence from the A exciton in high magnetic fields. The magnetic field causes a valley Zeeman splitting of the K^+ and K^- valleys of 8 meV at 30 T. The splitting causes a rotation of the emission polarization with respect to the excitation, accompanied by a reduction of the polarization degree. Both of these phenomena are explained with a model based on two noninteracting coherent two-level systems. Our results light the way for manipulating the phase between the K^+ and K^- valley, which is important for future valleytronic devices.

DS 17.34 Tue 18:15 Poster B

2-Dimensional Atomic Crystals of Transition Metal Dichalcogenides — •Jakub Schusser[1,2], Zakariae El Youbi[1,3], Jan Minar[2], Cephise Cacho[3], Christine Richter[1], and Karol Hricovini[1] — [1]University of Cergy-Pontoise, Paris, France — [2]University of West-Bohemia, New technologies research centre, Plzen, Czech Republic — [3]CLF, RAL, Harwell Campus, Didcot, United Kingdom

Recent development in two-dimensional materials such as graphene, hexagonal boron nitride or transition metal dichalcogenides (TMDCs) has shown such material promising for several applications. TMDCs in particular, are a group of layered materials (e.g. NbSe2, MoS2, MoSe2 WS2, MoTe2) which, despite being structurally similar are particularly interesting due to their strong chemical stability, large flexibility, optical properties and the array of electronic properties ranging from semiconducting to metallic depending on their exact composition, geometry and thickness. Due to similarities such as band gap in a visible spectrum, TMDCs have previously been studied for photovoltaic applications.

We measured thin films (one and several monolayers) of MoSe2, MoS2 and MoTe2 using photoelectron spectroscopy (XPS, ARPES, SARPES). More specifically, the aim of our studies was to determine the changes in the electronic structure when depositing the films on different substrates and when the film thickness is increasing. We followed as well the evolution of the spin texture near the K, K* and M points of the surface Brillouin zone.

DS 17.35 Tue 18:15 Poster B

Spin and Charge Transport in Doped Graphene as a Tailored Carbon Allotrope — •Marie-Luise Braatz[1,2], Nils Richter[1,2], Alexander Tries[1,2,3], Axel Binder[4], Hai I. Wang[3], and Mathias Kläui[1,2] — [1]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany — [2]Graduate School of Excellence Materials Science in Mainz (MAINZ), 55128 Mainz, Germany — [3]Max-Planck-Institut für Polymerforschung, 55128 Mainz, Germany — [4]BASF SE, 67056 Ludwigshafen, Germany

Graphene is a remarkable material with numerous extraordinary properties, among them a high charge carrier mobility. However, it does not have a band gap, which is necessary for many applications. To modify graphene in this respect we employ chemical doping which has been shown to have an effect on the electronic structure [1]. Hence, we use heteroatom-doping, in particular nitrogen, to modify the structure as well as the electronic and magnetotransport properties. The amount of dopants is systematically varied so different dopant concentrations can be compared. The samples are then analyzed by Raman and electron microscopy to elucidate the changes in structure. Measuring the magnetoresistance at various temperatures and fields allows us to correlate the structure to the charge transport properties [2].

[1] H. Wang et al., ACS Catal. 2, 781 (2012)

[2] M. Rein et al., ACS Nano 9, 1360 (2015)

DS 17.36 Tue 18:15 Poster B

Defect enhanced carrier cooling dynamics in graphene — •Eduard Unger[1], Roland Kozubek[2], Stefan Weber[1], Mischa Bonn[1], Marika Schleberger[2], and Dmitry Turchinovich[1,2] — [1]Max-Planck-Institut für Polymerforschung, 55128 Mainz — [2]Fakultät für Physik, Universität Duisburg-Essen, 47057 Duisburg

The present study deals with one of the main drawbacks that characterizes graphene namely the breakdown of THz conductivity for electric fields typical in the semiconductor industry. This results in undesirable limitations in its potential applications as a new material for the next generation of electronics. Our research aims to overcome this limitation by studying the influence of defects on the charge carrier dynamics. Specifically, in order to study the role of structural defects on the charge carrier cooling dynamics via optical pump - THz probe measurements, we introduce the defects into CVD graphene via Xenon irradiation. It comes out that irradiated graphene shows an increase in negative photoconductivity and enhanced charge carrier cooling. Furthermore, THz-TDS measurements confirmed an enhancement of THz conductivity for low defect concentrations. These findings provide a potential way to improve graphene high frequency performance.

DS 17.37 Tue 18:15 Poster B

Fully relativistic ab initio calculations based on the layer Korringa-Kohn-Rostoker method — •Andreas Held, Voicu Popescu, Jürgen Braun, and Hubert Ebert — Department Chemie, Ludwig-Maximilians-Universität München

Understanding the physics of systems with reduced dimensions (multilayer, 2d-materials, surfaces) is a crucial factor for the development of new electronic devices. For this purpose, a computationally extremely efficient and formally robust method, the layer Korringa-Kohn-Rostoker (LKKR) method, has been proposed by MacLaren and Pendry [1]. The scheme is hardly used in particular in its relativistic representation in dealing with the calculations for the electronic structure and transport properties. We included the LKKR scheme in our fully relativistic spin-polarized KKR code [2] that allows us to investigate the impact of relativistic effects like spin-orbit coupling onto layered systems. An implementation of the coherent potential approximation (CPA) allows the evaluation of disorder effect in alloys. With the so-called alloy-analogy [3] model finite temperatures can be treated with lattice vibrations and spin fluctuations.

[1] J.M. MacLaren *et al.*, *Phys. Rev. B* **40**, 12164 (1989); J.M. MacLaren *et al.*, *Comp. Phys. Comm.* **60**, 365 (1990). [2] H. Ebert *et al.*, *Rep. Prog. Phys.* **74**, 096501 (2011). [3] H. Ebert *et al.*, *Phys.*

Rev. B **91**, 165132 (2015).

DS 17.38 Tue 18:15 Poster B

In-situ TEM investigation of NaCl decomposition encapsulated in graphene liquid cells — Fredrik Bräuer, •Tibor Lehnert, and Ute Kaiser — Electron Microscopy Group of Materials Science, University of Ulm, Ulm 89081, Germany

By in-situ transmission electron microscopy we investigate the decomposition process of encapsulated sodium chloride (NaCl) in a graphene liquid cell. We repeated the experiments more than 15 times and found that the actual decomposition process is always very similar. However, it was found out, that these crystals have extremely different stability times. That means the electron dose they can accept before the decomposition process starts deviates massively. This leads to the assumption, that the process is not only determined by the interaction of electron beam and ionic crystal. Due to our investigations a connection between the stability of NaCl and the chemical etching of the graphene layers could be established.

DS 17.39 Tue 18:15 Poster B

Structural ordering of molybdenum disulfide studied via reactive molecular dynamics simulations — •Paolo Nicolini[1], Rosario Capozza[2], and Tomas Polcar[1,3] — [1]Czech Technical University in Prague, Prague, Czech Republic — [2]Istituto Italiano di Tecnologia-IIT, Genova, Italy — [3]nCATS, University of Southampton, Southampton, United Kingdom

Molybdenum disulfide, the most studied member of the transition metal dichalcogenides family, has been used as a solid lubricant for several decades, showing extremely low friction coefficients[1] and stability to high temperature. Its lubricating properties are ascribed to the weak van der Waals interactions between sulfur atoms in the crystalline layered structure. Moreover MoS2, even when prepared in the amorphous state or made of randomly oriented domains, can undergo shear induced structural transitions to the more ordered layered state affecting its tribological properties[2]. Exploiting a classical force field[3] able to treat explicitly formation and breaking of bonds, we investigate by molecular dynamics simulations, the shear induced structural changes and possible layer formation in the amorphous molybdenum disulfide. The ordering process is studied in details, with particular regard to the estimation of the thermodynamic properties that govern the process itself. A connection with crystallization theories is finally found, conferring a predictive power to the achieved results.

[1] J.M. Martin et al., Phys. Rev. B, 48, 10583(R) (1993). [2] J. Moser, F. Lévy, Thin Solid Films, 228, 257 (1993). [3] T. Liang et al., Phys. Rev. B, 79, 245110 (2009).

DS 17.40 Tue 18:15 Poster B

X-ray absorption spectroscopy studies on transition metal dichalcogenide heterostructures — •Florian Rasch[1], Sage Bauers[2], Gavin Mitchson[2], Kyle Hite[2], Danielle Hamann[2], David Johnson[2], Javier Herrero-Martín[3], Manuel Valvidares[3], Bernd Büchner[1,4], and Jorge Hamann-Borrero[1] — [1]Leibniz Institute for Solid State and Materials Research Dresden, Dresden, Germany — [2]Department of Chemistry and Materials Science, University of Oregon, Eugene, oregon, United States — [3]ALBA Synchrotron Light Source, Cerdanyola del Vallès, Barcelona, Spain — [4]Department of Physics, TU Dresden, Dresden, Germany

Over the last years transition metal dichalcogenides (TMDs) have provided a wide playground to study their electronic properties in the crossover from 3D bulk to 2D monolayer structures. A novel way to study the effect of dimensionality on TMDs is given by a new class of materials, i.e. thin film heterostructures with chemical formula $(MSe)_m/(TSe2)_n$, where m layers of a monochalcogenide MSe (e.g. M = Pb, Sn) and n layers of a TMD (e.g. T = Nb, V) are altenrately stacked. In these materials the dimensionalities m and n as well as the constituents M and T can be precisely controlled, allowing for systematic studies of the electronic properties as a function of m, n, M and T. Here, we want to introduce these materials and their trends in electrical properties upon tuning the dimensionality and exchanging the constituents. We will discuss details of the electronic structure of $(MSe)_1/(NbSe_2)_1$ (M = Bi, Sn, Pb) by combining results of x-ray absorption spectroscopy with preliminary bandstructure calculations.

DS 17.41 Tue 18:15 Poster B

Revisiting graphene oxide chemistry via spatially-resolved electron energy loss spectroscopy — •Alberto Zobelli[1], Anna Tararan[1], Ana Benito[2], Wolfgang Maser[2], and Odile Stéphan[1] — [1]Laboratoire de Physique des Solides, University of Paris-Sud, CNRS, Orsay, France — [2]Instituto de Carboquímica ICB-CSIC, Zaragoza, Spain

The type and distribution of oxygen functional groups in graphene oxide (GO) and reduced graphene oxide (RGO) remain still a subject of great debate. Local analytic techniques are required to access the chemistry of these materials at a nanometric scale. Electron energy loss spectroscopy in a scanning transmission electron microscope can provide the suitable resolution, but GO and RGO are extremely sensitive to electron irradiation. In this work we employ an optimized experimental setup to reduce electron illumination below damage limit. GO oxygen maps obtained at a few nanometers scale show separated domains with different oxidation levels. The C/O ratio varies from about 4:1 to 1:1, the latter corresponding to a complete functionalization of the graphene flakes. In RGO the residual oxygen concentrates mostly in regions few tens of nanometers wide. Specific energy-loss near-edge structures are observed for different oxidation levels. By combining these findings with first-principles simulations we propose a model for the highly oxidized domains where graphene is fully functionalized by hydroxyl groups forming a 2D-sp3 carbon network analogous to that of graphane.

DS 17.42 Tue 18:15 Poster B

Surface-assisted synthesis of 0-, 1-, and 2-dimensional structures — •Katayoun Gharagozloo-Hubmann, Niclas Sven Mueller, Christian Lotze, Katharina J. Franke, and Stephanie Reich — Department of Physics, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

The on-surface synthesis of graphene nanoribbons based on halogenated unsaturated hydrocarbons is an already known and often used concept.[1] Molecular precursors were designed that led to the synthesis of ribbons with different symmetry and width.[2]

We propose a novel concept for the on-surface synthesis of 0-, 1-, or 2-dimensional structures. We suggest to select the target precursor from commercially available molecules and use the template substrates for the growth of graphene substructures. We already demonstrated the growth of 2D graphene, when using extended metal substrates.[3] This concept not only provides access to the various graphene substructures, but also impressively demonstrates the use of weak molecular interactions for the production of more complex structures via covalent coupling.

[1] Cai, JM; Ruffieux, P; Jaafar, R; Bieri, M; Braun, T; NATURE 2010, 466, 7305, 470.

[2] Ruffieux, P; Wang, S; Yang, B; Sanchez-Sanchez, C; Liu, J; NATURE 2016, 531, 7595, 489.

[3]Gharagozloo-Hubmann, K; Müller, NS; Giersig, M; Lotze, C; Franke, KJ; Reich, S; J. Phys. Chem. C 2016, 120 (18), 9821.

DS 17.43 Tue 18:15 Poster B

A biosynthetic pathway reconstituted within compartmentalized vesicles — •Akanksha Moga — Max Planck Institute of colloids and Interfaces, Potsdam, Germany

Cells are complex chemical systems composed of distinct compartments that function in a systematic manner. Compartmentalization of the cell is considered as a key step in the direction of eukaryotic evolution that accommodates multiple bio-chemical reactions. These compartments establish physical boundaries for biological processes that enable the cell to carry out different metabolic activities at the same time. In the discipline of bottom-up synthetic biology, lipid vesicles serve as an artificial cell but there is need to compartmentalize the processes within these vesicles. Here, we aim to mimic a cell by developing compartmentalized Giant Unilamellar Vesicles (cGUVs), as an artificial cell model.To illustrate the role of compartments, we study a multi-compartment enzymatic pathway, biosynthesis of molybdenum co-factor (Moco). Moco biosynthesis is highly conserved and ubiquitous pathway that takes place in a typical eukaryotic mitochondrion. The reactions involves cascade of protein/enzymatic reactions but protein encapsulation is not always supported by conventional lipid vesicles generation techniques. Therefore, we have employed an emulsion based phase transfer method to not only produce cGUVs but also to encapsulate specific substrates. Our preliminary results have shown promise with reproducibility of stable GUVs encapsulating various compounds and enzyme from Moco biosynthesis.

DS 17.44 Tue 18:15 Poster B

Antiferromagnetic interfaces in ferromagnetic perovskite heterostructures — •Vitaly Bruchmann-Bamberg and Vasily

Moshnyaga — I. Physik. Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The magnetism in strongly correlated oxide perovskites, e.g. manganites $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), is well-known to be governed by indirect super- or double-exchange mechanism via oxygen p-states. A ferromagnetic (FM) or an antiferromagnetic (AFM) ground state evolves, depending on the configuration and occupancy of d-orbitals. An unusual AFM coupling at the interface between two FM perovskites, i.e. a metallic LSMO ($T_{C,LSMO}$=350 K) and an insulating double perovskite La_2CoMnO_6 (LMCO) ($T_{C,LMCO}$=230 K), was observed. The LSMO/LMCO heterostructures were grown on (100)- and (111)-oriented $SrTiO_3$ substrates by metalorganic aerosol deposition technique. The interfacial AFM coupling appears for $T<T_{C,LMCO}$=230 K and is maximal in (001)-oriented heterostructures. The role of termination layers at LSMO/LMCO interfaces on the exchange mechanisms is discussed within Goodenough-Kanamori-Anderson rules of magnetic couplings.

DS 17.45 Tue 18:15 Poster B

Ni_xO thin films - impact of composition x on optical parameters — •Martin Becker, Fabian Michel, Angelika Polity, and Peter J. Klar — Institute for Exp. Physics I and Center for Materials Research (LaMa), Justus Liebig University Giessen, Germany

Ni_xO thin films were grown on single crystal sapphire substrates of various orientation by ion beam sputtering of a Ni metal target in a mixed argon and oxygen atmosphere. Epitaxial growth was verified by X-ray diffraction measurements on all substrates. Surface morphology and surface roughness were explored via atomic force microscopy. Consequential, Ni_xO films on *c*-plane and *a*-plane sapphire were found to be best suited to serve as antiferromagnetic pinning layers.
For thin films grown on *c*-plane sapphire the composition of the film was varied systematically by changing the ratio of inert gas (Ar) and reactive gas (O_2). The information of chemical bonding was investigated via X-ray photoelectron spectroscopy. Optical characterization yielded a strong dependence of the refractive index and the optical band gap of Ni_xO on composition x, although the samples were very similar relating to their structure. The dependence of the refractive index of Ni_xO on composition x contributes substantially to the broad span of values reported for Ni_xO in literature.

DS 17.46 Tue 18:15 Poster B

Electrical conductivity measurements of ultrathin ferrite films on MgO(001) — •Tobias Pollenske, Jari Rodewald, Tobias Pohlmann, and Joachim Wollschläger — Fachbereich Physik, Universität Osnabrück, Barbarastr. 7, 49076 Osnabrück, Germany

The semiconducting and ferrimagnetic behavior make ultrathin epitaxial ferrite films like $NiFe_2O_4$ or $CoFe_2O_4$ promising candidates in the field of spintronics. Due to their spin dependent tunneling barrier they are well-suited to be used as spin filters. Here, the resistance of the films is a crucial property for the formation of suitable tunneling barriers and thus for the performance as a spin filter.

Hence, in this work a measurement setup is taken into operation to investigate the temperature dependent conductivity of ultrathin ferrite films. First, different types of contacts in van-der-Pauw geometry are tested in order to optimize the performance of the measurement setup. Furthermore, ultrathin $Ni_xFe_{3-x}O_4$ films on MgO(001) with different stoichiometries ($0 \leq x \leq 2$) are prepared via reactive molecular beam epitaxy (RMBE) and their conductivity is analyzed with respect to the different cation ratios.

DS 17.47 Tue 18:15 Poster B

Electrical Permittivity Determination of ScAlN Thin Films — •Niclas Feil[1], Nicolas Kurz[2], Mohammad Fazel Parsapourkolour[3], and Oliver Ambacher[1] — [1]Laboratory for Power Electronics, INATECH-Department of Sustainable Systems Engineering, University of Freiburg, Emmy-Noetherstr. 2, 79110 Freiburg, Germany — [2]Laboratory for Compound Semiconductor Microsystems, IMTEK-Department of Microsystems Engineering, University of Freiburg, Georges-Koehler-Allee 103, Germany — [3]Electroceramic Thin Films Group, EPFL, Laussane, Switzerland

Wurtzite scandium-aluminiumnitride ($Sc_xAl_{1-x}N$) is a material with outstanding properties. For instance, 400 % increase of the piezoelectric strain constant d_{33} for $Sc_{0.43}Al_{0.57}N$ compared to AlN was reported. This results in a substantially enhanced electromechanical coupling, which is needed for future high frequency piezoacoustic filter devices for the upcoming 5G mobile radio standard. All tensor components are needed for the design of these devices. However, dielectric tensor components are still missing. In this work, the missing ϵ_{11} component of the dielectric tensor for $Sc_xAl_{1-x}N$ is determined experimentally for the first time. We developed a method for the determination of the basal permittivity component ϵ_{11}. It is based on the electrical capacitance measurement of interdigital test structures and finite element model optimization. The developed approach was validated with c-axis oriented sapphire substrates and AlN thin films. We observe that the $\frac{\epsilon_{11}}{\epsilon_{33}}$ ratio of $Sc_{0.15}Al_{0.95}N$ and AlN are different which highlights the change in anisotropic properties.

DS 17.48 Tue 18:15 Poster B

Quantitative disentanglement of fully controllable coherent and incoherent laser-induced surface deformations by time-resolved x-ray reflectivity — •Marc Herzog[1], Mathias Sander[1], Jan-Etienne Pudell[1], Matias Bargheer[1,2], Roman Bauer[3], Valentin Besse[4], Vasily Temnov[4,5], and Peter Gaal[3] — [1]Institut für Physik und Astronomie, Universität Potsdam, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Germany — [3]Institut für Festkörper- und Nanostrukturphysik, Universität Hamburg, Germany — [4]IMMM CNRS 6283, Université du Maine, 72085 Le Mans cedex, France — [5]CNRS UMR 8635, Université Paris-Sacley, 78035 Versailles cedex, France

High-frequency surface acoustic waves (SAWs) are not only present in any mobile phone, they are a powerful tool for fundamental research, e.g., to investigate the coupling of the lattice to other degrees of freedom in solids. SAWs with specific wavevectors can be generated by transient grating (TG) excitation using ultrashort laser pulses. In absorbing media, however, most of the optical excitation energy is deposited as incoherent, thermal strain. By using time-resolved x-ray reflectivity, we measure and decompose the absolute amplitudes of these transient coherent and incoherent periodic surface distortions which is very challenging using all-optical experiments. Moreover, we refine the TG technique to get full spatiotemporal coherent control of both coherent and incoherent excitations individually in order to suppress or enhance whatever is of primary interest.

DS 17.49 Tue 18:15 Poster B

Partial Least Square Regression of AES depth profiles and UV-visible spectroscopy for determining oxide layer thicknesses on technical copper — •Jan Stiedl[1,2,3], Simon Green[3], Thomas Chassé[2], and Karsten Rebner[1] — [1]Reutlingen University, Alteburgstrasse 150, 72762 Reutlingen, Germany — [2]University of Tuebingen, Auf der Morgenstelle 18, 72076 Tuebingen, Germany — [3]Robert Bosch GmbH, Postfach 1342, 72703 Reutlingen, Germany

In research as in industry, copper is a very commonly used raw material. Due to its electrical properties, copper is used both in battery development and in the development of control units for automotive and non-automotive applications. To ensure the electrical properties and the adhesion of material used in the contacting and packaging technology, the surface of the copper must not be covered by uncontrolled growth of oxide layers. In order to assess this, photoelectron spectroscopy, such as XPS or AES is used. However, these methods are not sufficient for satisfactory statistics and cover-age of production batches. For this purpose, an UV-visible spectroscopy measurement system was developed, which can qualitatively and quantitatively characterize the surface with a Partial Least Square regression (PLS) model in the range of 0 - 50 nm. Superimposed absorption and interference spectra are used to determine oxide layers. PLS is used as a data evaluation tool to establish a regression between the UV-Visible spectra and AES depth profiles. The accuracy of the regression is about 5 %. Already known methods cannot be used in these cases, mostly due to the high roughness of the technical copper surfaces.

DS 17.50 Tue 18:15 Poster B

Infrared Mueller Ellipsometry of Thin Films — •Andreas Furchner, Cordula Walder, and Karsten Hinrichs — Leibniz-Institut für Analytische Wissenschaften – ISAS – e.V., Schwarzschildstraße 8, 12489 Berlin, Germany

Non-isotropic thin films can be characterized by their Mueller matrix (MM), a 4x4 matrix that describes the sample's optical properties upon interaction with polarized light. Besides anisotropy and structure, Mueller matrices in the infrared region provide information on, for example, film chemistry, composition, and molecular interactions. However, laboratory thin-film MM measurements in the infrared are inherently difficult, in part because of source prepolarization, non-ideal

polarizers, and low optical throughput.

We developed a powerful IR Mueller ellipsometer with high optical throughput that enables sensitive MM measurements of thin films below 100 nm. The measurement scheme can be restricted to a subset of defined polarizer settings, allowing one to extract quadruples of Mueller matrix elements within a few 10 seconds to minutes. Tandem polarizers gurantee a sufficiently high degree of polarization necessary to accurately measure block-offdiagonal MM elements, while optional retarders provide access the fourth row or column of the Mueller matrix. Both normalized and absolute Mueller matrices can be obtained.

We demonstate Mueller matrix measurements of thin polymer films and, in cooperation with HZB Berlin, of trapezoidal SiO2 gratings, the offdiagonal MM elements of which are highly sensitive towards structure and orientation.

DS 17.51 Tue 18:15 Poster B

Molecular Beam Deposition of thin YbzFeSb3 films on (001) oriented KCl — •Felix Timmermann — Universität Augsburg, Augsburg, Germany

Increasing interest in the development of alternative energy sources led to an extended research in the field of thermoelectricity. For a good efficiency of thermoelectric generators, there is a need of materials with special transport properties. The goal is to find compounds with a large Seebeck coefficient α, good electrical conductivity σ and low thermal conductivity κ. Skutterudites, such as FeSb3, are materials that meet those criteria well. The insertion of filler atoms like Yb increases the thermal stability and has the potential to increase to improve the thermoelectric properties further.

In this work the materials iron, antimony and ytterbium were thermally evaporated and deposited on heated (001) oriented KCl-substrates by molecular beam epitaxy in order to achieve epitaxial growth of thin YbzFeSb3 films. It could be shown that there is a strong dependence of the growth rate of antimony to the iron flux and the substrate temperature. Furthermore a drastic increase of the growth rates of iron and antimony with increasing ytterbium flux was observed. Structural characterization was carried out in situ by Reflection High-Energy Electron Diffraction and ex situ by X-Ray Diffraction and Transmission Electron Microscopy.

DS 17.52 Tue 18:15 Poster B

Investigation of the Density of States of Phase Change Materials by Tunneling Spectroscopy — •Lisa Metzner[1], Dominik Gholami Bajestani[1], Henrik Padberg[1], Tobias Schäfer[1], and Matthias Wuttig[1,2] — [1]I. Physikalisches Institut (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]JARA - FIT, RWTH Aachen University, Germany

Due to their unique physical properties, phase change materials (PCM) are promising candidates for future data storage applications. By applying electrical or laser pulses, they can be switched reversibly between an amorphous and a crystalline state on a nanosecond timescale. These states are characterized by a large optical and electrical contrast, which is utilized for rewritable optical data storage and phase change RAM applications. Furthermore, the resistivity can be tuned over several orders of magnitude by disorder control, which allows for possible multilevel memory devices in the future. In order to fully understand the electronic properties of those materials, the density of states (DOS), especially in the vicinity of the Fermi level, is a crucial quantity. This contribution presents the method of tunneling spectroscopy, which allows the determination of the DOS around the Fermi energy with a resolution of up to 0.2 meV, complementing to photoelectron spectroscopy which is typically limited by a resolution of around 0.1 eV. The measurements were performed using tunnel junctions, produced by in-situ sputter deposition in order to prevent the PCM from surface contamination. Besides the introduction of the procedure, tunneling spectra of PCMs with a varying degree of disorder are presented.

DS 17.53 Tue 18:15 Poster B

Structural Characterisation of Crystalline Lead-Antimony-Telluride Alloys — •Alexander Rochotzki[1], Johannes Reindl[1], and Matthias Wuttig[1,2] — [1]I. Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]JARA - FIT, RWTH Aachen University, 52056 Aachen, Germany

The material class of chalcogenides has great potential for practical applications, ranging from optical and electrical data storage to thermoelectrics. For the latter, materials on the tie line between PbTe and Sb_2Te_3 are interesting candidates. In the past, the group of Shelimova et al. has already investigated such compounds in their thermodynamic stable hexagonal phase with respect to structure and possible thermoelectric applications [1].
In the hexagonal phase of $(PbTe)_x(Sb_2Te_3)_{1-x}$, the intrinsic vacancies form layers, similar to the isoelectronic phase-change materials on the tie line between GeTe and Sb_2Te_3, which additionally exhibit a metastable cubic phase, not yet seen in $(PbTe)_x(Sb_2Te_3)_{1-x}$. In this work we aim to synthesise the metastable cubic phase of PbSbTe while characterising and optimising the structural properties of the compounds fabricated.
[1] Shelimova, L.E. et al., *Inorganic Materials*, Vol. 40, 1440 (2004)

DS 17.54 Tue 18:15 Poster B

Two-dimensional growth of three-dimensionally bonded GeTe — •Isom Hilmi, Andriy Lotnyk, Jürgen Gerlach, Philipp Schumacher, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung e.V., 04318, Leipzig, Germany

In this work, epitaxial thin films of three-dimensionally (3D)-bonded GeTe are grown on a two dimensionally (2D)-bonded ultra-thin Sb2Te3 seeding layer on Si(111) by pulsed laser deposition. The GeTe films are grown in trigonal phase with epitaxial relationships of GeTe(0001) || Sb2Te3(0001) || Si(111) and GeTe[11-20] || Sb2Te3[11-20] || Si[-110]. The use of a seeding layer is shown to extend the epitaxial window towards lower temperature regimes up to 145 °C. Additionally, the surface quality of the GeTe films is also significantly improved. Local structure investigation of the epitaxial films reveals the presence of a superposition of twinned domains, which is assumed to be an intrinsic feature of these thin films. This work paves a way to improve epitaxial growth and film quality of 3D-bonded alloys by the use of 2D-bonded seeding layer.

DS 17.55 Tue 18:15 Poster B

Structural changes in epitaxial Ge2Sb2Te5 thin films with highly ordered vacancy layers upon ns-laser irradiation — •Mario Behrens, Andriy Lotnyk, Jan Griebel, Jürgen Gerlach, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung e.V., Permoserstr. 15, 04318, Leipzig, Deutschland

Chalcogenide phase-change materials can be rapidly switched between their amorphous and crystalline phase by being exposed to electrical or optical pulses. Since both phases differ greatly in their reflectivity and conductivity, these materials can be employed for non-volatile optical and electrical data storage based on the phase-change storage mechanism. In this study, ns-laser pulse induced phase transformations of the most prominent chalcogenide phase-change material Ge2Sb2Te5 (GST225), epitaxially grown on Si(111) substrates by pulsed laser deposition, are investigated. X-ray diffraction and aberration-corrected high-resolution scanning transmission electron microscopy of the as-deposited films revealed the formation of cubic GST225 phase with ordered vacancy layers. By applying ns UV-laser pulses the GST225 films were reversibly switched between their crystalline and amorphous state, resulting in a reflectivity contrast of up to 22 %. Within the recrystallization process the amorphous thin films were transformed into a crystalline GST225 phase with disordered vacancies. The influence of laser parameters on the phase changes is discussed.

DS 17.56 Tue 18:15 Poster B

Thermoelectric performance of multilayers of Sb_2Te_3 thin films and Pt nanoparticles — •Darius Pohl, Heiko Reith, Frank Schmidt, Gabi Schierning, Kornelius Nilesch, and Bernd Rellinghaus — IFW Dresden

Three material properties (Seebeck coefficient, electrical and thermal conductivity) define the efficiency of a thermoelectric material stated as figure of merit ZT. Introducing additional interfaces in the material is considered as an effective means to further improve the performance of thermoelectric devices. This is generally attributed to either a change of the local electronic density of states or to a significant increase of phonon scattering at interfaces and defects. In the present study, we investigate the thermoelectric properties of discontinuous thin film multilayers of alternating Sb_2Te_3 thin films and Pt nanoparticles. Both, the thin films and the Pt nanoparticle are prepared by RF and DC magnetron sputtering, respectively. The thermoelectric performance of the likewise prepared $[(Sb_2Te_3)|Pt-nP's]_N$ samples is correlated with the details of the local structure and chemical composition as provided by (HR)-TEM, EDXS and EELS investigations.

DS 17.57 Tue 18:15 Poster B

Highly conductive thin-films based on solution-processed silver nanoparticles for spray-on antennas — •Marco Bobinger[1],

Michael Haider[1], Andreas Albrecht[1], Yash Goliya[1], Johannes Russer[1], Markus Becherer[1], and Paolo Lugli[2] — [1]Department of Electrical and Computer Engineering, Technical University of Munich, Munich, Germany — [2]Free University of Bozen-Bolzano, Bozen-Bolzano, Italy

Antennas are commonly deposited to rigid substrates using a physical vapour deposition process that requires high vacuum and eventually also high temperatures. Solution-processed inks that are based on e.g. metal nanowires or -particles have recently attracted a high research and commercial interest attributed to scalable synthesis protocols and readily available deposition techniques under ambient conditions.

In this contribution, we report on the fabrication and characterization of conductive thin-films based on spray-coated silver nanoparticles. In order to enhance the conductivity of the sub 250 nm thick films, different sintering techniques such as thermal annealing and high intensity light pulse sintering were investigated under ambient conditions. After sintering, films with a thickness around 130 nm and a resistivity around 64 nOhm*m, which is only around a factor of 4.8 higher than the value reported for bulk silver, were produced. The drastic reduction in resistance from almost non-conductive can be ascribed to the coalescence of the 50 nm particles to a percolating silver film. Furthermore, the highly conductive films were tested for spray-on antennas on rigid and flexible substrate using an original coplanar design.

DS 17.58 Tue 18:15 Poster B

Memsensors: emerging properties for neuromorphic engineering — •Alexander Vahl[1], Jürgen Carstensen[2], Sören Kaps[2], Thomas Strunskus[1], Oleg Lupan[2], Rainer Adelung[2], and Franz Faupel[1] — [1]Christian-Albrechts University at Kiel, Institute for Materials Science, Chair for Multicomponent Materials, Kaiserstr. 2, 24143, Kiel, Germany — [2]Christian-Albrechts University at Kiel, Institute for Materials Science, Chair for Functional Nano Materials, Kaiserstr. 2, 24143 Kiel, Germany

In biological neuronal systems such as the human brain, adaptation is very important for efficient use of neuronal capabilities and learning. In this work we present a concept to translate adaptation into neuromorphic engineering at the example of memsensors. Memsensors are a class of two terminal devices that combine the basic features of memristive devices (pinched hysteresis) and sensors (change in electrical resistivity depending on an external stimulus). Apart from their inherited properties, memsensors have the capability to adapt to the external stimulus as well as a strongly stimulus dependent I-V characteristic. The electrical behavior of a general memsensor was modelled by a three component equivalent circuit, based on two memristive elements in series and in parallel to a sensitive element respectively.

DS 17.59 Tue 18:15 Poster B

Resistive Switching Behavior of Polycrystalline PCMO Thin Films with AlOx Tunnel Oxide — •Alexander Gutsche[1], Christoph Bäumer[1], Rainer Waser[1,2], and Regina Dittmann[1] — [1]Peter Gruenberg Institut, Forschungszentrum Juelich GmbH, Germany — [2]Institut fuer Werkstoffe der Elektrotechnik (IWE-2), RWTH Aachen, Germany

Redox based memory is a promising candidate for nonvolatile memory to replace flash memory and can be used as basis for novel neuromorphic circuits. Most of the employed systems show filamentary switching, which causes a high variability in resistivity induced by the stochastic filament formation process. Another type of resistive switching is interface type switching, which occurs for example in hetero structures consisting out of a tunnel barrier (AlOx) and a mixed-valence manganite (PCMO). Interface type switching suffers less from resistivity variability, because of the area scaling, i.e., the resistance value is inversely proportional to the surface area. In addition it is possible to adapt the memory device current to a given circuit requirement. Here we will present the switching characteristics of polycrystalline PCMO thin films grown on Pt substrates with an Al tunnel barrier, taking into account the influence of the growth temperature on the pulsed laser deposited PCMO film. The investigation of the formation step of the AlOx tunnel barrier shows a strong dependence of the initial state of the memory device, what can also be seen in the formation voltage, which is influenced by the initial state. Also we will present measurements of the area scalability of the memory cell.

DS 17.60 Tue 18:15 Poster B

Flexible Co-based Heusler alloy/muscovite heteroepitaxy — •Yi-Cheng Chen[1,2], Min Yen[2], Anastasios Markou[1], Benedikt Ernst[1], Claudia Felser[1], and Ying-Hao Chu[2] — [1]Max Planck Institute CPfS, Dresden, Germany — [2]National Chiao Tung University, Taiwan

Co-based ferromagnetic Heusler compounds show high spin polarization combined with high Curie temperature of ≈ 700 K. In this study, we demonstrate the epitaxy of Co_2MnGa Heusler alloy on flexible muscovite substrate, which paves a way toward flexible spintronic devices. The epitaxial Co_2MnGa Heusler film on muscovite substrate was prepared by magnetron sputtering. Muscovite is chosen as a flexible substrate for Heusler alloy since its melting point meets growth condition for epitaxy. The epitaxy was characterized by X-ray diffraction and the epitaxial relationship between the substrate and the film was found to be [110] Mica||[1 -1 0]Co2MnGa. The bending affects the magnetization and the transport properties of the thin films. The saturation magnetization is increased by 7.6 percent under bending condition. The demonstration of Co_2MnGa/muscovite heteroepitaxy provides a new perspective on developing devices with a huge potential for flexible spintronic.

DS 17.61 Tue 18:15 Poster B

Large-scale spray deposition of carbon nanotube-based thin-film devices — •Florin-Cristian Loghin[1], Aniello Falco[2], Marco Bobinger[1], Alaa Abdellah[1], Markus Becherer[1], Paolo Lugli[2], and Almudena Rivadeneyra[1] — [1]Institute for Nanoelectronics-Technische Universität München, Munich, Germany — [2]Free University of Bozen-Bolzano, Bozen-Bolzano, Italy

Due to their remarkable electrical and mechanical characteristics, Carbon nanotubes (CNTs) are ideal candidates for a wide range of applications. The possibility to fabricate CNT thin-films via solution processing techniques has enabled the way to low-cost CNT thin-film devices including thin-film transistors (TFTs) and circuits, thermal and chemical sensors as well as transparent conductive films (TCFs). In this contribution, we report on a spray deposition technique, which can produce uniform, reproducible thin-films suitable for a wide range of applications. The use of non-invasive solvents (DI-H2O) as well as low processing temperatures (<65°C) permits for the process to be easily integrated into existing technology platforms. Furthermore, the resolution down to 10 CNTs/um2 per deposited layer allows for precise device engineering. In order to better display this technology, proof of concept devices were fabricated and characterized, including TFTs, chemical sensors and TCFs.

DS 17.62 Tue 18:15 Poster B

Pulsed Laser Deposition of $PbZr_{0.52}Ti_{0.48}O_3$ thin films on stainless steel — •Juliette Cardoletti, Aldin Radetinac, Philipp Komissinskiy, and Lambert Alff — Technische Universität Darmstadt, Institute of Materials Science, Alarich-Weiss-Straße 2, 64287 Darmstadt, Germany

With the acute need for miniaturisation of devices and components, the use of bending tongues (cantilevers or wider beams) based on piezoelectric ceramics is increasing. Up to date most devices are created by gluing piezoelectric elements onto metallic structures with epoxy.

Some papers present a new solution by depositing a $PbZr_{0.52}Ti_{0.48}O_3$ (PZT) thin film by sol-gel on nickel foils using HfO_2 and $LaNiO_3$ (LNO) as buffer layers [1].

This work aims to deposit PZT and LNO thin films on stainless steel by Pulsed Laser Deposition (PLD). Using a physical vapour deposition method potentially allows for a better process control and is better applicable to microelectromechanical systems (MEMS).

[1] H.G. Yeo and S. Trolier-McKinstry, J. Appl. Phys. 116, 014105 (2014).

DS 17.63 Tue 18:15 Poster B

Distinct Emission Characteristics of Nano-Sized Metal-Organic Hybrid Structures — •Maximilian Rödel[1], Verena Kolb[1], and Jens Pflaum[1,2] — [1]Experimental Physics VI, Julius Maximilian University of Würzburg, 97074 Würzburg — [2]Bavarian Center for Applied Energy Research (ZAE Bayern), 97074 Würzburg

Nano-sized organic-metal hybrid structures offer unique and attractive optical properties for example, in lighting applications like organic LEDs. Moreover, by means of shadow-nanosphere-lithography we are able to fabricate these structures in hexagonally ordered arrays [1]. In this contribution, we report on laterally structured zinc-phthalocyanine (ZnPc) films in close proximity to nanostrucured gold or silver facettes and their resulting optical excitations posessing a coupled exciton plasmon character. Besides demonstrating a remark-

able increase in light-outcoupling and quantifying the geometrical and plasmonic contributions, we investigate the occurrence and spectral signature of collective modes generated via plasmon-mediated interaction between the neighbouring discrete ZnPc nanovolumes.

[1] V. Kolb, J. Pflaum, Opt. Express 25 (2017) 6678

DS 17.64 Tue 18:15 Poster B

Interactions at the interface of TMPcs and graphene covered metal surfaces: Influence of fluorination and intercalation — •David Balle, Peter Grüninger, Reimer Karstens, Hilmar Adler, Thomas Chassé, and Heiko Peisert — Institute of Physical and Theoretical Chemistry, Auf der Morgenstelle 18, 72076 Tuebingen, University of Tuebingen, Germany

Recent years have seen increasing research efforts in the field of transition metal phthalocyanines (TMPc) due to their special electronic, optical and magnetic properties making them potential suitable candidates for organo-electronic applications.

To manipulate interface interactions, which can drastically alter said properties, Graphene buffer layers offer a valuable tool. On Ni(111), a strongly bound and coupled Graphene layer behaves vastly different in regards to its buffer properties than an uncoupled, intercalated layer on the same substrate. The degree of coupling and interaction between the Graphene layer and the substrate is subject to the intercalating element, though, providing a method to finely tune the coupling by carefully choosing the intercalant, like Fe, Cu or Ge. Other electronic parameters of the TMPc, such as substitution of the terminal hydrogen atoms with fluorine, also play a crucial role if an interface interaction persists through the buffer layer like in the case of $CoPcF_{16}$ while the corresponding interaction is blocked for CoPc on intercalated Graphene on Ni(111) [1]. Investigations were carried out using mainly X-ray absorption and photoemission spectroscopies (XAS, PES).

[1] Balle et al., J. Phys. Chem. C 2017, 121, 18564-18574

DS 17.65 Tue 18:15 Poster B

Kelvin-Probe Force Microscopy and Conductive-AFM Studies of the Contact Formation with 1-(Pyridin-2-yl)-3-(quinolin-2-yl)imidazo[1,5-a]quinoline in Layered Structures — •Clemens Geis[1], Eric Yanchenko[1], Georg Albrecht[1], Jasmin Martha Herr[2], and Derck Schlettwein[1] — [1]Institute of Applied Physics, JLU Giessen, Germany — [2]Institute of Organic Chemistry, JLU Giessen, Germany

1-(Pyridin-2-yl)-3-(quinolin-2-yl)imidazo[1,5-a]quinoline was investigated as a model compound of a new class of organic semiconductors which receives increased interest for applications in material science, mainly regarding blue organic light emitting diodes (OLED). In order to construct electronic devices, a proper alignment of the energy levels of contact materials and emitters is mandatory for an efficient charge carrier injection. In this work the contact potential differences of emitters, anode and cathode materials are investigated by Kelvin-probe force microscopy (KPFM). A layered sample design allowed to measure all potential differences in a single device. A Fermi level close to the occupied orbitals of the organic layer was determined showing the dominance of hole conduction. Current-voltage characteristics of test devices confirmed appropriate contact formation by current onsets at low voltages. These results are compared to first measurements at 1,3-disubstituted imidazo[1,5-a]pyridines and -quinolines to establish a systematic optimization.

DS 17.66 Tue 18:15 Poster B

Initial Growth of DNTT Thin Films on Ag(111) — •Daniel Bischof, Maximilian Dreher, Andrea Huttner, Felix Widdascheck, Tobias Breuer, and Gregor Witte — FB Physik Phillips-Universität Marburg 35032 Marburg, Germany

The high charge carrier mobility of the novel organic semiconductor (OSC) dinaphthothienothiophene (DNTT) has created large interest in this compound in view of potential efficient devices. Since device characteristics are largely governed by interfaces to metallic electrodes, the structure and coupling at metal surfaces is of fundamental interest. Here, we combined STM and NEXAFS to investigate the initial stage of DNTT film growth on Ag(111) substrates. While initially a relaxed monolayer of flat-lying molecules is formed, at large coverage a compressed monolayer forms, where molecules exhibit a herringbone arrangement. Interestingly, multilayer films reveal a temporal dewetting, yielding the formation of discrete islands surrounded by regions with the relaxed monolayer.

DS 17.67 Tue 18:15 Poster B

Gas adsorption on self-assembled monolayers — •Christian Albers, Susanne Dogan, Michael Paulus, and Metin Tolan — Fakultät Physik/DELTA, TU Dortmund

The influence of gases on hydrophobic surfaces especially on self-assembled monolayers (SAM) is in focus of the recent research [1, 2]. An X-ray reflectivity study on the adsorption behaviour of different organic gases on long alkyl chains (Octadecyltrichlorosilane (OTS) $SiCl_3C_{18}H_{37}$) is presented. Silicon wafers were exposed to piranhia solution to get a hydrophilic interface and then treated with OTS-solution in order to induce SAM formation on the surface [3]. Subsequently, they were exposed to dense gas phases near the condensation pressure of isobutane, perfluorobutane and octafluoropropane. The results show, that the SAM are not penetrated by the gas molecules. Even at pressures close to the condensation pressures of the used gases there is no change in the SAM structures.

[1] L. Böwer et al. J. Phys. Chem. 15 (2011), S. 8235-18238.
[2] F. Giebel et al. Coll. Surf. A 504 (2016), S 126-130.
[3] M. Mezger et al. Proc. Natl. Acad. Sci. U.S.A. 103 (2006), S. 18401.

DS 17.68 Tue 18:15 Poster B

Infrared Spectroscopic Study on Phosphonic Acid Modification of Nickel Oxide — •Valentina Rohnacher[1,2], Sabina Hillebrandt[1,2], Florian Ullrich[2,3], Sebastian Hietzschold[2,4], Sebastian Beck[1,2], and Annemarie Pucci[1,2] — [1]Kirchhoff Institut für Physik, Uni Heidelberg — [2]Innovationlab GmbH, Heidelberg — [3]TU Darmstadt — [4]TU Braunschweig

Solution-processed nickel oxide (sNiO) thin films have shown promising characteristics as hole transport material in organic photovoltaic cells (OPVs) leading to a better interfacial compatibility between the transparent conductive oxide electrode and the organic semiconductor layer. In this study, sNiO thin films have been modified by a dipolar self-assembled monolayer (SAM) of 4-cyanophenylphosphonic acid (CYNOPPA) to gain full control of the surface properties. Infrared vibrational spectroscopy gives insight into the composition of the investigated material and can be used for monitoring orientation of characteristic vibrations or functional groups. Together with photoelectron spectroscopy, contact angle measurements and OPV device characteristics, a deeper understanding of the structure-function relationship of the modified sNiO have been achieved. The results reveal that hydroxide species of the sNiO films play a crucial role for the chemisorption of SAMs on sNiO. Besides the increased work function and improved wettability, the sNiO surface has been successfully passivated by chemisorption of CYNOPPA.

DS 17.69 Tue 18:15 Poster B

Growth Kinetics-Controlled Morphology of DNTT Thin Films on KCl (001) — •Darius Günder, Andrea Huttner, Tobias Breuer, and Gregor Witte — FB Physik, Philipps-Universität Marburg

The novel organic semiconductor dinaphthothienothiophene (DNTT) has recently gained interest for molecular electronic devices due to its high charge carrier mobility [1]. While the main focus here is typically on transistor characteristics, the microstructure and morphology of the organic semiconductor films are usually less well known. In previous work, a substrate mediated control of the molecular orientation as well as notable dewetting was observed for DNTT [2]. In the present study, we report on the coexistence of two different film morphologies on KCl (001) substrates. Using atomic force microscopy (AFM) we show that by variation of the kinetic growth parameters such as substrate temperature and evaporation rate the amount of both structures can be precisely tuned. Complementary X-Ray diffraction (XRD) measurements reveal different molecular orientations in these two morphologies. Interestingly, both structures grow epitaxially on the KCl (001) surfaces in different discrete azimuthal orientations as observed from statistical analysis of AFM data and inplane XRD scans.

[1] Xie et al., Advanced Materials 25, 3478 (2013)
[2] Breuer et al., ACS Applied Materials & Interfaces 9, 8384 (2017)

DS 17.70 Tue 18:15 Poster B

FePc and $FePcF_{16}$ on Rutile: Influence of the defects and the crystal orientation on the interaction — •Reimer Karstens, David Balle, Axel Belser, Thomas Chassé, and Heiko Peisert — Institute of Physical and Theoretical Chemistry, Auf der Morgenstelle 18, 72076 Tuebingen, University of Tuebingen, Germany

Nowadays, organic semiconductor electronics are extensively investigated due to their electronic, magnetic, optical properties and their possible applications. Transition metal phthalocyanines (e.g. FePc) on rutile surfaces represent an important model system for organic semiconductor-oxide interfaces. Moreover, such interfaces are of high interest for applications, like dye-sensitized solar-cells. Our research focus lies on the influence of three parameters on the interface interaction: vacancies, crystal orientation and changed electronic properties by fluorination of the phthalocyanine molecule. Reconstructed rutile single crystal surfaces (TiO_2 (100)-(1×3) and TiO_2 (110)-(1×1)) are used, where the defect concentration is controlled by the oxygen amount during the annealing. The orientation of the phthalocyanine molecules and the interface interaction were investigated by photoemission and x-ray absorption spectroscopy. The interaction involves in particular the nitrogen atoms of the phthalocyanine. Clear differences are observed in the interaction for different TMPc molecules and defect concentrations.

DS 17.71 Tue 18:15 Poster B

Hexacene - Thin film studies on Au(110) with x-ray spectroscopies — •Peter Grüninger[1,2], David Balle[1], Reimer Karstens[1], Heiko Peisert[1] und Holger F. Bettinger[2] — [1]Institute of Physical and Theoretical Chemistry, University of Tübingen, Germany — [2]Institute of Organic Chemistry, University of Tübingen, Germany

Acenes are an important class of polycyclic aromatic hydrocarbons. However molecules larger than pentacene, a well-known material for organic electronics, are difficult to handle due to their low solubility and high reactivity. Here, we focus on the synthesis and thin film properties of the six-ringed hexacene. Although hexacene could be isolated in the bulk many years ago, the preparation of well-defined thin films remains a challenge. After synthesis of hexacene via modified Meerwein-Ponndorf-Verley reduction of hexacene-6,15-quinone, we successfully evaporated hexacene on Au(110) for the first time. We studied the electronic properties and the molecular orientation using x-ray absorption and photoemission spectroscopy (XAS, PES). The occupied and unoccupied structure is compared to pentacene. The orientation of hexacene in the monolayer range was almost flat lying, whereas larger tilt angles to the surface were found in thin films.

DS 17.72 Tue 18:15 Poster B

Controlling the work function of metals by means of phthalocyanine thin films — •Felix Widdascheck, Alrun Hauke, and Gregor Witte — Molekulare Festkörperphysik, Philipps-Universität Marburg, Renthof 7, D-35032 Marburg, Germany

Efficient charge transfer at the interface between organic semiconductors and the respective device electrodes is of key importance for the advancement of organic electronics. It depends crucially on the energy level alignment and the reduction of potential injection barriers at such interfaces. A promising approach to effectively tune work functions and therefore optimize interface energetics are monolayers of flat lying molecules as contact primers. Compared to self-assembled monolayers they promise lower contact resistance due to shorter tunneling distances. Due to their high flexibility and flat absorption geometry phthalocyanines are an ideal model system to identify important parameters for this process. The presented study combines STM and Kelvin Probe measurements to compare the effect of highly ordered thin films of different phthalocyanines on the work function of metals and their possible use as contact primers. An additional focus is the importance of structural order and the influence of adsorbed film thickness.

DS 17.73 Tue 18:15 Poster B

Planar and porous polypyrrole/silicon hybrid material systems — •Pirmin Lakner[1], Manuel Brinker[2], Andreas Stierle[1], Patrick Huber[2], and Thomas Keller[1] — [1]DESY Deutsches Elektronen-Synchrotron Hamburg, Nanolab — [2]TU Hamburg-Harburg, Institut für Werkstoffphysik und Werkstofftechnologie

The investigation of interfaces in two-dimensional planar systems plays an elementary role in the investigation of porous hybrid materials, since it allows effects in more complex geometries to be attributed to their underlying causes. For the analysis of polypyrrole/silicon hybrid material systems, an electrochemical cell has been developed that enables the in-situ and nanometer-accurate investigation of the electropolymerization of pyrrole on planar silicon crystals using X-ray reflectometry. At the same time, electron density profiles and characteristic potential curves are recorded and layer heterogeneity is measured using SEM and AFM. The electrochemical cell enables the investigation of the voltage-induced swelling behaviour of polypyrrole, which opens up possible applications of porous polypyrrole/silicon hybrid material systems as actuators or sensors and optimizes them with regard to mechanical and electrical properties.

DS 17.74 Tue 18:15 Poster B

Materials Science of ALD Fresnel Zone Plates — •Umut T. Sanli[1], Chengge Jiao[2], Margarita Baluktsian[1], Kersten Hahn[3], Yi Wang[3], Vesna Srot[3], Gunther Richter[1], Iuliia Bykova[1], Markus Weigand[1], Gisela Schütz[1], and Kahraman Keskinbora[1] — [1]MPI for Intelligent Systems, Stuttgart — [2]FEI, Eindhoven — [3]MPI for Solid State Research, Stuttgart

X-ray microscopy is a very strong tool to investigate matter providing high penetration depths combined with structural, chemical and magnetic contrast. One of the most widely used X-ray optics is the Fresnel zone plate (FZP), particularly for ultrahigh resolution X-ray microscopy. A FZP is an alternating set of transparent and opaque concentric rings and its resolution is given by the width of its outermost zone. Currently, the direct imaging resolutions using FZPs have saturated to about 10 nm (in half-pitch). For lower values, wave-coupling effects dominate with a significant penalty to the diffraction efficiencies. One promising solution is to tilt the zones to the Bragg angle, which is a significant fabrication challenge. Hereby the material properties, which require a more stringent quality, are of critical importance since the zones must have a low roughness both radially and longitudinally and the interfaces must be chemically extremely smooth. Furthermore, the microstructure and morphology must be controlled to avoid diffuse scattering. Here we present a new fabrication route for FZP arrays with zones tilted to the Bragg angle by a combination of FIB pre-structuring and subsequent ALD. We demonstrate the quality of these optics and discuss their potential for sub-10 nm resolutions.

DS 17.75 Tue 18:15 Poster B

Investigation of the influence of molecular and atomic nitrogen ion species during thin film growth — •Michael Mensing, Philipp Schumacher, Jürgen W. Gerlach, and Bernd Rauschenbach — Leibniz Institute of Surface Engineering (IOM), Leipzig, Germany

Ion beam assisted deposition enables the control of thin film properties by changing the ion beam parameters such as the ion kinetic energy or the ion flux. However, as a consequence of the utilization of typical ion sources, the ion beam consists of a blend of multiple ion species at distinct ion kinetic energy distributions. In this work, an energy and mass selected ion beam is created and utilized to deposit epitaxial GaN nanofilms on $Al_2O_3(1\bar{1}02)$ at elevated temperatures of up to 700°C. This well established material system is used to independently investigate the influence of hyperthermal molecular and atomic nitrogen ions on the resulting film properties during the initial stages of the film growth. In addition, ion energies and material fluxes are varied. The resulting films are characterized by *in situ* RHEED, *in vacuo* AES and AFM, XRD as well as XRR.

DS 17.76 Tue 18:15 Poster B

Deposit Transition Metal or Metal Oxides Thin film on Silicon Wafer by Atomic Layer Deposition (ALD) for High Efficient Photoelectrochemical Water Splitting — •Haojie Zhang[1], Alexander Sprafke[1], Stefan L. Schweizer[1], Wouterg A. Maijenburg[2], and Ralf Wehrspohn[1,3] — [1]Institute of Physic, Martin-Luther-University Halle-Wittenberg, Heinrich-Damerow-Strasse 4, 06120 Halle, Germany. — [2]Center for Innovation Competence (ZIK) "SiLi-nano", Martin Luther University Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Straße 3, 06120 Halle, Germany. — [3]Fraunhofer Institute for Microstructure of Materials and Systems, IMWS, Walter-Hülse-Straße 1, 06120 Halle, Germany.

Photoelectrochemical water splitting is advanced by the development of the highly efficient catalysts that promote the performance of the water splitting, while also maintaining the excellent stability for integration with the photoactive semiconductor as the light absorber. Here, we demonstrate the deposition of Ni, Co and/or their oxides thin films on the silicon wafer by the plasma enhanced atomic layer deposition (ALD). The deposited thin film with the uniform properties and simultaneously provide excellent water splitting performance. Furthermore, the combined silicon, as a light absorber also been protected effectively by the deposited thin film to perform a highly efficient light absorb. The combined device provides an excellent performance for the photoelectrochemical water splitting contributed by the synergy

effect of high activity deposited thin film and semiconductor.

DS 17.77 Tue 18:15 Poster B

Electrochemical Deposition of Compact or Porous ZnO Thin Films on Metallic or Non-Metallic 3D-Microstructures — •Dominik Damtew, Martina Stumpp, and Derck Schlettwein — IAP, JLU Giessen, Germany

Semiconducting thin films of ZnO are of interest as electrode materials, e.g. in dye-sensitized solar cells, chemical sensors. Compared to physical gas-phase methods like thermal evaporation or sputtering, electrochemical deposition of thin films is more cost effective, less harmful to the environment and allows deposition onto complex-shaped objects and into blind holes. Our study is focused on the electrochemical deposition of ZnO out of aqueous zinc nitrate or zinc chloride baths at 70 $°C$ onto metallic and non-metallic wires, nets and 3D foams. Aside from the deposition of thin compact ZnO films, hybrid ZnO/dye (EosinY) films were deposited to produce porous films following dissolution of EosinY. Depositions were carried out both by galvanodynamic and by potentiostatic methods. The films were characterized by laser and scanning electron microscopy. Applying short (galvanodynamic) pulses of 10 ms of a constant current density of around 7.5 - 35 mA/cm^2 allowed deposition of very homogenous compact ZnO films on different materials and structures. Porous films could be deposited with pore sizes of 1 - 20 nm. The galvanodynamic method proved as perfectly suited to deposit in deeper regions of the 3D structures, while potentiostatic deposition led to film growth preferably on outer regions and to less homogenous films.

DS 17.78 Tue 18:15 Poster B

Chemical Solution Deposition of Poly(methyl methacrylate) thin films via dielectric barrier discharge — •Fan Guo[1,2], Lisa Wurlitzer[1,2], Wolfgang Maus-Friedrichs[1,2], and Sebastian Dahle[1,2] — [1]Clausthal Centre of Material Technology, 38678 Clausthal-Zellerfeld, Germany — [2]Institute of Energy Research and Physical Technologies, 38678 Clausthal-Zellerfeld, Germany

Plasma-enhanced chemical vapour deposition (PECVD) is an effective method to synthesise Poly(methyl methacrylate)(PMMA) thin films. Normally, the monomer methyl methacrylate (MMA), used as a precursor, is plasma polymerized in the gas phase. In this work, a new way to synthesize PMMA thin films from the liquid phase of MMA via a dielectric barrier discharge (DBD) is presented. The idea of this plasma-enhanced chemical solution deposition (PECSD) is based on radical initiation at the interface with a liquid phase of MMA by a non-thermal plasma. With this method, no vacuum condition or carrier gas streams are needed as opposed to the common PECVD technique. The deposited films were characterized with attenuated total reflection (ATR) infrared spectroscopy, differential scanning calorimetry (DSC) and gel permeation chromatography (GPC).

DS 17.79 Tue 18:15 Poster B

Plasma-assisted atomic layer deposition of Cobalt — •Mihir Dass[1], Sara Azimi[1], Haojie Zhang[2], Bodo Fuhrmann[3], and Stuart Parkin[1] — [1]Max Planck Institute of Microstructure Physics — [2]Fraunhofer Institute for Microstructure of Materials and Systems — [3]Martin Luther University Halle-Wittenberg

Atomic layer deposition (ALD) is a vapor phase technique capable of producing thin films of a variety of materials. Based on sequential, self-limiting reactions, ALD offers exceptional conformality on three-dimensional and patterned structures, thickness control at nearly monolayer level, and tunable film composition. With these advantages, ALD has emerged as a powerful tool for many industrial and research applications. Although some materials like certain metal oxides (Aluminium Oxide and Zinc Oxide) have received tremendous attention, deposition of pure metals is still in its infancy. We have shown plasma-assisted ALD deposition of Cobalt and are developing new processes for deposition on various substrates (unpublished data). We assess the deposition quality through XPS, AFM, XRD and TEM. Successful deposition of such stacks will open up possibilities to include new materials and develop novel electronic and spintronic devices.

DS 17.80 Tue 18:15 Poster B

Zone-Casting as a fully scalable deposition technique for high quality perovskite films — •Daniel Heimfarth, Simon Ternes, and Yana Vaynzof — Center for Advanced Materials, Heidelberg

With the performance of hybrid organometal-halide perovskite solar cells improving rapidly over the last several years, the future integration of this technology into industrial applications becomes a relevant topic. Specifically, common fabrication processes used in a laboratory setting, such as spin-coating, need to be replaced by scalable techniques, while maintaining excellent photovoltaic performance.

We investigate the suitability of zone-casting(also known as bar-casting), a meniscus-assisted deposition method for the fabrication of high quality perovskite films for photovoltaic applications. The method offers a large parameter space for investigation, including among others the substrate and solution temperatures as well as the deposition speed. We demonstrate that by tuning these parameters we are able to obtain a variety of perovskite films with different microstructures. A combination of high deposition speed and moderate substrate temperature results in uniform layers with large crystalline domains (200 μm) advantageous for perovskite photovoltaics. We demonstrate that the technique can be utilized for the large area fabrication of functional photovoltaic devices, with initial studies showing promising results with regards to the device power conversion efficiencies.

DS 17.81 Tue 18:15 Poster B

Optical ellipsometry used for real-time monitoring of atomic layer epitaxy — •Fryderyk Lyzwa[1,2], Premysl Marsik[2], Vladimir Roddatis[3], Christian Bernhard[2], Markus Jungbauer[1], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]University of Fribourg, Department of Physics and Fribourg Center for Nanomaterials, Chemin du Musée 3, 1700 Fribourg, Switzerland — [3]Institut für Materialphysik, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Nanoscience and modern material physics are based on the growth and study of thin films with thicknesses spreading down to one atomic layer. The monitoring process itself is of great importance in order to confirm the successful film growth and to gain information on the electronic properties, defect formation, interfacial reconstructions etc. already during the growth. In this study, Ruddlesden-Popper thin films of SrO(SrTiO3)n=4 were grown by means of metalorganic aerosol deposition in the atomic layer epitaxy mode on SrTiO3(100), LSAT(100) and DyScO3(110) substrates. An optical ellipsometry setup was used to monitor the deposition of single atomic layers with subatomic sensitivity. The measured time dependences of ellipsometric angles, Δ(t) and Ψ(t), were described by using a simple optical model, considering the sequence of atomic layers SrO and TiO2 with corresponding bulk refractive indices. As a result, valuable online information on the growth process, the film structure and defects were obtained.