DS 35: Poster I: Application of thin films; Focus session: Sensoric micro and nano-systems; Focus Session: Sustainable photovoltaics with earth abundant materials; Graphen (joint session with TT; MA; HL; DY; O); Ion and electron beam induced processes; Layer properties: electrical, optical, and mechanical properties; Magnetic/organic interfaces, spins in organics and molecular magnetism; Micro- and nanopatterning (jointly with O); Organic electronics and photovoltaics (jointly with CPP, HL, O); Thermoelectric materials

Time: Wednesday 17:00–20:00 Location: P1

DS 35.1 Wed 17:00 P1

Preparation and Characterization of oxide Heterostructures for future Applications in Information Technology — •Markus Waschk, Alexander Weber, Markus Schmitz, Paul Zakalek, and Thomas Brückel — Jülich Center for Neutron Science JCNS and Peter Grünberg Institut PGI: Streumethoden, Forschungszentrum Jülich GmbH, 52428 Jülich, Germany

Nowadays the increased demand on highly efficient storage devices leads to the development of new materials for future devices. Promising candidates are multifunctional oxides that open a wide field of physical properties due to their correlated electron system. Especially the interface of two oxide thin films can exhibit different properties as found in bulk. For instance, the combination of the antiferromagnetic materials $LaMnO_3$ and $SrMnO_3$ in a thin film system leads to an interface with ferromagnetic behavior.
We want to present two state of the art preparation methods, which is the oxide molecular beam epitaxy on the one hand and the high oxygen pressure sputtering system on the other hand. These techniques provide the possibility to grow stoichiometric oxide thin films very precisely.
We identify the structural parameters of the films by using x-ray scattering and atomic force microscopy. Furthermore a SQUID magnetometer and a MOKE setup are used to determine the magnetic parameters of the samples. We use polarized neutron scattering to gain informations about the magnetic depth profile of our samples.

DS 35.2 Wed 17:00 P1

Ferromagnetic InMnAs prepared by Ion implantation and pulsed laser annealing — Ye Yuan[1], •Yutian Wang[1], Kun Gao[1], Muhammad Khalid[1], Eugen Weschke[2], Wolfgang Skorupa[1], Manfred Helm[1], and Shengqiang Zhou[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O. Box 510119, 01314 Dresden, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, D-12489 Berlin, Germany

Ferromagnetic InMnAs has been previously prepared by low temperature MBE. In this contribution, we present an alternative method what combines Mn ion implantation and pulsed laser annealing to achieve In1-xMnxAs (x = 0.04 and 0.08) [1], and to obtain a remarkably high Curie Temperature (TC) up to 80 K compared to InMnAs with the same Mn concentration as prepared by MBE. The advantage of pulsed laser annealing is its high process temperature within the nano-second range, eliminating n-type defects which can decrease its magnetization and TC. The saturation magnetization is ˜2.6μB / Mn by consideration of all implanted Mn ions. The out-of-plane [001] is the easy axis displaying a nearly square like hysteresis loop. Our results suggest that InMnAs prepared by ion implantation and pulsed laser annealing shows a promising prospect to get high TC DMS after optimizing the preparation parameters.

1) S. Zhou, et al. :Appl. Phys. Express 5 (2012) 093007

DS 35.3 Wed 17:00 P1

$BaTiO_3$ memristors for neuromorphic engineering circuits. — •Florian Hofmann[1], Savio Fabretti[2], Stefan Niehörster[2], Joachim Sterz[2], Andy Thomas[2], and Elisabetta Chicca[1] — [1]Technische Fakultät, Universität Bielefeld, Germany — [2]Fakultät für Physik, Universität Bielefeld, Germany

We investigated the memristive properties of Barium Titanate and its application in the field of Neuromorphic Engineering. It is suggested in [1] that memristive elements may be a perfect fit for replacing synaptic circuits in modelled neuronal networks. Therefore we sputtered thin BTO films and characterized them with X-ray defraction (XRD). We observed the required tetragonal stucture in the XRD spectra. Furthermore we measured first memristive i-v tunneling characteristic. Finally we plan to integrate memristive elements with a neuromorphic CMOS chip and discuss advantages over previous attempts.

[1] Giacomo Indiveri et al. "Integration of nanoscale memristor synapses in neuromorphic computing architectures"

DS 35.4 Wed 17:00 P1

LiPON electrolyte prepared by RF sputtering for solid state electrochromic and battery applications — •Yurong Su[1], Jane Falgenhauer[2], Matthias Geiss[3], Benedikt Kramm[1], Angelika Polity[1], and Bruno K. Meyer[1] — [1]I. Physics Institute, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Institute of Applied Physics, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [3]Institute of Physical Chemistry, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 58, 35392 Giessen, Germany

Lithium phosphorus oxynitride (LiPON) is one of the promising solid state electrolytes which can be used in lithium batteries as well as all solid state electrochromic (EC) devices due to their relatively high ionic conductivity and better durability among oxides.In the present study, amorphous LiPON films were prepared by radio frequency (RF) magnetron sputtering of a Li_3PO_4 target in N_2 atmosphere. The LiPON films were deposited by varying RF power and N_2 pressure in order to evaluate the best deposition conditions. The composition of films was determined by ICP-OES and EDX. The structural, optical and electrochemical properties were characterized by XRD, XPS, UV-visible and impedance spectroscopy, respectively. The highest ionic conductivity at room temperature observed in this study was about $3.6\times10^{-6}Scm^{-1}$ with the activation energy of 0.47 eV. In addition the prepared LiPON films have good transparency in visible light region. This good performance of LiPON film may make it suitable both for solid state EC devices and battery applications.

DS 35.5 Wed 17:00 P1

Assisted ion beam interface investigation for highly reflective Cr/Sc multilayer mirrors — •Alexander Guggenmos[1,2], Stefan Radünz[1,2], Roman Rauhut[1,2], Bert Nickel[3], Sriram Venkatesan[4], Angela Wochnik[4], Christina Scheu[4], Eric M. Gullikson[5], Ferenc Krausz[1,2], and Ulf Kleineberg[1,2] — [1]LMU München, Fakultät für Physik, Garching, Germany — [2]MPQ, Garching, Germany — [3]CeNS, LMU München, München, Germany — [4]LMU München, Fakultät für Chemie, München, Germany — [5]CXRO, Lawrence Berkeley National Lab, Berkeley, USA

Extending single attosecond pulse technology from currently sub-200 eV to the water window spectral range may enable for the first time the unique investigation of ultrafast electronic processes within the core states of bio-molecules. The demand on highly reflective multilayer mirrors for spectral shaping or focusing attosecond pulses in the water window wavelength range, between the K-absorption edges of carbon and oxygen (2.3-4.4 nm), manifests itself due to the lack of sources with sufficient photon flux. Realizing this requisite utilizes interface optimized multilayer mirrors with almost perfect interfaces due to the huge loss in reflectivity which arises from boundary imperfections. We present our achievements in minimizing the interface roughness of ion-beam deposited Cr/Sc multilayer mirrors by optimizing the kinetic energy of the utilized Krypton ions both in the deposition and the interface polishing process. Experimental results from measurements using X-ray reflectometry, spectral ellipsometry and XUV reflectrometry as well as TEM cross section images are shown and discussed.

DS 35.6 Wed 17:00 P1

NIR-VUV Spectroscopic Study of $ZnFe_2O_4$, $CoFe_2O_4$ and $ZnCo_2O_4$ Thin Films — •Vitaly Zviagin[1], Peter Richter[2], Tammo Böntgen[1], Michael Lorenz[1], Dietrich R.T. Zahn[2], Georgeta Salvan[2], Rüdiger Schmidt-Grund[1], and Marius Grundmann[1] — [1]Universtät Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, Germany — [2]Technische Universtät Chemnitz,

Semiconductor Physics, Reichenheinerstr. 70, Germany

We present optical and structural properties of $ZnFe_2O_4$, $CoFe_2O_4$, and $ZnCo_2O_4$ spinel oxides grown at different temperatures on MgO substrates by pulsed laser deposition. The optical properties were determined by spectroscopic ellipsometry in the range from 0.5 eV to 9.0 eV, and at temperatures from 10 K to 300 K. A model, consisting of Gauss and critical point functions located at the optical transition energies was developed to describe the measured dielectric function. The magneto-optical response of the dielectric tensor was measured by magneto-optical Kerr effect spectroscopy at room temperature.
The crystal structure of the films was determined from wide-angle X-ray diffraction. It was found that the temperature during the deposition induces a distinct shift in the observed transition energies as well as a change in the structural properties and surface topology of the thin films.

DS 35.7 Wed 17:00 P1

Generation of Hypersound Strain Pulses: Polyelectrolyte Nanolayers vs. Thin Metal Films — •Mathias Sander[1,2], Steffen Mitzscherling[1], Andre Bojahr[1], Daniel Schick[1], Peter Gaal[2], and Matias Bargheer[1,2] — [1]Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam/Golm, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Wilhelm-Conrad-Röntgen Campus, Bessy II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

Ultrafast optical excitation of a thin transducer layer generates hypersound strain pulses that can be observed by pump-probe-spectroscopy. Typically, such transducers are realized by vacuum deposition of thin metal films. We demonstrate the generation of hypersound strain pulses by transducers composed of polyelectrolyte nanolayers that were grown by spin-assisted layer-by-layer deposition. Excitation of polyelectrolytes results in a several times higher strain compared to their metallic counterparts. We prepare samples with a reflecting interlayer, that allow for a direct comparison of both transducer materials. The measured phonon spectra are repoduced by theoretical simulations.

DS 35.8 Wed 17:00 P1

Homoepitaxial growth of single crystalline diamond — •Reinhard Remfort, Nicolas Wöhrl, and Volker Buck — University of Duisburg-Essen, Germany

Störstellen in Diamant stellen zentrale Elemente für eine Vielzahl von Anwendungen z.B. in der Quanteninformations- und Sensortechnologie dar. Diese Zentren, insbesondere das Stickstoff-Leerstellen (NV)-Zentrum werden daher seit einigen Jahren intensiv erforscht. Um die Eigenschaften dieser Zentren besser charakterisieren zu können und in größerem Maßstab nutzbar zu machen ist es nötig den Einfluss umliegender weiter Defekte zu minimieren. Ein erster Schritt hierbei ist die Erzeugung besonders reiner stickstoffarmer einkristalliener Diamantschichten. Das für diese Anforderungen am besten geeignete Verfahren bietet im Bereich der Niederdruckdiamantsynthese die MPCD (Microwave Plasma Chemical Vapor Deposition), da bei dieser Art der Diamantsynthese keine Elektroden für die Plasmaanregung erforderlich sind. Durch die zusätzliche Verwendung reiner Prozessgase ist es daher möglich sehr stickstoffarme Diamantschichten auf HPHT-Diamantsubstraten abzuscheiden. In einem weiteren Schritt können dann gezielt Stickstoffatome zur Erzeugung von (NV)-Zentren eingebracht werden. Dies kann entweder durch Ionenimplatation oder schon während des Syntheseprozesses durch die gezielte Beimischung sehr geringer Mengen Stickstoff geschehen.

DS 35.9 Wed 17:00 P1

rientation Dependent Enantioselective Adsorption of Homochiral Surface Mounted Metal Organic Framework — •Zhi-Gang Gu[1], Jochen Bürck[2], Jinxuan Liu[1], Xia Stammer[1], Zhengbang Wang[1], Peter Weidler[1], Anne Ulrich[2], Hartmut Gliemann[1], and Christof Wöll[1] — [1]Institute of Functional Interfaces, KIT — [2]Institute for Biological Interfaces 2, KIT

The research based on assembly of bulk crystal Metal-Organic Frameworks (MOFs) for nonlinear optics, enantioselective catalysis, and medicine has been extensively carried out1. However, the synthesis and properties of MOFs thin films on self-assembled monolayers (SURMOFs)are still a challenge. Up to now, MOFs (HKUST-1, MOF-2) formed by single ligand and other pillared-layer MOFs (MOF508a, [Cu2(bdc)2dabco]n and [Cu2(ndc)2dabco]n) constructed by mixed ligands on functionalized substrates by employing a step-by-step liquid-phase-epitaxy method (LPE) have been reported2. In previous works chiral linker were used to grow MOFs on substrate and the first example of chiral SURMOF [Cu2(+/-)Cam2dabco]n has been reported in 2012. In this work we grow another chiral SURMOFs [Cu2Cam2bipy]n with highly oriented and homogenous thin film via LPE method3. The potential of chiral SURMOFs for enantioselective adsorption of chiral molecules is studied by quartz crystal microbalance. 1.Shekhah, O.;Wöll, C.,et al. Chem. Soc. Rev. 2011, 40 (2), 1081-1106. 2.Shekhah O.,Wöll C.,et al. J. Am. Chem. Soc. 2007, 129 (15), 118-217. 3.Shekhah, O.; Woll, C.,et al. Nat. Mater. 2009, 8 (6), 481-484.

DS 35.10 Wed 17:00 P1

Spinel based magnetic tunnel junctions — •Torsten Hübner — Universität Bielefeld — Thin Films and Physics of Nanostructures

Using $MgAl_2O_4$ instead of MgO as barrier material in magnetic tunnel junctions has attracted some attention due to its small lattice mismatch of ∼1% with regard to standard ferromagnetic electrodes. The Δ_1 symmetry filter effect, which is responsible for the huge TMR effect in MgO based magnetic tunnel junctions, is also predicted for MgAl2O4 tunnel barriers[1]. Additionally, MAO barriers achieved a V_{half} twice as much as MgO ones, which makes them even more interesting for spintronic devices and applications[2]. We fabricated $CoFeB/MgAl_2O_4/CoFeB$ exchange biased magnetic tunnel junctions via rf sputtering of a pure MAO target. A TMR effect of more than 30% was achieved reproducibly as well as a comparatively high area resistance product in the range of several $k\Omega\mu m^2$. In conclusion, MAO barriers require continuing research in order to take advantage of their potentially superior properties. [1]Zhang et al., Appl. Phys. Lett. 100, 222401 (2012) [2]Sukegawa et al., Appl. Phys. Lett. 96, 212505 (2010)

DS 35.11 Wed 17:00 P1

Dielectric constants of polycrystalline (Ba,Sr)TiO3 (BSTO) films — •Xueyong Yuan[1], Tiangui You[1], Varun John[1], Sabine Engelmann[1], Ilona Skorupa[1,2], Danilo Bürger[1], Heidemarie Schmidt[1], Daniel Grimm[1], and Oliver G. Schmidt[1,3] — [1]Material Systems for Nanoelectronics, Chemnitz University of Technology — [2]Helmholtz-Zentrum Dresden-Rossendorf e.V — [3]IFW Dresden, Institute for Integrative Nanosciences

The dielectric constant for SrRuO3/30nm thick BaxSrxTiO3/SrRuO3 all oxide capacitor was measured to be 550, which corresponds to an equivalent SiO2 thickness of 0.21 nm [1]. Although the leakage current of epitaxially-grown BSTO films is small compared to polycrystalline BSTO films, the low-cost polycrystalline capacitors are widely used in modern semiconductor technology. We studied the frequency dependent electrical polarization of polycrystalline BSTO films which have been grown by pulsed laser deposition (PLD) on large scale Pt bottom electrodes as a function of PLD growth conditions in the test frequency range from 100 Hz to 1 MHz. Most BSTO films reveal the expected constant bulk dielectric constant of around 20. Here the focus is on selected BSTO films which show a relatively high dielectric constant in the low frequency range up to 100 kHz. A model which considers the occupancy of bulk traps in insulators [2] is used to explain the frequency dependent capacitance of polycrystalline BSTO.

References [1] N. Fukushima et al. 493, 1997. [2] Y. Yuan et al. IEEE Trans. on Electron Devices, 59, 2012.

DS 35.12 Wed 17:00 P1

Low chromatic dispersion and high diffraction efficiency of zone plate for XUV and soft X-ray bandwidth — •Huaihai Pan[1,2], Christian Späth[3], Alexander Guggenmos[1,3], Jürgen Schmidt[3], Soo Hoon Chew[1,3], Quanzhong Zhao[2], and Ulf Kleineberg[1,3] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany — [2]State Key Laboratory of High Field Laser Physics, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai 201800, China — [3]Ludwig-Maximilians-Universität München, Fakultät für Physik, Am Coulombwall 1, 85748 Garching, Germany

Zone plate has a great potential in achieving high spatial resolution for the XUV and X-ray radiations [1]. However, due to strong chromatic dispersion [2] and low diffraction efficiency of the zone plate, the highest achievable spatial resolution is limited. Here we report the theoretical calculation based on the design of achromatic optics [3] which can potentially reduce chromatic dispersion and improve diffraction efficiency. Such optics is a combination of zone plate and lens, in which the positive dispersion induced by lens can compensate the negative dispersion induced by zone plate. An ultrafast laser pulse with a duration of 120 as and central wavelength at 13.5 nm is employed. The

simulated results show that the intensity distribution of propagation is partially achromatic and the specific profile of zone plate can improve the diffraction efficiency at first order diffraction. [1] W. Chao, et al., Opt. Express 17, 17669 (2009).[2] J. Kirz., J. Opt. Soc. Am. 64, 301 (1974).[3] Y. Wang, et al., Nature 424, 50 (2003).

DS 35.13 Wed 17:00 P1

Nano Microphone — •Martin Bohrisch[1], Xianghui Zhang[2], Thomas Weimann[1], and Armin Gölzhäuser[2] — [1]Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany — [2]Fakultät für Physik, Universität Bielefeld, 33615 Bielefeld, Germany

We plan to build and test a nano microphone that utilizes a 1 nm thick carbon nanomembrane (CNM) as a sensitive diaphragm. The CNM is made by electron induced crosslinking of aromatic self-assembled monolayers. To convert oscillations of the CNM into electrical signals, we have to integrate the molecular CNMs and electronic circuits into a functional nano electro- mechanical system (NEMS). The operation principle is based on a field effect transistor (FET). A freestanding conductive diaphragm is placed over the source-drain-channel of the FET and acts as flexible gate-electrode. Accordingly an oscillation of the membrane leads to an AC signal of the source-drain-current. Our objective is to build a prototype that will be used for sound measurements in air and water; it will be tested for spatially and timely resolved sound detection. The proof-of-concept experiments and first results of CNM-gated FETs will be presented.

DS 35.14 Wed 17:00 P1

Elastic Properties of Nickel Carbides — •Jeffrey Kelling[1,2], Peter Zahn[2], and Sibylle Gemming[1,2] — [1]Institute of Physics, TU Chemnitz, Chemnitz, Germany — [2]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The nickel – carbon system has received increased attention over the past years due to the relevance of nickel as a catalyst for carbon nanotube growth and as a substrate for metal-induced crystallization of graphene and graphite. Nickel carbides as bulk materials are out of reach for experimental studies because of their meta-stability. Ab-initio studies are rare. We present our ab-initio – frozen phonon results for the elastic properties of Ni_3C, Ni_2C and NiC.

DS 35.15 Wed 17:00 P1

Carbon-Nickel Interface Dynamics During Physical Vapor Deposition — •Robert Wenisch[1], Matthias Krause[1,2], René Hübner[1], Sibylle Gemming[1,3], and Gintautas Abrasonis[1] — [1]Bautzner Landstraße 400, 01328 Dresden — [2]Mommsenstraße 9, 01069 Dresden — [3]Technische Universität Chemnitz, 09107 Chemnitz

Interface dynamics play a crucial role in Nickel catalyzed fabrication of carbon nanotubes, carbon nanowires and graphene. Interface dynamics are studied by deposition of atomic C on Ni at temperatures of 23–550°C. The obtained films are characterized by transition electron microscopy, Raman-spectroscopy, nuclear reaction analysis and X-ray photoelectron spectroscopy. Bulk diffusion and solubility are found negligible in the present experiments leaving surface diffusion as the main graphitization mechanism. The presented process may open new avenues for the fabrication of graphene on Ni at low temperatures (< 300°C).

DS 35.16 Wed 17:00 P1

Spectroscopic Monitoring of Carbon Nanotube Dispersion Preparation — •Toni Hille[1,2,3], Thomas Blaudeck[1], Sascha Hermann[1], Christian von Borczyskowski[2], and Stefan E. Schulz[3] — [1]TU Chemnitz, Zentrum für Mikrotechnologien (ZfM), 09107 Chemnitz, Germany — [2]TU Chemnitz, Center for Nanostructured Materials and Analytics (nanoMA), 09107 Chemnitz, Germany — [3]Fraunhofer ENAS, 09126 Chemnitz, Germany

In this contribution, we introduce a systematic inspection tool for carbon nanotube dispersion preparation based UV-Vis-NIR-spectroscopy. Goal is the wafer-level integration of the CNTs by an electrokinetic deposition approach from an aqueous dispersion [1]. In order to estimate the dispersion quality during the preparation process, a microfluidic system with a quartz flow cell is built up. Related to the non-resonant and resonant features in the UV-Vis-NIR-spectra, the CNT concentration and degree of debundeling can be monitored and sonication paramters can be optimized [2]. It turns out that the degree of debundling is a function of both the absolute concentration of the CNTs and the relative concentration between the CNTs and the dispersion agents (sodiumlauryl sulfate, sodium deoxycholate, etc.)

[1] S. Hermann, H. Fiedler, H. B. Yu, S. Loschek, J. Bonitz, S. E. Schulz, T. Geßner, IEEE Proceedings Systems, Signals, and Devices (SSD), article ID 6198090 (5 pages) (2012).

[2] H. B. Yu, S. Hermann, S. E. Schulz, T. Geßner, Z. Dong, W. J. Li, Chemical Physics 408, 11-16 (2012).

DS 35.17 Wed 17:00 P1

Wafer-Level Functionalization of Carbon Nanomaterials with Metal Nanoparticles — •Thomas Blaudeck[1], David Adner[2], Sascha Hermann[1], Youwei Zhang[1,3], Stefan E. Schulz[4], Ran Liu[3], Heinrich Lang[2], and Thomas Gessner[1] — [1]TU Chemnitz, Zentrum für Mikrotechnologien (ZfM), 09107 Chemnitz, Germany — [2]TU Chemnitz, Inorganic Chemistry, 09107 Chemnitz, Germany — [3]Fudan University, School of Microelectronics, Fudan, P. R. China — [4]Fraunhofer ENAS, 09126 Chemnitz, Germany

We report about different technical approaches for an on-chip functionalization of single-walled carbon nanotubes (SWCNTs) with metal nanoparticles after electrokinetic deposition of individualized SWCNTs in the configuration of a CNT-based field effect transistor (CNT-FETs) for sensor applications. Based on a side-wall functionalization of the SWCNTs with (R-)oxocarbonylnitrene linkers according to Holzinger et al. [1] we extended the protocols towards long-chained ethylene glycol units for an effective deposition of nanoparticles. Characterization of the precursor included IR, Raman and NMR spectroscopy, the functionalized CNT-FETs were analyzed with morphological (AFM, Raman) and electric characterization . For the on-chip functionalization on silicon wafers (150 mm diameter), a microfluidic tool on a controlled heating stage was designed and applied on the integrated SWCNTs on a silicon wafer. Our experiments show that a selective functionalization of the SWCNTs with gold nanoparticles is possible. Results for other carbon-based nanomaterials are discussed.

[1] M. Holzinger et al., J. Am. Chem. Soc. 125, 8566-8580 (2003).

DS 35.18 Wed 17:00 P1

Integration von MOS-Transistoren als Wandler für mechanische Spannungen — •Michael Schramm[1], Sven Haas[2], Danny Reuter[2,3], Kay-Uwe Loebel[1], Steffen Heinz[1], Andreas Bertz[2], John Thomas Horstmann[1] und Thomas Gessner[2,3] — [1]Professur Elektronische Bauelemente der Mikro- und Nanotechnik, TU Chemnitz, 09107 Chemnitz — [2]Zentrum für Mikrotechnologien, TU Chemnitz, 09107 Chemnitz — [3]Fraunhofer Institut für Elektronische Nanosysteme, 09126 Chemnitz

Zur Wandlung einer mechanischen Spannung in ein elektrisches Signal finden häufig Piezowiderstände Anwendung. Um den Flächenbedarf zu reduzieren und die Kompatibilität zu CMOS-Prozessen zu erhöhen, ist es möglich, MOS-Transistoren als Wandlerelement einzusetzen. Die Wandlung einer mechanischen Spannung in ein elektrisches Signal erfolgt unter Ausnutzung des piezoresistiven Effekts. Im Fokus dieser Arbeit stehen die Simulation und Charakterisierung von MOS-Transistoren als Wandlerelement für mechanische Spannungen. Zur Erzeugung der mechanischen Spannung fanden dünne Siliziummembranen Anwendung. Um die Transistoren in den Gebieten der maximalen mechanischen Spannung zu platzieren, wurden die Membranen mit einer FEM-Software simuliert. Der Stresseinfluss auf das elektrische Verhalten der Transistoren ist mit einem angepassten BSIM3v3-Modell simuliert worden. Die Skalierbarkeit wurde durch Simulationen von Halbleitertechnologien unterschiedlicher minimaler Strukturweiten nachgewiesen. Mit Hilfe der Messungen wurde der Stresseinfluss auf die Transistorkennlinien und Transistorparameter untersucht.

DS 35.19 Wed 17:00 P1

Laser induced changes in single-walled carbon nanotubes — •Jana Kalbacova, Raul D. Rodriguez, Honeyeh Matbaechi, and Dietrich R.T. Zahn — Semiconductor Physics, Technische Universität Chemnitz, 09107 Chemnitz, Germany

Carbon nanotubes (CNTs) are one of the materials of future technologies and already today they are finding their way into applications, such as in field effect transistors and photovoltaics. However, for the performance of the device, it is crucial to keep the ratio of metallic to semiconducting at minimum. To monitor this ratio, it is beneficial to use Raman spectroscopy where the so-called radial breathing mode (RBM) of CNTs is observed [1].

It was also shown that in order to induce defects in CNTs, high power laser can be employed. On the other hand, laser illumination was also proposed to eliminate carbonaceous contaminations without CNT destruction [1]. Thus predictably, with optimized laser power we

can achieve changes within carbon nanotubes without their destruction. In this contribution, we show how optimized laser power can lead to changes in carbon nanotubes, while preserving the CNT integrity. Changes are observed mostly in the radial breathing mode region. We attribute these to the selective elimination of CNTs with certain chiralities. Simultaneously, by using spatially resolved Raman spectroscopy mapping, we show that the defective region is larger than expected, extending beyond the laser-illuminated spot. We will discuss the changes in the Raman spectra that originate from such defect gradient.

DS 35.20 Wed 17:00 P1

Interaction of gold nanoparticles with wafer-level integrated carbon nanotubes probed by Raman spectroscopy — •Raul D. Rodriguez[1], Jana Kalbacova[1], Thomas Blaudeck[2], Sascha Hermann[2], Parisa Bayat[1,2], David Adner[3], Heinrich Lang[3], Stefan E. Schulz[2,4], and Dietrich R.T. Zahn[1] — [1]Semiconductor Physics, Technische Universität Chemnitz, 09107 Chemnitz, Germany — [2]Center for Microtechnologies (ZfM), Technische Universität Chemnitz, 09107 Chemnitz, Germany — [3]Faculty of Natural Sciences, Institute of Chemistry, Inorganic Chemistry, Technische Universität Chemnitz, 09107 Chemnitz, Germany — [4]Fraunhofer Institute for Electronic Nanosystems (ENAS), 09126 Chemnitz, Germany

By means of Raman spectroscopy we aim at determining the effect of gold nanoparticle decoration on single-walled carbon nanotubes (CNT) in a field effect transistor configuration (CNT-FET). The experiments were performed under green laser excitation (514.7 nm) focused by a 100x objective giving a power below 150 μW on the sample and spatial resolution below 500 nm. The spectral resolution allowed detecting changes in the Raman spectra with accuracy as low as 0.6 cm^{-1}. It was found from the analysis of the radial breathing mode (RBM) that small diameter CNT are preferentially affected by the decoration process while no significant increase in defect concentration was observed from the intensity ratio of the D and G bands. This suggests an optimal way of achieving functionalized CNT-FET devices without degrading its electronic properties but preserving the CNT crystallinity and sp^2 nature.

DS 35.21 Wed 17:00 P1

Nanomechanics of carbon nanotube-metal contacts investigated by molecular dynamics and validating experiments — •Steffen Hartmann[1], Ole Hölck[2], Sascha Hermann[1], Thomas Blaudeck[1], Stefan E. Schulz[1], Thomas Gessner[1], and Bernhard Wunderle[1] — [1]TU Chemnitz, Sachsen, Germany — [2]Fraunhofer IZM, Berlin, Germany

With this contribution we present our recent progress in understanding the mechanics of carbon nanotube-metal interfaces at the nano scale. A detailed understanding of the behaviour of a mechanically stressed CNT inside a metal support is of fundamental importance for thermo mechanical reliability predictions and failure-mechanistic treatment of future CNT devices. A simple test to study the reaction behavior of CNTs inside a metal support is the pull-out test. We simulated this pull-out test with molecular dynamics and varying parameters and conducted in-situ pull-out tests inside a scanning electron microscope. From our simulations we find that the ideal incommensurate interface between the lattices of chiral CNTs and metals leads to a behaviour that is independent on embedding length. On the other hand the CNT diameter is of significant importance. We report on predicted pull-out forces which were determined to be in the nN range. Further we explain the influence of defects on the pull-out forces. The results from our experiments are maximum forces between 20 and 35 nN. We compare our experimental findings with results of our numerical investigations and give interpretations for deviations according to material impurities or defects and their influence on the pull-out data.

DS 35.22 Wed 17:00 P1

MEMS based integration of nano scaled architectures manufactured by the rolled-up nanotech method — •Christian Helke[1], Tom Enderlein[1], Stefan M. Harazim[2], Jörg Nestler[1], Oliver G. Schmidt[2], Thomas Otto[3], and Thomas Gessner[1,3] — [1]TU Chemnitz, Zentrum für Mikrotechnologien, Reichenhainer Str. 70, 09126 Chemnitz, Germany — [2]IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany — [3]Fraunhofer ENAS, Technologie-Campus 3, 09126 Chemnitz, Germany

In contrast to conventional laboratory based analysis methods Lab-on-a-Chip (LoC) systems reveal their advantage of performing complex bio-assays on very limited space right at the point of care. To fulfill these laboratory steps in a LoC system all necessary steps from sample preparation until evaluation have to be integrated within this smart system. For this approach rolled-up sensor elements based on the method of *rolled-up nanotech* have to be integrated. The possible integration techniques are limited regarding the sensor elements itself (architecture, material layer system and properties), the feasible functionalization on the inside wall of the sensor elements and the wafer level integration approach, which is aimed. Therefore a *dry* integration technique is favored, because of its not influencing of the inside wall functionalization and the aimed realizing at wafer level with standard CMOS microtechnologies. This system consists out of lithographically manufactured negative photoresist SU8 multilayered structures with microfluidic and integration layers for the rolled-up sensor elements.

DS 35.23 Wed 17:00 P1

Characterization of integrated single-walled carbon nanotubes by transmission electron microscopy — •Martin Hartmann[1], Sascha Hermann[1], and Stefan Schulz[1,2] — [1]TU Chemnitz, Center for Microtechnologies (ZfM), 09126 Chemnitz, Germany — [2]Fraunhofer Institute for Electronic Nano Systems (ENAS), 09126 Chemnitz, Germany

There is a strong interest in using single-walled carbon nanotube (SWCNTs) as ultrasensitive piezoresistive sensor element. For this kind of applications the knowledge of SWCNT properties and its environment are of crucial importance for understanding the device performance and for technology development. In our work we are particularly interested in effects of different process steps along a waferlevel technology for the fabrication of micro or nano electro mechanical devices (MEMS or NEMS) with integrated piezoresistive SWCNT sensors.

Therefore we present studies with a test structure which allows us to use transmission techniques such as transmission electron microscopy (TEM) to get profound information about chirality, defects and impurities introduced during the integration process of the SWCNTs. With a minimal invasive method, this test structure was dissected from a wafer-level processed sample with the focused ion beam (FIB) method. We present first results of a TEM investigation, which integrated SWCNTs between two electrodes of a MEMS structure. Moreover we present an approach for a systematic TEM characterization of a large amount of structures with integrated SWCNTs without using the time-consuming FIB method.

DS 35.24 Wed 17:00 P1

Laser based integration method of rolled-up nano membranes in polymer based LoC systems — •Tom Enderlein[1], Christian Helke[1], Stefan M. Harazim[2], Jörg Nestler[1], Oliver G. Schmidt[2], Thomas Otto[3], and Thomas Gessner[1,3] — [1]TU-Chemntiz, Zentrum für Mikrotechnologien, Reichenhainer Str. 70, 09126 Chemnitz, Germany — [2]IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany — [3]Fraunhofer ENAS, Technologie-Campus 3, 09126 Chemnitz, Germany

The functionalities of Lab-on-a-Chip (LoC) systems today still become more and more complex and the degree of integration is further growing. Mostly driven by conventional MEMS technologies, the preparation for example of channels, pumps and valves is mainly realized in silicon and glass, but also in silicones like PDMS. In the case of LoC systems in the field of point of care diagnostics (PoC), those silicon based systems are barely applicable due to the high costs of the substrate materials for the large areas needed for the sample storage, preparation and so on. This is where polymer substrates reveal their advantage for those one-time-only LoC-cartridges and can well be processed by ultra-short pulse laser systems. Besides the laser structuring of channels and reservoirs, polymer welding is as well possible. The here demonstrated new approach shows on the one hand the integration of those functionalized rolled-up sensor elements by laser structured integration channels in the micrometer range. On the other hand this method uses laser micro-welding and the simultaneously melting of the surrounding material of the rolled-up membranes for their fixation.

DS 35.25 Wed 17:00 P1

A low-cost solution method to fabricate $Cu_2ZnSn(S,Se)_4$ solar cells — Chao Gao[1], Thomas Schnabel[2], •Christoph Krämmer[1], Erik Ahlswede[2], Michael Powalla[2,3], Heinz Kalt[1], and Michael Hetterich[1] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), 70565 Stuttgart, Germany — [3]Light Technology Institute (LTI), Karlsruhe Institute of Technology (KIT), 76131 Karl-

sruhe, Germany

$Cu_2ZnSn(S,Se)_4$ is a promising absorber material to fabricate high-efficiency environmentally friendly solar cells. Here a low-cost solution method has been developed to fabricate $Cu_2ZnSn(S,Se)_4$ solar cells. For the preparation, first SnS, CuS, and ZnS layers are successively deposited on a molybdenum/soda-lime glass substrate by chemical bath deposition, then the $Cu_2ZnSn(S,Se)_4$ thin films are obtained by a selenization process utilizing a graphite box in a tube furnace. The obtained $Cu_2ZnSn(S,Se)_4$ thin films show good crystallization and no obvious evidence for impurity phases except ZnSe is found in the selenized films. By optimizing the preparation process of the $Cu_2ZnSn(S,Se)_4$ thin films, $Cu_2ZnSn(S,Se)_4$ solar cells with efficiencies up to 3.2 % can be obtained. Current-voltage and quantum efficiency measurements imply that a barrier may exist at the $Cu_2ZnSn(S,Se)_4$/CdS interface that could be the limiting factor for the solar cell efficiency.

DS 35.26 Wed 17:00 P1

$Cu_2ZnSnSe_4$ layers and solar cells from selenized co-evaporated precursors — •Timo Musiol[1], Chao Gao[1], Thomas Schnabel[2], Mario Lang[1], Christoph Krämmer[1], Erik Ahlswede[2], Michael Powalla[2,3], Heinz Kalt[1], and Michael Hetterich[1] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), 70565 Stuttgart, Germany — [3]Light Technology Institute, KIT

$Cu(In,Ga)Se_2$ (CIGS) is a well-established absorber material for thin-film solar cells and efficiencies up to 20.8% have been demonstrated. Due to its earth-abundant components, kesterite $Cu_2ZnSn(S,Se)_4$ is a very promising alternative. In this contribution we present results for $Cu_2ZnSnSe_4$ (CZTSe) layers fabricated by coevaporation of Cu, Zn, Sn, and Se, followed by a high-temperature selenization step. The layers are investigated with various techniques such as Raman spectroscopy, X-ray diffration, and photoluminescence spectroscopy. Based on CZTSe absorbers, solar cells have been processed and investigated. I–V data indicates that a conversion efficiency of up to 4.7% is achieved in these devices.

DS 35.27 Wed 17:00 P1

Polycrystalline $Cu_2ZnSnSe_4$ layers on GaAs(001) with a preferential grain orientation — •Johannes Sachs[1], Christoph Krämmer[1], Mario Lang[1], Chao Gao[1], Michael Powalla[2], Heinz Kalt[1], and Michael Hetterich[1] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [2]Light Technology Institute, KIT, and Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), 70565 Stuttgart, Germany

Due to its earth-abundant components the kesterite $Cu_2ZnSnSe_4$ (CZTSe) material system is a very promising alternative to $Cu(In,Ga)Se_2$. However, material properties such as the band structure or the impact of grain boundaries on solar cell performance are still poorly understood. In order to investigate these properties further, high-quality layers of CZTSe would be highly desirable. Towards this aim, we introduce a two-step fabrication approach which is based on the selenization of Sn/Cu/ZnSe(001) structures on GaAs(001) substrates. X-ray diffraction and Raman measurements do not only confirm the formation of the kesterite phase but also indicate a preferential orientation of the CZTSe grains in all three dimensions.

DS 35.28 Wed 17:00 P1

FDTD Simulations for Optimization of Light-Management in Thin-Film Solar Cells — •Benjamin Fries[1,2], Jonathan Lehr[1,2], Ruben Hünig[2], Heinz Kalt[1], Michael Powalla[2,3], and Michael Hetterich[1] — [1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [2]Light Technology Institute, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [3]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), 70565 Stuttgart, Germany

Thin-film solar cells made of Cu(In,Ga)Se2 (CIGS) have reached a high level of both energy conversion efficiency (20.8 %) and commercial cost-effectiveness. Yet a number of aspects remain to be understood and optimized. In this contribution we present a numerical model of a CIGS solar cell being developed in order to investigate the effects of minority carrier collection as well as light-management on the external quantum efficiency (EQE). Experimental data for the latter could be reproduced employing a finite-difference time-domain (FDTD) method. Surface-patterning of a solar cell lead to an experimentally observed increase in short-circuit current which could also be simulated successfully.

DS 35.29 Wed 17:00 P1

Temperature Dependent Electrical Charge Carrier Mobility and Concentration Measurements of Spin Coated Silicon Films — •Daniel Bülz, Michael Fronk, Ronny Fritzsche, Michael Mehring, Georgeta Salvan, and Dietrich R. T. Zahn — TU Chemnitz, 09126 Chemnitz, Germany

Nowadays many different methods for the production of silicon films are investigated. The main goal of these techniques is to lower the production costs and increase the production speed. For electronic applications the charge carrier mobility is a crucial parameter. This can be obtained from electrical Hall and conductivity measurements. Here a magneto-optical Oxford Spectromag Cryostat was upgraded with electrical wirings for electrical Hall and four point probe measurements in order to enable the determination of the charge carrier mobility and concentration. Furthermore, the Spectromag Cryostat offers the possibility of illuminating the sample to investigate the mobility of light induced charge carriers. The system is tested with an n-doped standard silicon wafer sample. Finally, the temperature dependent charge carrier mobility of silicon films is measured. For this purpose, the silicon films are prepared by spin coating of a Si-precursor (neopentasilane). After deposition the films are thermally treated to form amorphous silicon films.

DS 35.30 Wed 17:00 P1

Localisation and finite-size effects in graphene flakes — Clara González-Santander[1], Francisco Domínguez-Adame[1], •Michael Hilke[2], and Rudolf A. Römer[3] — [1]GISC, Departamento de Física de Materiales, Universidad Complutense - E-28040 Madrid, Spain — [2]Department of Physics, McGill University, Montréal (Québec) - H3A 2T8, Canada — [3]Department of Physics and Centre for Scientific Computing, University of Warwick - Coventry, CV4 7AL, UK

We show that electron states in disordered graphene, with an onsite potential that induces inter-valley scattering, are localised for all energies at disorder as small as 1/6 of the band width of clean graphene. We clarify that, in order for this Anderson-type localisation to be manifested, graphene flakes of size $\approx 200 \times 200$ nm^2 or larger are needed. For smaller samples, due to the surprisingly large extent of the electronic wave functions, a regime of apparently extended (or even critical) states is identified. Our results complement earlier studies of macroscopically large samples and can explain the divergence of results for finite-size graphene flakes.

DS 35.31 Wed 17:00 P1

Dry transfer method for CVD-graphene using hexagonal Boron Nitride — •Luca Banszerus[1], Michael Schmitz[1], Kenji Watanabe[2], Takashi Taniguchi[2], and Christoph Stampfer[3] — [1]JARA-FIT and II. Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany — [2]National Institute for Materials Science, 1-1 Namiki, Tsukuba, 305-0044, Japan — [3]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, 52425 Jülich

Growing graphene on copper, using chemical vapor deposition is a promising technique allowing to produce high quality single crystals on large areas. However, recent results have shown that surface contamination by ionic substances and polymer residues substantially lower the quality of the grown graphene. In this work we present a novel transfer method where, in contrast to the common transfer technique, the graphene does not come into contact with any polymer or ionic substances. In a first step we grow graphene single crystals on copper with diameters of up to 400 μm. The graphene is then lifted off the copper with hexagonal boron nitride (hBN), using a van der Waals-pick up technique. Subsequently, the flakes are transferred to SiO_2 or hBN and are characterized using Raman spectroscopy. The Raman spectra show a low D-peak amplitude together with a ratio of G/2D of up to 10 and a G-Peak position around $1583cm^{-1}$ suggesting a high crystal quality and a low doping concentration. Our novel technique additionally allows us to transfer high quality CVD grown graphene from copper onto arbitrary substrates, which makes it potentially interesting for a number of scalable applications.

DS 35.32 Wed 17:00 P1

Raman Spectroscopy of Few-Layer Graphene after Oxygen Plasma Etching — •Mahsa Zoraghi, Jose Barzola-Quiquia, and Pablo Esquinazi — Division of Superconductivity and Magnetism, University of Leipzig, D-04103 Leipzig, Germany

The purpose of this study was to obtain few-layer graphene (FLG) samples of tens of nanometer thickness, from graphite flakes (GF) of 100 nm thickness. Rubbing process is used to prepare FLG samples on the top of isolating substrates. Using this method, GF and FLG samples can be produced without disorder according to Raman measurements. Oxygen plasma etching technique is used at room temperature to reduce the thickness of GF samples and also to study how obtained FLG samples are affected by etching process. Thickness variations can be measured by atomic force microscopy (AFM) after etching process. Raman spectroscopy was used to characterize the possible defects in FLG samples produced by oxygen plasma etching. As the Raman spectroscopy results indicated, we learned that by rubbing method, we do not produce defects in the GF sample however, oxygen plasma etching does. The temperature dependence of the electrical resistance of FLG samples before and after oxygen plasma treatment was also studied.

DS 35.33 Wed 17:00 P1

Charge transport in graphene and nitrogen-doped graphene — •Fabienne Musseau[1], Markus Rein[1], Nils Richter[1], Khaled Parvez[2], Hermann Sachdev[2], Mathias Kläui[1], and Klaus Müllen[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, Mainz, Germany — [2]Max Planck Institute for Polymer Research Mainz, Mainz, Germany

Graphene is a promising candidate for replacing silicon-based transistors due to its two-dimensional structure and high charge carrier mobilities. To this end it is necessary to engineer the band gap in this carbon-based material. One strategy to overcome this problem is the intentional doping of graphene.

Our work is based on a comparison between undoped and nitrogen-doped single graphene layer grown by chemical vapour deposition (CVD) on copper foils. First Raman spectroscopy was used to characterize the samples. Electrical measurements were performed at variable temperatures down to 2.3 K and at variable magnetic field perpendicular to the plane up to 8 T.

The behaviour of undoped samples is comparable to what was previously found in CVD grown graphene, including mobilities of around 1100 cm*/Vs and weak localisation at low temperatures. For the doped samples, the charge carrier concentration is significantly higher than in undoped cases, indicating an effective doping. Furthermore a negative magnetoresistance is observed in the range of -8 T to +8 T, which is not found for undoped graphene.

DS 35.34 Wed 17:00 P1

Hyperdoping Si with deep level impurities by ion implantation and short-time annealing — •Fang Liu, Slawomir Prucnal, Kun Gao, Muhammad Khalid, Wolfgang Skorupa, Manfred Helm, and Shengqiang Zhou — Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O. Box 510119, 01314 Dresden, Germany

It has been proposed that deep level impurities, such as Titanium (Ti) or chalcogens in Si, can induce an impurity band inside the bandgap at high enough doping concentration [1, 2]. The insertion of an impurity band can enhance the absorption at a broader wavelength range and leads to as applications in the so-called intermediate band solar cell [3]. In the present work, we are using ion implantation combined with short-time annealing to realize hyperdoping of Ti and chalcogens in Si. Our results show that the implanted Si layer can be recrystallized by both flashlamp and pulsed laser annealing. Ti ions mainly occupy the interstitial sites, while S and Se ions substitute the Si in the lattice. The consequent changes in electrical properties are also observed. [1] J. Olea, et al., J. Appl. Phys. 109, 063718 (2011). [2] B. P. Bob, et al., J. Aziz J. Appl. Phys. 107, 123506 (2010) [3] A. Luque and A. Martí, Phys. Rev. Lett. 78, 5014 (1997).

DS 35.35 Wed 17:00 P1

Analysis of lateral energy distribution for passive ion beam scattering element — Weiqi Han[1], •Constantin Csato[1], Florian Krippendorf[1], Michael Rüb[1], and Carsten Ronning[2] — [1]Ernst-Abbe-Fachhochschule Jena, Carl-Zeiss-Promenade 2, 07745 Jena — [2]Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena

The task is to analyse the lateral energy distribution of ions passing through an energy filter. Details of the filter are given elsewhere [1]. Simulation with Geant4 [2] has shown that the lateral energy distribution of transmitted ions of an energy filter can be modified by the parameters ion energy, ion species, filter structure and material and filter - substrate distance. We present a tool for characterizing the lateral energy distribution experimentally. We demonstrate that our experimental approach is suitable to analyse the lateral energy distribution of transmitted ions. We implanted $7MeV$ Boron ions with a dose of $3 \cdot 10^{12} cm^{-2}$ through a silicon energy filter into a PMMA substrate. After implantation the PMMA is developed according to [3]. The developed structures are analysed by atomic force microscope and confocal microscope. The results confirm the dependency of the lateral energy distribution on filter-substrate distance.

[1] F. Krippendorf et al., Proceedings MikroSystemTechnik Kongress 2013, 14.-16. Oktober 2013, Aachen: VDE Verlag, 2013, 8.12, 662-665 [2] S. Agostinelli et al., Geant4 - a simulation toolkit, Nuclear Instruments and Methods section A, 2003, 506, 250-303 [3] F. Schrempel et al., Deep light ion lithography in PMMA - A parameter study, Nuclear Instruments and Methods section B, 1997, 3, 430 - 438

DS 35.36 Wed 17:00 P1

Determination of Fluorine dopants in Fused Silica by means of Nuclear Reaction Analysis (NRA) — •Emanuel Schmidt, Anne Nathanael, and Elke Wendler — Institut für Festkörperphysik Jena

Fluorine doped fused silica has plenty of applications, e.g. in modern optical systems or in the production of micro-electronic components. However the absolute determination of light elements, such as fluorine, in an substrate containing heavier atoms, such as fused silica, is a non-trivial task. Ion beam analysis provides therefore suitable methods, as they are independent of chemical processes and offers the possibility to measure absolute concentrations of light elements even for values smaller than 1ppm.

Therefore we used a proton-fluorine nuclear reaction ($^{19}\mathrm{F(p,\alpha_0)^{16}O}$) to measure absolute concentrations of fluorine atoms in fused silica. We have characterized the excitation-function of the nuclear reaction $^{19}\mathrm{F(p,\alpha_0)^{16}O}$ in our laboratory-system and could measure profiles of fluorine concentrations over sample depths and determine dopant concentrations within the SiO_2 matrix.

DS 35.37 Wed 17:00 P1

cAFM measurements of conductive ion tracks in ta-C — •Julian Alexander Amani[1], Johann Krauser[2], Hermann Rothard[3], Tristan Koppe[1], Ulrich Vetter[1], Hans Hofsäss[1], Serge Della-Negra[4], and Christina Trautmann[5] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen — [2]Department of Automation and Computer Sciences, Harz University of Applied Sciences — [3]Centre de Recherche sur les Ions, les Matériaux et la Photonique Ganil, Caen — [4]Matière Nucléaire, Institute de Physique Nucléaire, Orsay — [5]Materialforschung, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The passage of a swift heavy ion through tetrahedral amrophous carbon (ta-C), unlike through boron nitride (BN), leaves a conductive ion track behind. In this work three types of ion tracks were created: uninterrupted conductive ion tracks in ta-C only samples, tracks with a single, highly resistive barrier of BN and samples with two high-resistance BN barriers and a conductive island in the thin ta-C layer in between. The ta-C and BN layers were consecutively grown using mass selective ion beam deposition. The tracks were formed by irradiation with 30MeV C_{60}^{2+} fullerenes. The irradiated samples were analysed using conductive atomic force microscopy (cAFM) at room temperature. As a measure for the homogeneity of the created tracks, the distribution of track conductivities over a large-area of the sample is presented. Additionally, the current-voltage behaviour of the three variants of tracks will be shown.

DS 35.38 Wed 17:00 P1

Morphological heterogeneities of chemically exfoliated GaSe flakes and their impact on photoluminescence and Raman spectra — •Susanne Müller[1], Raul D. Rodriguez[1], Alexander Villabona[1,2], Tao Zhang[3], Ihsan Amin[3], Rainer Jordan[3], Santos A. Lopez-Rivera[2], and Dietrich R.T. Zahn[1] — [1]Semiconductor Physics, Technische Universität Chemnitz, 09107 Chemnitz, Germany — [2]Universidad de Los Andes, Applied Physics Lab, Merida 05101, Venezuela — [3]Professur für Makromolekulare Chemie, Department Chemie, Technische Universität Dresden, Mommsenstraße 4, 01069 Dresden, Germany

Gallium selenide (GaSe) is a two-dimensional material with a high anisotropy of the electrical and optical properties, which makes this material interesting for optoelectronic applications. We are interested in investigating the dependence of both Raman and photoluminescence (PL) spectra on the thickness and the morphology of GaSe flakes.

Therefore, we deposited chemically exfoliated GaSe flakes on highly

oriented pyrolytic graphite. Raman spectra measured on GaSe flakes match bulk GaSe spectra, thus they were not modified by the preparation procedure. The thickness and morphology of the same flakes, where PL and Raman spectra were obtained, were determined by atomic force microscopy. We observed that the PL peak position varies for different flake thicknesses. We discuss the correlation of the flake orientation with respect to the polarization of incident light and the PL peak position. Furthermore, we can see that some of the typical bulk GaSe Raman modes vanish for some flakes.

DS 35.39 Wed 17:00 P1

Electronic properties and morphology of Cu-Phthalocyanine - C_{60} composite mixtures — •Friedrich Roth[1], Cosmin Lupulescu[2], Tiberiu Arion[1,3], Erik Darlatt[4], Alexander Gottwald[4], and Wolfgang Eberhardt[1,2] — [1]Center for Free-Electron Laser Science / DESY, Notkestraße 85, D-22607 Hamburg, Germany — [2]Inst. of Optics and Atomic Physics, TU Berlin, Straße des 17. Juni 135, D-10623 Berlin, Germany — [3]Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg, Germany — [4]Physikalisch-Technische Bundesanstalt (PTB), Abbestraße 2-12, D-10587 Berlin, Germany

Phthalocyanines in combination with C_{60} are benchmark materials for organic solar cells. Here we have studied the morphology and electronic properties of co-deposited mixtures (blends) of these materials forming a bulk heterojunction as a function of the concentration of the two constituents. For a concentration of 1:1 of CuPc:C_{60} a phase separation into about 100 nm size domains is observed, which results in electronic properties similar to layered systems. For low C_{60} concentrations (10:1 CuPc:C_{60}) the morphology, as indicated by Low-Energy Electron Microscopy (LEEM) images, suggests a growth mode characterized by (amorphous) domains of CuPC, whereby the domain boundaries are decorated with C_{60}. Despite of these markedly different growth modes, the electronic properties of the heterojunction films are essentially unchanged.

DS 35.40 Wed 17:00 P1

Work function measurements of sputtered TiO_2 in UHV ambience — •Sonja Urbahn, Rüdiger M. Schmidt, Alexandera Yatim, and Matthas Wuttig — I. Physikalisches Institut (IA), RWTH Aachen, 52056 Aachen

Titanium Dioxide (TiO_2) is a material with unique properties which have led to various applications such as anti-reflective coatings or self-cleaning surfaces. In particular, self-cleaning is possible by the high photocatalytic activity. However, the underlying process behind this attractive feature is still not understood in sufficient detail.

To improve the understanding of the correlation between the structural features of reactively sputtered TiO_2 with its photocatalytical activity we built a UHV Kelvin probe setup. Since self-cleaning implies the diffusion of photo generated charge carriers to the surface where they react with adsorbates, a change of the photocatalytic activity involves a change of the surface potential and thus of the work function. We show data measured with a Kelvin probe in UHV-ambience and link the behavior under UV illumination with structural properties. Although the Kelvin probe technique is very sensitive to the environment, the setup allows to measure data which show a correlation between the change in the work function under UV illumination and structural properties.

DS 35.41 Wed 17:00 P1

Electrical Properties of turbostratically disordered $[(SnSe)_{1.15}]_m(VSe_2)_n$ misfit layer compounds — •Andreas Fiedler[1], Corinna Grosse[1], Ryan Atkins[2], David C. Johnson[2], and Saskia F. Fischer[1] — [1]Novel Materials, Department of Physics, Humboldt-Universität zu Berlin, 10099 Berlin, Germany — [2]Department of Chemistry, University of Oregon, Eugene OR 97401-3753, USA

Progress in materials science depends on the ability to discover novel materials and to investigate and understand their properties. The $[(SnSe)_{1+x}]_m[VSe_2]_n$ ferecrystals are novel materials containing turbostratically disordered layers of SnSe and VSe_2. The aim of this study is to investigate the influence of the stacking sequence on the electrical properties. Therefore, these ferecrystals were electrically characterized by determining the in-plane resistivity and Hall coefficient between 4.2 K and 300 K, using the van der Pauw method. Assuming a single-band model, an increase in resistivity and a decrease in carrier concentration was observed for the $[(SnSe)_{1+x}]_m[VSe_2]_1$ ferecrystals with $m = 1, 2, 3$ and 4, below an onset temperature between 100 K and 150 K. This is consistent with a localization of charge carriers, when, for example, a charge-density-wave (CDW) forms. The electrical measurements imply that it is possible to tailor the electrical properties of these ferecrystals by varying the stacking sequence, as the onset temperature increases with increasing m.

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DS 35.42 Wed 17:00 P1

Characterization of $Zn_xMg_{1-x}O$:Al thin films deposited by RF sputtering — •Philipp Schurig, Marc Dietrich, Philipp Hering, Angelika Polity, and Bruno K. Meyer — Justus-Liebig-Universität Gießen, 1. Physikalisches Institut, Giessen, Deutschland

$Zn_xMg_{1-x}O$:Al is a transparent conductive oxide-semiconductor (TCO) with a tunable band gap which can be used for example as a photovoltaic electrode material. For this application a wide band gap as well as good conductivity is necessary. The thin films were deposited by RF sputtering on c-sapphire and float glass substrates. A ceramic ZnO target with two weight percent Al_2O_3 and mounted Mg-stripes was used. The band gap can be controlled through the magnesium content between 3.3 and 7.8 eV. The influences of the magnesium content on structural, optical and electrical properties are investigated using XRD-, SEM-, transmission- and Hall-measurements.

DS 35.43 Wed 17:00 P1

Stress Analysis on Copper Through Silicon Vias with Micro-Raman Spectroscopy — •Parisa Bayat[1], Dietmar Vogel[2], Raul D. Rodriguez[1], Evgeniya Sheremet[1], Sven Rzepka[2], Bernd Michel[2], and Dietrich R. T. Zahn[1] — [1]Technische Universität Chemnitz, Semiconductor Physics, D-09107 Germany — [2]Fraunhofer ENAS, Micro Materials Center, D-09126 Chemnitz, Germany

Most through silicon vias (TSVs) are filled with copper. The coefficient of thermal expansion of copper (c.a. 16-17 x10^{-6} /°C) is around six times higher than that of silicon (c.a. 2.7 x10^{-6} /°C). Therefore, temperature loadings on Cu-TSV lead to a very large local thermal expansion mismatch between copper and silicon/dielectric (e.g. SiO_2). This imposes very large stresses and strains in the vicinity of the interface region. The local strain/stress fields remaining after packaging processes can be high enough to introduce reliability issues in electronic devices. To evaluate the stress within the silicon surrounding of the TSV, micro-Raman spectroscopy is one of the most appropriate methods capable of providing local measurement of stress at high spatial resolution. We report on the analysis of the stress field in silicon adjacent to Cu-TSVs and the impact of thermal annealing in stress reduction.

DS 35.44 Wed 17:00 P1

Embedded Au nanoparticles in ZrO2 thin films for optical and electronical applications — •Sarah Seidel[1], Alex Sabelfeld[2], Tina Nestler[1], Ronald Otto[1], Johannes Heitmann[1], and Yvonne Joseph[2] — [1]TU Bergakademie Freiberg, Institut für Angewandte Physik, Leipziger Str. 23, 09599,Freiberg,Germany — [2]TU Bergakademie Freiberg, Institut für Elektronik- und Sensormaterialien, Gustav-Zeuner-Str. 3, 09599 Freiberg, Germany

The Au-nanoparticle (NP) was deposited via layer by layer self-assembly. The Au-nanoparticles are stabilized with dodecylamine and dissolved in toluene and have an average diameter of 4.5 nm. On the substrates an amin-terminated surface was prepared using (3-aminopropyl-)-triethoxysilan. We use the spin-coating technique for precipitation of the Au-NP. For the up-conversion a ZrO2 sol gel was doped with Er3+ und thin films were prepared using spin coating technique. We ascertained an optimum in the PL-signal for the 4I13/2-> 4I15/2 transition in Er3+ at 1536 nm with a doping concentration of 0.1 mol% Er3+ and 800°C annealing temperature. On top of the ZrO2 film we deposited a multilayer of Au-NP and analyzed the effect on the PL signal. For the nanofloating memory devices we deposited the Au-NC on a thin SiO2 tunnel oxide und use ZrO2 via electron beam evaporation as blocking oxid. The influence of tunnel oxide thickness on memory characteristics was investigated.

DS 35.45 Wed 17:00 P1

Transmission and optical properties of III-nitride multiple quantum wells and superlattices with disturbed periodicity — •Iglika Asenova and Evgenia Valcheva — Sofia University St. Kliment Ohridski, Faculty of Physics, 5 James Bourchier Blvd, 1164 Sofia, Bulgaria

The III-nitride semiconductors (AlN, GaN and InN) are object of a

significant interest in the past years for they enable a wide range of innovative multiple layered nanosized systems and devices. Usually grown by MOCVD, the barrier periodic structures, such as superlattices and multiple quantum wells, sometimes exhibit a certain breach in their periodicity. In this study we will examine the 1 and 2 monolayer fluctuations in the barrier widths of III-nitride superlattices and multiple quantum wells and the effect the broken periodicity exerts upon the tunneling and the optical properties of the considered structures. Since in most cases the III-nitride structures are negatively doped, we restrain ourselves on examining the transmission coefficient in the conduction band only. Our calculations take account of the macroscopic internal polarization fields (spontaneous and piezoelectric) in the composing layers and the model we exploit is based on the envelope function approximation. Finally, we will compare our theoretical results with experimental data we have previously obtained.

DS 35.46 Wed 17:00 P1

Thin film stress evolution during deposition and interrupts: a thermodynamical assessment — •Amirmehdi Saedi and Marcel J. Rost — kamerlingh Onnes Laboratory, Leiden University, P.O. Box 9504, 2300 RA Leiden, The Netherlands

During Volmer-Weber thin film growth at conditions with sufficiently high atom mobility, the intrinsic film stress becomes compressive in the later stages. Moreover, upon deposition interruptions, the film reacts with a huge tensile jump, that surprisingly, is fully restored back to the original stress values before the interruption, if the deposition is switched on again.

Several mechanisms have been proposed to explain these phenomena, but none of them were able to explain all the details of the experimental results and they remain as mere hypotheses waiting for their proof to come. One suggestion is that the diffusion of adatoms into/out of the grain boundaries during the deposition/interruption would be responsible for the observed effects. There are some models, based on kinetic arguments, attempting to show that this mechanism is capable of reproducing the experimental observations. However all of these models suffer from a critical shortcoming as they do not take into account the thermodynamical aspects. These include e.g. relationships between the flux, adatom densities, chemical potentials of the surface and grain boundaries, and the elastic energy of the bulk. Here our aim is to check for the first time whether the adatom-GB theory can really survive the test of a rigorous thermodynamical analysis.

DS 35.47 Wed 17:00 P1

Organic lateral spin devices fabricated by trench technology — •Sreetama Banerjee[1,2], Peter Richter[1], Danny Reuter[2,3], Karla Hiller[2], Thomas Gessner[2,3], Dietrich R.T. Zahn[1], and Georgeta Salvan[1] — [1]Institute of Physics, Technische Universität Chemnitz, Germany — [2]Centre for Microtechnologies, Technische Universität Chemnitz, Germany — [3]Fraunhofer Institute ENAS, Chemnitz, Germany

Organic semiconductors are considered as attractive materials for spintronic applications. One of the current challenges in this field resides in the cost-effective fabrication of devices with laterally stacked electrodes and their integration at the wafer level. In this work lateral devices with electrodes separated by sub-100 nm gaps were fabricated using conventional UV lithography combined with semiconductor processing. Following a metallization step for the preparation of Au or Co electrodes, organic films were evaporated in high vacuum. Typically an average film thickness of 350 nm was required to form a nanomembrane that closes the gap between the electrodes. These structures allow the systematic investigation of electric and magnetoresistive properties of diamagnetic and paramagnetic organic semiconductor materials (in this case Alq_3 and cobalt phthalocyanine) as a function of the width of the electrode gap. These devices are intended to be used in magnetoresistive devices and molecular spintronics.

DS 35.48 Wed 17:00 P1

Characterisation of Terbium(III) Bis(phthalocyanine)/Cobalt Heterostructures by Ellipsometry and Magneto-optical Kerr Effect Spectroscopy — •Peter Robaschik[1], Michael Fronk[1], Svetlana Klyatskaya[2], Mario Ruben[2,3], Dietrich R.T. Zahn[1], and Georgeta Salvan[1] — [1]TU Chemnitz, 09126 Chemnitz, Germany — [2]KIT, 76344 Eggenstein-Leopoldshafen, Germany — [3]ICPMS, 67034 Strasbourg, France

The single molecule magnet (SMM) terbium(III) bis(phthalocyanine) is considered as a promising candidate for spintronic applications. In this work, films with thicknesses below 100 nm were deposited by organic molecular beam deposition on ferromagnetic, in-plane magnetized Co films. The (magneto-)optical properties were investigated by means of variable angle spectroscopic ellipsometry (VASE) and magneto-optical Kerr effect (MOKE) spectroscopy at room temperature. The molecular orientation was determined from the degree of uniaxial anisotropy of the optical constants and from the amplitude of the magneto-optical Voigt constant. The magnetic coupling of the molecules with the substrate is investigated by MOKE magnetometry in the temperature range from 4 K to 300 K.

DS 35.49 Wed 17:00 P1

Rigorous simulations and analysis of the optical response of silica sculptured thin films — •Eike Lennart Fricke[1], Christoph Grüner[2], Carsten Bundesmann[2], Rüdiger Schmidt-Grund[1], and Marius Grundmann[1] — [1]Universität Leipzig, Inst. für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig, Germany — [2]Leibniz-Institut für Oberflächenmodifizierung e.V, Permoserstr. 15, 04318 Leipzig, Germany

We present full Mueller-matrix spectra of columnar silica sculptured thin films prepared by electron beam glancing angle deposition on silicon substrates in a wide spectral range from 0.5 to 6.5 eV. We analyse the data in two ways: (i) using anisotropic effective medium theory and (ii) using rigorous simulations based on the Rigorous Coupled Wave Approach.

The analysis by means of anisotropic Bruggeman effective medium approximation reproduces the measured data only qualitatively . Especially in the UV spectral range, where the long wavelength assumption of the Bruggeman EMA does no longer hold, the deviation drastically increases. As an alternative we employ the two-dimensional Fourier-Modal-Method, also known as Rigorous Coupled Wave Approach. The model takes the geometric parameters of the columns namely the inter-columnar distance, the radius and the inclination angle of the columns as well as their dielectric function as input parameters, that are optimised using non-linear regression.

A comparison of both methods highlights their different limitations for the analysis of complex surfaces.

DS 35.50 Wed 17:00 P1

Fabrication of sub-microstructures in solid copper surfaces by inverse laser microembossing — •Martin Ehrhardt, Pierre Lorenz, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany

Both the ongoing miniaturization and integration of microdevices and the increasing complexity of microelectromechanical systems (MEMS) call for new machining and fabrication techniques. Laser microembossing is a manufacturing technology which enables the direct fabrication of three-dimensional microstructures in metal foils by replication of a master surface. In the present study a laser embossing process is employed which overcomes the traditional limitation of laser processing. A KrF excimer laser (wavelength $\lambda = 248$ nm, pulse duration $t_{pulse} = 25$ ns) was used to generate different kinds of 3D micro- and nanopatterns in metallic surfaces. The influence of the most important laser parameters on the embossing process with respect to the achieved quality of the generated surface pattern is presented. Therefore, the formed micro- and nanostructures were analyzed by scanning electron microscopy, atomic force microscopy, and white light interferometry. To investigate the material modification, e.g. defect formation and grain size changing due to the embossing process, cross section of the formed microstructures were analyzed by scanning electron microscopy.

DS 35.51 Wed 17:00 P1

Laser-based fabrication of MEMS structures on flexible polymeric substrates — Satish Panchani, •Pierre Lorenz, Martin Ehrhardt, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04315 Leipzig, Germany

Silicon has been a primary material for fabrication of microelectromechanical systems (MEMS) for several decades. However, MEMS devices on flexible substrates are important for non-planar and non-rigid surface applications. To support the rapid advancements of non-silicon MEMS it is necessary to introduce innovative techniques to process-different MEMS material. Numbers of techniques for polymer-based microactuations have been demonstrated in recent years. One promising microactuation technique is based on the bimetallic effect which relies on the thermal coefficient of expansion mismatch between two components of sandwiched layers to provide displacement with change in temperature. In this study, the laser-based fabrication of MEMS

on the example of the bimetal system Al/Mo on polyimide was studied. The temperature dependence of the system was measured by white light interference microscopy (WLIM) and verified by comparison with finite element studies. Furthermore, the resultant structures were investigated by scanning electron microscopy (SEM).

DS 35.52 Wed 17:00 P1

Topography-Controlled Alignment of DNA Origami Nanotubes on Nanopatterned Surfaces — •Bezuayehu Teshome[1,2], Stefan Facsko[1], and Adrian Keller[1] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, Mommsenstraße 13, 01069 Dresden, Germany

The controlled positioning of DNA nanostructures on technologically-relevant surfaces represents a major goal along the route toward the full-scale integration of DNA-based materials into nanoelectronic and sensoric devices. Previous attempts to arrange DNA nanostructures into defined arrays mostly relied on top-down lithographic patterning techniques combined with chemical surface functionalization.

Here we combine two bottom-up techniques for nanostructure fabrication, i.e., self-organized nanopattern formation and DNA origami self-assembly, in order to demonstrate the electrostatic self-alignment of DNA nanotubes on topographically patterned silicon surfaces. Self-organized nanoscale ripple patterns with periodicities ranging from 20 nm to 50 nm are fabricated by low-energy ion irradiation and serve as substrates for DNA origami adsorption. Electrostatic interactions with the charged surface oxide during adsorption direct the DNA origami nanotubes to the ripple valleys and align them parallel to the ripples. By optimizing the pattern dimensions and the Debye length of the adsorption buffer, we obtain an alignment yield of ˜ 70 %.

DS 35.53 Wed 17:00 P1

Investigation of metal nanoparticles formed by means of excimer laser irradiation of ion-exchanged glasses — •Maximilian Heinz[1], Manfred Dubiel[1], Jörg Meinertz[2], and Jürgen Ihlemann[2] — [1]Institute of Physics, Martin Luther University of Halle-Wittenberg, Halle, Germany — [2]Laser-Laboratorium Göttingen e. V., Göttingen, Germany

The localized formation of very small metal particles enables the generation of nanostructured materials, which are of interest for manifold applications in photonic and optoelectronic devices. This study investigates the space-selective precipitation of Ag and Ag/Au nanoparticles induced by 193 nm laser irradiation. The Ag and Au ions were introduced into the soda-lime silicate glass matrix by melt and ion exchange processes. The experimentally recorded spectra of optical spectroscopy demonstrated that the reduction of metal ions is due to defect generation, for example the generation electron hole centres. The sizes of nanoparticles, their distribution and their thermal stability were investigated as a function of the used laser parameters and the thermal treatments, respectively. Measurements of the optical density and experiments of small angle X-ray scattering (SAXS) allowed to identify the resulting surface plasmon resonance in correlation with the size and composition of formed nanoparticles.

DS 35.54 Wed 17:00 P1

Structuring of sub-wavelength Au nano-gratings — Christian Dull[1], •Gernot Goll[1], Silvia Diewald[1], Patrice Brenner[1], and Dmitry Strelnikov[2] — [1]DFG-Center for Functional Nanostructures, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany — [2]Institute of Physical Chemistry, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany

Plasmon resonances of noble metal nanostructures are employed for developing sensors used for sensitive detection of molecules. We report on the structuring of arrays of sub-wavelength Au nano-gratings by electron-beam lithography on 20 x 20 mm^2 SiO_2 wafer pieces coated by a 64-nm thick PMMA resist layer. Sixteen grating arrays were exposed in one run, and the periodicity was varied between 100 nm and 1225 nm from array to array. A typical groove width of $W \approx 16$ nm was achieved. After development a 51-nm thick Au layer was evaporated. First measurements of the optical properties show a dip in the reflectance spectrum which moves from 600 to 1000 nm with increasing the periodicity from 400 to 700 nm. The polarization dependance was investigated as well by illuminating the grating with polarized light parallel and perpendicular to the direction of the lines. The result encourages the usage of such functionalized nano-grating surfaces for highly sensitive sensors.

DS 35.55 Wed 17:00 P1

Evolution of nanostructures induced by low energy ion sputtering on Si surfaces — •Kun Zhang, Hans Hofsäss, and Omar Bobes — II. Physikalisches Institut, Universität Göttingen, Göttingen, Germany

In order to study the allotropic effect on ripple formation on silicon surfaces induced by ion-beam sputter erosion, three types of silicon materials, single crystalline silicon, amorphous silicon grown with evaporation and amorphous silicon produced with ion irradiation, were irradiated with 1-keV Ar^+ ions at incidence angles from 30° to 87°. The ion fluence was 2 x 10^{17} /cm^2 for all irradiations. No ripples were formed for incidence angles smaller than 60° for all three materials, while perpendicular ripples occurred only in amorphous silicon at incidence angles between 82° and 85°. The presented results show, that ripple formation is influenced by the underlying silicon material, which reveal different atom densities depending on the growth of the Si substrate material.

DS 35.56 Wed 17:00 P1

Proton Beam Writing in p-GaAs and controlled subsequent electrochemical etching to create 3D structures for MEMS applications — •Charlotte Rothfuchs, Tristan Koppe, Ulrich Vetter, and Hans Hofsäss — 2. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Recently, 3D structuring with Proton Beam Writing was demonstrated [1] and especially in combination with a variation of the irradiation fluence it has been shown to be a promising lithographic technique for semiconductors [2].

In order to create 3D structures with well-defined feature heights, we simulated the electrochemical etching process of irradiated p-GaAs with finite element simulations. The FEM simulations make use of Monte-Carlo simulations of the recoil distribution and implantation isolation data [3]. Based on those theoretical results it is possible to fabricate free-standing or undercutted structures in a controlled way. The fabrication is work in progress on which we are going to present latest results.

[1] J.A. van Kan et al., Appl. Phys. Lett. 83 (2003) 1629.

[2] M. Schulte-Borchers , U. Vetter, T. Koppe, H. Hofsäss, J. Micromech. Microeng. 22 (2012) 025011.

[3] H. Boudinov, A. V. P. Coelho, J. P. de Souza, Journal of Applied Physics 91(10) (2002) 6585

DS 35.57 Wed 17:00 P1

Self-organized nanopatterns on carbide surfaces by low energy ion irradiation with metal surfactants — •Omar Bobes, Kun Zhang, and Hans Hofsäss — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

We investigate the ripple pattern formation on tetrahedral amorphous carbon (ta-C) films during normal incidence ion beam erosion under simultaneous deposition of different metallic co-deposited surfactant atoms. We have irradiated ta-C films using 1 keV Ar ions under continuous deposition of titanium, tungsten, Molybdenum and Platinum surfactants. The co-deposition of small amounts of Ti, W and Mo leads to the steady state formation of a TiC, WC or MoC nanocomposite surface layer of few nm thickness. This has a tremendous impact on the evolution of nanoscale surface patterns on ta-C. While the surface keeps always flat under co-deposition of Pt-atoms, where there is no possibility for phase separation, ripple pattern are observed under co-deposition of Ti-atoms. The results confirm that the phase separation is the major driving force for the pattern formation in the case of irradiation with normal incident beam.

DS 35.58 Wed 17:00 P1

Influence of dipoles on the recombination in organic photovoltaic devices — •Jędrzej Szmytkowski — Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, Gdańsk, Poland

Although organic compounds are promising materials to use them in photovoltaic devices, the efficiencies of organic solar cells are still lower in comparison to inorganic photocells. The recombination of charge carriers leads to the loss of photocurrent, therefore a detailed theoretical description of this process is required. In the present work, an influence of interface dipoles on the recombination process is discussed. We show how electrical dipoles cause the reduction of nongeminate recombination in organic bulk heterojunction solar cells.

DS 35.59 Wed 17:00 P1

The degradation process of spin coated and flexo printed polytriarylamine thin films studied by IR ellipsometry — •Michael Sendner, Jens Trollmann, and Annemarie Pucci — Kirchhoff-Institut für Physik der Universität Heidelberg

Due to their potential in a roll-to-roll printing process, solution processed organic semiconductor thin films require basic research on the production-related properties. Especially, the knowledge of the degradation processes in organic devices consisting of such thin films is of importance for the application. Therefore, spin coated and flexo printed thin films of polytriarylamine (PTAA) that is used in p-type organic field effect transistors were degraded in a controlled manner by heat and high humidity (65°C, 85% r.h.) over a period of 60 days. The changes of vibrational modes of PTAA during the degradation process were studied in the mid infrared region by IR ellipsometry. Additionally, changes in film morphology were investigated with atomic force microscopy. Our work contributes to a better understanding of the degradation processes and helps to prevent aging of organic devices. Funding by BMBF (Polytos) is gratefully acknowledged.

DS 35.60 Wed 17:00 P1

Studying the contacts of organic solar cells — •Tobias Jenne[1,2], Felix Schell[1,2], Michael Scherer[1,3], Robert Lovrincic[1,3], and Wolfgang Kowalsky[1,2,3] — [1]InnovationLab GmbH, Speyerer Str. 4, 69115 Heidelberg, Germany — [2]University of Heidelberg, Kirchhoff-Institute for Physics, INF 227, 69120 Heidelberg, Germany — [3]TU Braunschweig, Institute for High-Frequency Technology, Schleinitzstr. 22, 38106 Braunschweig, Germany

During the last two decades, the power conversion efficiencies of organic solar cells (OCSs) substantially improved due to new materials and more complex device structures. For further optimization, a deeper understanding of the electric potential within OSCs is necessary. To achieve this, we perform in situ scanning Kelvin probe microscopy (SKPM) [1] measurements in high vacuum on cross sections of OSCs with different active layers and contact materials. These SKPM measurements are accompanied by IV characterization and linked with simulations to gain deeper insights into the fundamentals of complete OSC devices.

[1] Saive et al.: Imaging the Electric Potential within Organic Solar Cells, Adv. Funct. Mater. 2013, DOI: 10.1002/adfm.201301315

DS 35.61 Wed 17:00 P1

Impact of PC[60]BM on the Photo-Degradation of PCPDTBT — •Ulf Dettinger[1], Heiko Peisert[1], Hans-Joachim Egelhaaf[2], and Thomas Chassé[1] — [1]Eberhard-Karls-University, Institute for Physical and Theoretical Chemistry, Auf der Morgenstelle 18, D-72076 Tübingen, Germany — [2]Belectric OPV GmbH, Landgrabenstr. 94, D-90443 Nürnberg, Germany

Organic photovoltaic (OPV) offer a promising low-cost technology for the increasing energy demand of the future. Although higher device efficiencies are still required, the stability of the device materials remains an important factor for organic solar cells. It was shown, that the electron acceptor (EA) in bulk-heterojunction solar cells can affect the stability of electron donor materials in different ways, significantly [1], [2]. The impact of the commonly used EA material PC[60]BM on the Photo-Degradation of the Low-Band-Gap Polymer (LGB) PCPDTBT, as well as its own degradation under irradiation of standard Air Mass 1.5 conditions are studied. The Photo-Degradation of the materials was observed using UV/VIS and FTIR transmission spectroscopy. Basically PCPDTBT exhibits an enhanced stability compared to its blend with PC[60]BM. In particular, IR spectroscopy allows the discussion of the influence of PC[60]BM on the stability of the LBG polymer PCPDTBT.

[1] A. Dupuis et al. Eur. Phys. J. Appl. Phys. 2011, 56, 34104
[2] A. Distler et al. Chem. Mater. 2012, 24, 4397

DS 35.62 Wed 17:00 P1

Infrared spectroscopic study of molecular orientation and interaction in emitter systems for blue organic light emitting diodes — •David Gerbert[1,2,3], Tobias Glaser[1,2], Sebastian Beck[1,2], Christian Lennartz[1,4], and Annemarie Pucci[1,2,5] — [1]Kirchhoff-Institut für Physik, Heidelberg, Germany — [2]InnovationLab GmbH, Heidelberg, Germany — [3]Institut für Physikalische Chemie, Heidelberg, Germany — [4]BASF SE, Ludwigshafen, Germany — [5]Center of Advanced Materials, Heidelberg, Germany

In this study, two emitter systems for blue phosphorescent organic light emitting diodes were investigated by means of infrared spectroscopy. Thin layers of the single materials as well as doped layers have been achieved by evaporation under ultrahigh vacuum conditions. By performing angle-dependant measurements, a preferred molecular orientation has been found for the pure layer of the blue phosphorescent emitter material Ir(dbfmic)3. Such a preferred orientation could not be observed in thin films of the related emitter material Ir(dpbic)3, which can be explained by mutual screening of possible hydrogen bonds by the molecules' ligands themselves. Doping thin films of the matrix material SiDBF with different amounts of Ir(dbfmic)3 leads to small changes in the vibrational spectra with respect to the spectra of the single materials. These spectral changes are probably arising due to van-der-Waals forces and serve as a measure for the interface area between SiDBF and Ir(dbfmic)3 in the doped layers.

DS 35.63 Wed 17:00 P1

Morphology of Small Molecule Vacuum Deposited Organic Solar Cells from Analytical Transmission Electron Microscopy — •Felix Schell[1,2], Tobias Jenne[1,2], Diana Nanova[1,2,3], Anne Katrin Kast[1,2,4], Michael Scherer[1,3], Robert Lovrincic[1,3], Rasmus R. Schröder[1,4], and Wolfgang Kowalsky[1,2,3] — [1]InnovationLab GmbH, Heidelberg, Germany — [2]Kirchhoff-Institute for Physics, Heidelberg University, Germany — [3]Institute for High-Frequency Technology, TU Braunschweig, Germany — [4]CellNetworks, BioQuant, Heidelberg University, Germany

For efficient charge generation and extraction in bulk heterojunction (BHJ) organic solar cells a suitable morphology of the active layer is crucial. However, most imaging techniques cannot distinguish among typical donor/acceptor systems used in BHJs, as these have similar characteristics. It has been shown that spectral information obtained by electron energy loss spectroscopy (EELS) and electron spectroscopic imaging (ESI) can be combined with multivariate statistics and machine learning to yield contrast between the two materials of the interpenetrating network of polymer solar cells. We extend these techniques to small molecule co-evaporated devices using fluorinated zinc phthalocyanine (F_4ZnPc) as donor and the fullerene C_{60} as acceptor. F_4ZnPc exhibits strong optical absorption features in EELS. Vacuum deposition of materials allows better control of morphology compared to solution processing, making it possible to directly correlate microstructural with electrical properties and ultimately with the performance of photovoltaic devices.

DS 35.64 Wed 17:00 P1

Charge Transport in Organic Solar Cells studied by (Photo-) CELIV — •Lars Müller[1,2], Diana Nanova[1,2,3], Norman Mechau[1,4,5], Robert Lovrincic[1,2,3], Uli Lemmer[1,2,4,5], Rasmus R. Schröder[6], and Wolfgang Kowalsky[1,2,3] — [1]InnovationLab GmbH, Heidelberg, Germany — [2]University of Heidelberg, Kirchhoff-Institute for Physics, Germany — [3]TU Braunschweig, Institute for High-Frequency Technology, Germany — [4]Karlsruhe Institute of Technology, Light Technology Institute, Germany — [5]Karlsruhe Institute of Technology, Institute of Microstructure Technology, Germany — [6]CellNetworks, BioQuant, University of Heidelberg, Germany

The efficiency of organic solar cells is determined by certain factors such as the materials themselves or the morphology. Parameters like thermal treatment or the processing technique highly influence some of these factors. Therefore, investigations on working devices are of utmost importance to deepen the already achieved understanding. We study this relationship between processes, materials, and intrinsic properties with the CELIV- and Photo-CELIV-technique (Photoinduced Charge Extraction by Linearly Increasing Voltage). Parameters such as overall device performance and morphology are linked to the CELIV-measured intrinsic properties charge carrier mobility and density. We investigate fully working solar cells with varying materials, processes and treatments. Additionally, charge-transport-studies on P3HT with different molecular weights are performed and compared to morphological changes, measured with analytical TEM and AFM.

DS 35.65 Wed 17:00 P1

Highly conductive vapor phase deposition of poly-3,4-ethylenedioxythiophene (PEDOT) as transparent electrode in organic devices — •Jakob Holfeld, Jan Ludwig Bormann, Lars Müller-Meskamp, and Karl Leo — Institut für Angewandte Photophysik - Technische Universität Dresden, Dresden, Deutschland

Highly conductive poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) is a promising alternative to the brittle and

expensive indium tin oxide (ITO) as transparent electrode in organic solar cells. However, since PSS is highly acidic and hygroscopic, residual PSS can harm the devices after integration.

We investigate a PSS and water free deposition of PEDOT by introducing its monomer via vapor phase. This was carried out in different ways: In a process with iron-(III)-tosylate as pre-spin-coated oxidant, the addition of pyridine as base inhibitor or an amphiphilic block-copolymer as structure directing additive can lead to an dramatic improvement in conductivity (we achieved over 1100 S/cm) and makes PEDOT competitive to ITO. An all-gas-phase PEDOT layer growth with Fe(III)Cl as oxidant agent was also carried out, offering excellent possibilities on solvent sensitive and rough surfaces. Furthermore, planarization of silver nanowires by the use of vapor phase PEDOT, increasing their integrability into organic devices, was tested.

DS 35.66 Wed 17:00 P1

Solution-processed small molecule absorber layer for organic photovoltaics — •Matthias Saalfrank, Ludwig Bormann, Christian Körner, Lars Müller-Meskamp, and Karl Leo — Institut für Angewandte Photophysik, Technische Universität Dresden, George-Bähr-Straße 1, 01069 Dresden, Deutschland

Organic solar cells (OSCs) based on small molecules are commonly processed by vacuum deposition, while for polymer OSCs solution-processing (e.g. spin-coating) is the means of choice. Since the latter technique is also more promising for processing of small molecules in terms of low-cost mass production of organic photovoltaics, it is investigated in this work.

As a first step towards all-solution-processed small molecule OSC we deposit the active layer materials by spin-coating the donor-acceptor blend from solution onto ITO-coated glass substrates covered with an insoluble metal oxide transport layer (MoO_3 as hole transport layer for normal pin structures, TiO_2 as electron transport layer for inverted nip structures). Subsequently, the transport layer and aluminium electrode are deposited by vacuum evaporation. As the small-molecule donor we use an oligothiophene derivative with butyl side chains (DCV6T-Bu) and the commonly used acceptor PCBM. The solution-processed DCV6T-Bu:PCBM bulk heterojunction cells are compared with a corresponding vacuum-deposited DCV6T-Bu:C_{60} reference cell.

DS 35.67 Wed 17:00 P1

Atomistic calculation of thermoelectric properties of Si nanowires — Igor Bejenari and •Peter Kratzer — Fakultät für Physik and Center for Nanointegration (CeNIDE), Universität Duisburg-Essen, Duisburg, Germany

In contrast to the bulk materials conventionally used in thermoelectrics, nanostructured materials offer the possibility to design thermoelectric devices with improved efficiency by exploiting the quantum confinement of electrons and phonons on the nanoscale. In this case, a fully atomistic simulation considering both the electron and phonon band structures as well as electron-phonon interaction is required to estimate thermoelectric properties.

We study thermoelectric properties of Si square nanowires with <100> crystalline orientation taking into account atomistic electron-phonon interaction. In our model, facets <010> and <001> are passivated by hydrogen and there are Si dimers on the nanowire surface. The electronic structure was calculated by using the sp3-spin-orbit-coupled atomistic second-nearest-neighbor tight-binding model. The phonon dispersion and density of states were calculated in framework of Brenner's model. Based on Fermi's golden rule, the electron-phonon scattering rate was obtained by combining the electron and phonon eigenstates. Both elastic and inelastic scattering processes are taken into consideration. We used a solution of linearized Boltzmann transport equation to calculate transport characteristics. For the Si nanowire with a thickness of 1.6 nm at room temperature, the electron mobility is 422 $cm^2V^{-1}s^{-1}$ and ZT=0.8 at $n = 10^{20}$ cm^{-3}.

DS 35.68 Wed 17:00 P1

Bor-dotierte nanokristalline Diamantschichten für thermoelektrische Anwendungen — •Regina Berendakova, Nicolas Wöhrl und Volker Buck — Universität Duisburg-Essen und CENIDE, Fakultät für Physik, Lotharstr. 1, 47057 Duisburg, Deutschland.

Nanokristalline Diamantschichten werden durch Mikrowellenplasma unterstützte CVD aus einem $Ar/H_2/CH_4$ Plasma mit Zusatz von Trialkylboran $B(C_3H_7)_3$ p-dotiert erzeugt. In vorhergehenden Arbeiten wurde gezeigt, dass sich Bor-dotierte Nanodiamantschichten gut für thermoelektrische Anwendungen eignen. Dabei wurde eine thermische Leitfähigkeit niedriger als 10 W/mK und ein Seebeck-Koeffizient höher als 200 μV/K erreicht. Das Ziel der vorliegenden Arbeit ist die unabhängige Variation von Kristallitgröße (entscheidend für die thermische Leitfähigkeit) und Dotierstoffkonzentration (entscheidend für elektrische Leitfähigkeit).

DS 35.69 Wed 17:00 P1

Phase separation in the (Ti,Zr,Hf)$CoSb_{0.8}Sn_{0.2}$ system for improved thermoelectric properties — •Elisabeth Rausch[1], Benjamin Balke[1], and Claudia Felser[1,2] — [1]Institut für Anorganische und Analytische Chemie, Johannes Gutenberg-Universität Mainz — [2]Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden

Heusler compounds with $C1_b$ structure are very promising materials for high-temperature thermoelectric applications. Their advantages are excellent electronic properties reflected in high power factors and high mechanical stability. However, disadvantage is their relatively high thermal conductivity. To overcome this obstacle the fabrication process of state-of-the-art p-type materials based on the TiCoSb system all involve a nano structuration via ball-milling. We herein present an alternative approach for the improvement of the thermoelectric properties. The effect of an intrinsic phase separation caused by isoelectronic alloying of Ti with Zr and Hf was investigated in the system $Y CoSb_{0.8}Sn_{0.2}$ (Y = Ti, Zr, Hf, $Ti_{0.5}Hf_{0.5}$, $Zr_{0.5}Hf_{0.5}$, $Ti_{0.5}Hf_{0.5}$, $Ti_{0.3}Zr_{0.35}Hf_{0.35}$). Upon this we achieved a thermal conductivity as low as 3.1 mW/K and a maximum figure of merit ZT of 0.9 at 979 K with a simple arc melting fabrication process.

DS 35.70 Wed 17:00 P1

Tailored thermoelectric efficiencies by controlling disorder — •Stefan Jakobs[1], Felix Lange[1], and Matthias Wuttig[1,2] — [1]I. Physikalisches Institut (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]JARA - Fundamentals of Future Information Technology, RWTH Aachen University, Germany

Thermoelectric materials require high complexity in material tailoring since both electrical and thermal transport properties play a significant role for their energy conversion efficiency.

A relatively high electrical conductivity as well as a low thermal conductivity is described by the phonon glass-electron crystal (PGEC) concept.

One approach is the concerted variation of stoichiometry (e.g. doping) to enhance the power factor or embedding 'rattling atoms' to reduce the lattice thermal conductivity.

Another approach is the controlled use of disorder. Sittner *et al.* have shown recently that disorder in pseudo-binary $(GeTe)_x(Sb_2Te_3)_{1-x}$ phase-change materials (PCM) can be tuned to obtain moderate thermoelectric efficiencies up to $zT = 0.7$ at 120 °C[1].

Here we explore the potential of concerted doping of pseudo-binary PCM with SnTe to further enhance thermoelectric properties.

[1] E.-R. Sittner *et al.*, Phys Status Solidi **A**, 210 (2013)