

Section Thin Films Fachverband Dünne Schichten (DS)

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Overview of Invited Talks and Sessions

(lecture rooms H32 and H34; Poster B)

Invited Talks

DS 8.1	Mon	14:30–15:15	H34	Processing, properties and application potential of nanostructured hard coatings — ●PAUL MAYRHOFER
DS 11.1	Tue	9:30–10:00	H32	Strained silicon for advanced nanotechnology — ●MICHAEL GORYLL, DAN BUCA, QING-TAI ZHAO, BERND HOLLÄNDER, SIEGFRIED MANTL, ROGER LOO, DUY NGUYEN, MANFRED REICHE
DS 11.2	Tue	10:00–10:30	H32	Integration of functional epitaxial oxides into silicon: From high-K application to nanostructures — ●H. JÖRG OSTEN
DS 11.3	Tue	10:30–11:00	H32	Rare Earth based amorphous ternary oxide layers as alternative gate dielectrics — ●JÜRGEN SCHUBERT, TASSILO HEEG, MARTIN ROECKERATH, JOAO MARCELO JORDAO LOPES, UFFE LITTMARK, CHAO ZHAO, MATTY CAYMAX, VALERIE AVANASIEV, LISA EDGE, YUNFA JIA, WEI TIAN, DARRELL SCHLOM
DS 11.4	Tue	11:00–11:30	H32	Advanced SOI CMOS transistors for high performance microprocessors — ●MANFRED HORSTMANN
DS 11.6	Tue	11:45–12:15	H32	Graphene: A new Electronic Material — ●MAX CHRISTIAN LEMME, TIM ECHTERMAYER, MATTHIAS BAUS, HEINRICH KURZ
DS 11.7	Tue	12:15–12:45	H32	Electronic Transport in Carbon Nanotube FETs — ●JOACHIM KNOCH
DS 12.1	Tue	14:30–15:15	H34	Surface Analytics with Monolayer Resolution using Ions — ●PEDRO GRANDE, AGENOR HENTZ, RAFAEL PEZZI, ISRAEL BAUMVOL, GREGOR SCHIWIETZ
DS 18.1	Wed	15:00–15:30	H34	Analysis of protein layer structure using real-time ellipsometry — ●HANS ARWIN
DS 18.2	Wed	15:30–16:00	H34	Optical Spectroscopy with high Spatial Resolution — ●WOLFGANG RICHTER, EUGEN SPEISER, BENJAMIN BUICK, SILVANO DEL GOBBO
DS 18.3	Wed	16:00–16:30	H34	Surface enhanced Raman spectroscopy as a probe for studying metal/organic interfaces — ●GEORGETA SALVAN, DIETRICH ZAHN
DS 18.4	Wed	16:30–17:00	H34	In-situ monitoring of stress evolution in growing group-III-nitride layers — ●ALOIS KROST, ARMIN DADGAR, RAINER CLOS, GUNTHER STRASSBURGER, FABIAN SCHULZE
DS 19.1	Wed	17:15–17:45	H34	Optical in-situ diagnostics of device growth in MOVPE — ●MARTIN ZORN, FRANK BRUNNER, THOMAS ZETTLER, MARKUS WEYERS
DS 19.2	Wed	17:45–18:15	H34	In-situ investigations of electronic and structural properties of Si surfaces during electrochemical surface functionalization — ●JÖRG RAPPICH, FLORENT YANG, KATY ROODENKO, ALEX GÜELL, CARL MATTHIAS INTEL-MANN, THOMAS DITTRICH, KARSTEN HINRICHS
DS 19.3	Wed	18:15–18:45	H34	Water at model membranes: structure, dynamics and biomolecular sensing — ●MISCHA BONN
DS 21.1	Thu	11:15–12:00	H32	Growth morphology evolution in real time and real space — ●JOACHIM KRUG
DS 21.2	Thu	12:00–12:45	H32	Growing metals on silicon surfaces - STM study in-vivo — ●IVAN OŠTÁDAL, PAVEL SOBOTÍK, PAVEL KOCÁN, JAN PUDL

DS 22.1	Thu	9:30–10:00	H34	Grain Growth and Film Growth observed with Real-time, in-situ STM — ●MARCEL J. ROST
DS 25.1	Thu	15:00–15:45	H32	Pentacene thin film growth — ●GEORGE MALLIARAS
DS 25.4	Thu	16:15–17:00	H32	Growth, Interface Formation and Electron Dynamics of Pentacene Thin Films — ●FRANK MEYER ZU HERINGDORF
DS 25.7	Thu	17:30–18:15	H32	Charge Injection across Self-Assembly Monolayers in Organic Field Effect Transistors: Odd-Even Effects — ●FABIO BISCARINI, PABLO STOLIAR, RAJENDRA KSHIRSAGAR, MASSIMILIANO MASSI, PAOLO ANNIBALE, CRISTIANO ALBONETTI, DAGO DE LEEUW

Invited Talk in Section Surface Physics

O 3.1	Mon	10:15–11:00	H36	Some aspects of chirality in molecules adsorbed at metal surfaces — ●NEVILLE RICHARDSON
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Prize Talk of the Gaede Prize Winner

O 37.1	Wed	14:00–14:45	H36	Gallium-Nitride-on-Silicon: Mission possible! — ●ARMIN DADGAR
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Invited talks of the joint symposium SYSE

See SYSE for the full program of the Symposium.

SYSE 1.1	Mon	14:30–15:00	H1	Wavy and Buckled Nanoribbons and Nanotubes: Mechanics and Applications — ●JOHN ROGERS
SYSE 2.1	Mon	16:15–16:45	H1	Enhancing Ferroelectrics and Multiferroics using Strain — ●D.G. SCHLOM, M.D. BIEGALSKI, A. SOUKIASSIAN, J.H. HAENI, J.H. LEE, R.W. ULBRICHT, C.M. BROOKS, Y. JIA, V. VAITHYANATHAN, W. TIAN, X. KE, D.A. TENNE, A.V. RAO, A. KUMAR, L. TIAN, A. SHARAN, S. CHOUDHURY, Y.L. LI, P. SCHIFFER, S. TROLIER-MCKINSTRY, X.X. XI, V. GOPALAN, L.Q. CHEN, K.J. CHOI, D.M. KIM, C.B. EOM, Y.B. CHEN, H.P. SUN, X.Q. PAN, D.D. FONG, M.A. ZURBUCHEN, J.A. EASTMAN, P.H. FUOSS, S.K. STREIFFER, P. IRVIN, J. LEVY, W. CHANG, S.W. KIRCHOEFER, T. HEEG, J. SCHUBERT, A. BRUCHHAUSEN, N.D. LANZILLOTTI-KIMURA, A. FAINSTEIN, R.S. KATIYAR, A. CANTARERO, M.E. HAWLEY, Q.X. JIA, C.J. FENNIE, S.M. NAKHMANSON, K.M. RABE, A.K. TAGANTSEV, B. VELICKOV, R. UECKER, P. REICHE
SYSE 2.3	Mon	17:00–17:30	H1	Patterning ferroelectric nanostructures by epitaxial strain — ●HO NYUNG LEE, MATTHEW CHISHOLM
SYSE 2.4	Mon	17:30–18:00	H1	Curl in Photonic Crystals Induced by Drying Stresses upon Sol-Gel Infiltration — ●VLADIMIR KITAEV, EVANGELLOS VEKRIS, GEOFFREY OZIN

Invited talks of the joint symposium SYOE

See SYOE for the full program of the Symposium.

SYOE 4.1	Tue	9:30–10:15	H1	Vapor and Solution Deposited Small Molecule Organic Thin Film Transistors — ●THOMAS JACKSON
SYOE 5.1	Tue	11:15–12:00	H1	Organic electronic devices and their applications — ●PAUL HEREMANS
SYOE 6.1	Tue	14:30–15:15	H32	Theory of polymer devices: OFETs and OLEDs — ●REINDER COEHOORN
SYOE 7.1	Tue	16:30–17:15	H32	Electronic spectrum and spin states of a single organic molecule — ●HERRE VAN DER ZANT
SYOE 10.1	Wed	16:45–17:30	H32	Single grain contacts — ●GREGOR WITTE

Invited talks of the joint symposium SYBM

See SYBM for the full program of the Symposium.

SYBM 1.1	Thu	9:30–10:00	H1	Using Ice to Mimic Nacre: From Structural Materials to Artificial Bone — •A. P. TOMSIA, S. DEVILLE, E. SAIZ
SYBM 1.2	Thu	10:00–10:30	H1	On the structure of biogenic CaCO₃ — •B. POKROY
SYBM 1.3	Thu	10:30–11:00	H1	Bio-Inspired Hybrid Materials from Block Copolymer Assemblies and Nanoparticle Co-assemblies — •U. WIESNER
SYBM 1.4	Thu	11:15–11:45	H1	Bio-Inspired Organic-inorganic Hybrid Materials — •U. STEINER
SYBM 1.5	Thu	11:45–12:15	H1	Structural, Nanomechanical, and Nanotribological Characterization of Human Hair Using Atomic Force Microscopy and Nanoindentation — •BHARAT BHUSHAN

Sessions

DS 1.1–1.6	Mon	9:30–11:00	H32	Organic Thin Films I
DS 2.1–2.7	Mon	11:15–13:00	H32	Organic Thin Films II
DS 3.1–3.6	Mon	9:30–11:00	H34	Metal Layers and Multilayers
DS 4.1–4.6	Mon	11:15–12:45	H34	Nanoengineered Thin Films
DS 5.1–5.5	Mon	14:30–15:45	H32	Organic Interfaces (SYOE 1)
DS 6.1–6.7	Mon	16:00–17:45	H32	Organic Photovoltaics (SYOE 2)
DS 7.1–7.4	Mon	18:00–19:00	H32	Organic Film Aging (SYOE 3)
DS 8.1–8.1	Mon	14:30–15:15	H34	Hard Coatings I
DS 9.1–9.7	Mon	15:15–17:00	H34	Hard Coatings II
DS 10.1–10.7	Mon	17:15–19:00	H34	Layers with Magnetic Properties
DS 11.1–11.9	Tue	9:30–13:15	H32	Symposium: New Materials for Nanoelectronics
DS 12.1–12.1	Tue	14:30–15:15	H34	Thin Film Analytics I
DS 13.1–13.5	Tue	15:15–16:30	H34	Thin Film Analytics II
DS 14.1–14.5	Tue	16:45–18:00	H34	Thin Film Analytics III
DS 15.1–15.66	Tue	15:00–17:00	Poster B	Poster Session
DS 16.1–16.8	Wed	14:30–16:30	H32	Organic Light Emitting Diodes (SYOE 9)
DS 17.1–17.6	Wed	16:45–18:45	H32	Contact Properties (SYOE 10)
DS 18.1–18.4	Wed	15:00–17:00	H34	Symposium: In situ Optics I
DS 19.1–19.3	Wed	17:15–18:45	H34	Symposium: In situ Optics II
DS 20.1–20.6	Thu	9:30–11:00	H32	Symposium: Real Time Growth Studies I
DS 21.1–21.2	Thu	11:15–12:45	H32	Symposium: Real Time Growth Studies II
DS 22.1–22.1	Thu	9:30–10:00	H34	In situ STM
DS 23.1–23.4	Thu	10:00–11:00	H34	Symposium: In situ Optics III
DS 24.1–24.8	Thu	11:15–13:15	H34	Ion Beam Techniques
DS 25.1–25.8	Thu	15:00–18:30	H32	Symposium: Real Time Growth Studies III
DS 26.1–26.11	Thu	15:00–17:45	H34	Oxides
DS 27.1–27.7	Fri	9:30–11:15	H32	Polymer and Composite Films
DS 28.1–28.5	Fri	11:30–12:45	H32	Silicon Thin Films and Interfaces

Mitgliederversammlung des Fachverbands Dünne Schichten

Mittwoch 18:45–19:15 H34

Mitgliederversammlung der Deutschen Vakuumgesellschaft

Mittwoch 19:15–19:45 H34

DS 1: Organic Thin Films I

Time: Monday 9:30–11:00

Location: H32

DS 1.1 Mon 9:30 H32

Anisotropic optical constants and exciton-phonon coupling of diindenoperylene thin films — •UTE HEINEMEYER¹, STEFAN KOWARIK¹, ALEXANDER GERLACH¹, REINHARD SCHOLZ², M. ISABEL ALONSO³, MIQUEL GARRIGA³, J. ORIOL OSSÓ³, and FRANK SCHREIBER¹ — ¹Institut für Angewandte Physik, Universität Tübingen — ²Walter Schottky Institut, Technische Universität München — ³Institut de Ciència de Materials de Barcelona

Diindenoperylene (DIP) has received increased attention due to its well defined ordering and promising electronic transport properties [1,2]. We investigate the optical properties of DIP thin films on Si-substrates by spectroscopic ellipsometry. Since the molecules are highly ordered, the DIP films exhibit strong anisotropic optical properties with uniaxial symmetry so that it is necessary to perform variable angle ellipsometry. The data analysis of such anisotropic systems and the results in the energy range of 1.25 to 3 eV are presented. The aggregated molecules show a pronounced vibrational progression, allowing direct access to the exciton-phonon coupling. In addition a new mode appears that does not exist in the absorption spectra of free molecules in solution. It cannot be assigned to the vibronic progression and it is probably due to intermolecular coupling. Furthermore it is possible to take the spectra sufficiently fast to follow organic molecular beam deposition in detail. The analysis of the in-situ and real-time data taken at one fixed angle of incidence will be discussed. [1] S. Kowarik *et al.*, PRL **96**, 125504 (2006) [2] A. K. Tripathi and J. Pflaum, APL **89**, 082103 (2006).

DS 1.2 Mon 9:45 H32

Influence of substrate treatment and temperature on the electronic structure of diindenoperylene (DIP) thin films on Ag(111) — •STEFAN KRAUSE, SÖNKE SACHS, ACHIM SCHÖLL, and EBERHARD UMBACH — University of Würzburg, Experimental Physics II, Am Hubland, 97074 Würzburg, Germany

Diindenoperylene (DIP) has recently attracted high interest in the organic electronics community due to the reported very high hole mobility and favorable ordering properties in thin films on SiO₂ and gold substrates.

In this work we focus on the growth of DIP on the stronger interacting Ag(111) substrate. Due to the increased interface interaction an additional influence of the substrate can be expected, giving additional possibilities to manipulate the film growth. Ultraviolet Photoelectron Spectroscopy (UPS) data show substantial differences in the valence electronic structure before and after the annealing of low temperature deposited films. The annealing is believed to increase the degree of structural order particularly in the case of film growth far from thermal equilibrium conditions. Moreover, a marked influence of the substrate treatment could also be observed in the UPS spectra. The Ag(111) sample reveals a change of the work function depending on the duration and temperature of the annealing cycle after the Ar⁺-sputter treatment which can be associated with differences in the step density. The photoemission results indicate that different structural phases with different intermolecular interaction exist on the substrate morphology and growth parameters.

DS 1.3 Mon 10:00 H32

Epitaxial Heterolayers of Quaterylene and HBC on Au(111) — •DANIEL KASEMANN, ROBERT FRANKE, ROMAN FORKER, and TORSTEN FRITZ — Institut für Angewandte Photophysik, Mommsenstr. 13, D-01069 Dresden, Germany

As growth and electronic properties of perylene derivatives [1] and other medium-sized planar aromatic molecules [2] have already been studied intensively, we have now investigated larger organic molecules, namely quaterylene (QT).

In our contribution, we will present the first results on the investigation of thin, highly ordered double layers of QT and hexa-perihexabenzocoronene (HBC). These layers were prepared on a gold single crystal (Au(111)) by Organic Molecular Beam Epitaxy (OMBE).

We were able to image these structures with molecular resolution by room temperature STM. With these real space images and an additional LEED analysis, the system could be successfully characterized. The QT was found to grow in a point-on-line mode on the HBC, the lattice vectors are relaxed compared to the growth of QT directly on

Au(111) [3].

- [1] M. Toerker *et al.*, PRB **65** (2002) 245422
- [2] H. Proehl *et al.*, PRB **63** (2001) 205409
- [3] R. Franke *et al.*, APL **88** (2006) 161907

DS 1.4 Mon 10:15 H32

Molecular chains and carpets of sexithiophenes on Au(111) — •HENDRIK GLOWATZKI¹, STEFFEN DUHM¹, KAI F. BRAUN², JÜRGEN P. RABE¹, and NORBERT KOCH¹ — ¹Humboldt-Universität zu Berlin, Institut für Physik, Newtonstrasse 15, 12489 Berlin — ²Universität Hamburg, Institut für Angewandte Physik, 20355 Hamburg, Germany

We investigated two organic semiconductors sexithiophene (6T) and dihexylsexithiophene (DH6T) adsorbed on Au(111) in the (sub-)monolayer range by scanning tunneling microscopy (STM). At low coverage, 6T formed continuous chains of single molecular width along Au step edges, facilitated by 6T conformation changes. At monolayer coverage, substantially different structures were observed for the two molecules, despite the identical conjugated core. 6T formed rows of molecules with parallel long molecular axes, whereas DH6T formed lines along these axes, where the conjugated cores were embedded in a matrix of hexyl chains (brick-wall-like). Alkylation of 6T thus led to significantly reduced inter-molecular interactions of conjugated parts in the monolayer. Consequently, 6T formed a continuous "molecular carpet" on extended Au(111) terraces, whereas DH6T resembled a patchwork-like carpet, as domain boundaries were induced by the Au(111) herringbone surface structure.

DS 1.5 Mon 10:30 H32

Combined Spectroscopic Ellipsometry and Reflectance Anisotropy Spectroscopy Measurement of Phthalocyanines on ZnO (0001) Semiconducting Surface — •SINDU JOHN LOUIS, MARION FRIEDRICH, and DIETRICH ZAHN — Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany

Phthalocyanines (Pcs) are important class of materials exhibiting high thermal and chemical stability and also high optical absorption in the visible range. The growth of this molecule on the wide gap (3.2 eV) semiconductor ZnO of wurtzite structure is an interesting study. Detailed information about the interaction between the Pcs and the ZnO substrate can be obtained from Spectroscopic Ellipsometric (SE) measurements and the extent of in-plane anisotropy can be detected by the Reflectance Anisotropy Spectroscopy (RAS) measurements.

Thin films of Pcs are prepared by organic molecular beam deposition method in ultrahigh vacuum conditions. Spectroscopic ellipsometric studies were carried out using Variable Angle Spectroscopic Ellipsometer (VASE) in the NIR-Vis-UV range from 0.75 eV to 5 eV. RAS is sensitive to very small anisotropies of order 10⁻³ or even smaller. The accessible range is from 1.5 eV to 5.5 eV. Both these RAS and SE measurements are performed in situ together.

Since the optical absorption of the Pcs in the Q band region (around 2 eV) is due to π to π^* transitions of the macro cycle π - system, any change in the line shape of imaginary part of the dielectric function for ultra thin layers provide insight to the interaction with the surface through π - orbitals.

DS 1.6 Mon 10:45 H32

Photochromism in thin spiropyran films — •MICHAEL KARCHER, CELINE ELSÄSSER, CHRISTOPH RÜDT, MARTIN SCHÜBBE, and PAUL FUMAGALLI — Freie Universität Berlin, Deutschland

Photochromic molecules are reversibly switchable molecules that can be both addressed and read out using light. Possible applications are optical memory devices and smart materials [1]. Thin films of 6-nitro derivatives of the spiropyrans have been prepared using thermal evaporation under high vacuum conditions on different substrates. The photochromism of the films has been studied using optical absorption spectroscopy in the UV-VIS range. Reversible switching by light irradiation between the spiropyran and the merocyanine state was observed.

Steady-state transmission spectra of 10 to 40 nm thick films on quartz and magnesium-oxide substrates will be shown for both the spiropyran ground state as well as the metastable merocyanine state. Furthermore, the switching kinetics on a time scale of seconds will be presented.

- [1] Chem. Rev. **100**, 1741-1753 (2000)

DS 2: Organic Thin Films II

Time: Monday 11:15–13:00

Location: H32

DS 2.1 Mon 11:15 H32

Structural analysis of small organic hydrocarbon ring molecules on GaAs(001) surfaces — ●R. PASSMANN^{1,2}, T. BRUHN², W. BRAUN³, M. KNEISSL², W. RICHTER⁴, N. ESSER¹, and P. VOGT² — ¹ISAS Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany — ²TU Berlin, Institute of Solid State Physics, Hardenbergstr. 36, 10623 Berlin, Germany — ³BESSY GmbH, Albert-Einstein-Str. 15, 12489 Berlin, Germany — ⁴Universita Tor Vergata, Via della Ricerca Scientifica 1, 00133 Rome, Italy

Organic molecules are capable to functionalize semiconductor surfaces. Therefore it is essential to understand the resulting structure of the organic molecules and the semiconductor surfaces. To get some insight into the question how this depends on the molecule properties and the substrate surface, we investigated the dependence of the number of double bonds within hydrocarbons to the adsorption process. We have studied the structural configuration of three different GaAs(001) surface reconstructions occurring with Cyclopentene (C₅H₈) and 1,4-Cyclohexadiene (C₆H₈) adsorbed on them. This was studied by reflectance anisotropy spectroscopy (RAS), soft X-ray photo electron spectroscopy (SXPS), scanning tunnelling microscopy (STM) and LEED. SXPS measurements show clear new contributions in the As3d and C1s core levels. Additionally the RAS line shape changed significantly for the surface related features. This indicates a bonding between C₅H₈ (C₆H₈) and the top-layer dangling bonds. STM measurements support these results. Based on these experiments we can derive possible structure models for the bonding configuration.

DS 2.2 Mon 11:30 H32

Self-assembled alkyl monolayers on Si(111) investigated by NEXAFS and HR-UPS — ●M. HÄMING¹, J. ZIROFF¹, S. HAME¹, A. SALOMON², L. SEGEV², T. BOECKING³, O. SEITZ², D. CAHEN², F. REINERT¹, A. SCHÖLL¹, and E. UMBACH¹ — ¹University of Würzburg, Experimental Physics II, 97074 Würzburg — ²Weizmann Institute of Science, Department of Materials and Interfaces, Rehovot 76100 Israel — ³The University of New South Wales, Sydney, NSW 2052, Australia

The electronic structure of organic condensates is of crucial importance for the charge transport properties in these materials. Inter- and intramolecular interactions have a strong impact on the electronic system, leading to energy shifts in all levels. Moreover, for oriented chains band dispersion may occur and in the case of long range order even lateral band dispersion is possible. Self-assembled monolayers (SAMs) are ideal model systems to systematically study the intramolecular electronic band dispersion along the chains as function of chain length. In this work we investigate alkyl SAMs of various chain lengths directly bound to Si(111) substrates via Si-C bonds. Near edge x-ray absorption fine structure (NEXAFS) measurements provide information on unoccupied states and the molecular orientation with respect to the surface (~40° for C₁₄H₂₉). Also, the influence of radiation damage is observed in the NEXAFS spectra by the formation of intra- or intermolecular π -bonds. The high resolution UV photoemission spectroscopy (HRUPS) data recorded with variable photon energy (UE112-PGM at BESSY) shows marked dispersion within the valence regime which is compatible with a tight binding model taking into account the film geometry.

DS 2.3 Mon 11:45 H32

Arrays of crystalline C₆₀ and pentacene nanocolumns — ●JIAN ZHANG¹, INGO SALZMANN¹, FUJUN ZHANG^{1,2}, ZHENG XU², SIEGFRIED ROGASCHESKI¹, JÜRGEN RABE¹, and NORBERT KOCH¹ — ¹Institut für Physik, Humboldt-Universität zu Berlin, Newtonstrasse 15, D-12489 Berlin — ²Key Laboratory of Luminescence and Optical Information, Ministry of Education, Institute of Optoelectronic Technology, Beijing Jiaotong University, Beijing 100044, China

Organic nanocolumn arrays have been the focus of many research studies owing to the wide range of potential applications for these structures, particularly in the field of optoelectronics. In our work, crystalline nanocolumnar arrays of two widely studied organic semiconductors, i.e., Fullerene (C₆₀) and pentacene were fabricated by glancing angle deposition (GLAD), and characterized by scanning electron microscopy and X-ray diffraction. For both materials, column diameters of typically 100 nm are found on the transparent conductive oxide ITO, essentially independent of column height (up to 360 nm for pentacene).

However, on Si-oxide only C₆₀ formed nanocolumns, while pentacene exhibited a morphology resembling that obtained by regular normal incidence deposition. The molecular surface diffusion length on the substrate is thus identified as critical parameter for the formation of columnar nanostructures by GLAD. Our results indicate that glancing angle deposition is a simple technique to fabricate organic crystalline nanocolumn arrays, and that controlling the molecular surface diffusion via chemical and/or morphological patterning may lead to entirely new functional organic nanostructures.

DS 2.4 Mon 12:00 H32

Unusual narrow absorption bands of PTCDA submonolayers on potassium chloride — ●THOMAS DIENEL, CHRISTIAN LOPPACHER, KARL LEO, and TORSTEN FRITZ — Institut für Angewandte Photo-physik, Technische Universität Dresden, 01062 Dresden, Germany

Here we report on the first observation of unusually narrow absorption bands of perylene-3,4,9,10-tetracarboxylic-dianhydride (PTCDA) on potassium chloride (KCl(001)) at room temperature. While submonolayers of the same compound deposited on muscovite mica exhibit absorption bands of similar width as in solution spectra [1], the full width at half maximum of a submonolayer PTCDA on KCl(001) is 3 times smaller. The molecular layer starts to crystallize immediately once a thickness of 1 monolayer (ML) is reached, accompanied with the absorption development towards the well-known spectrum of PTCDA crystallites.

As the spectral width is usually caused by inhomogeneous broadening, we are going to present low-temperature AFM measurements, which exhibit a very unusual structure of the PTCDA submonolayers on KCl, where all molecules are commensurately aligned in rows rather than in the common herringbone structure, therefore experiencing the very same local environment. On top of the aggregated islands one observes the herringbone arrangement, as reported for PTCDA islands on potassium bromide (KBr(001)) [2], which confirms nicely the optical assignment of polycrystalline PTCDA.

[1] H. Proehl et al., Phys. Rev. Lett., 2004, 93, 097403

[2] T. Kunstmann et al., Phys. Rev. B, 2005, 71, 121403

DS 2.5 Mon 12:15 H32

Characterization and Modification of the Hexaphenyl Wetting Layer on Mica (001) — ●PAUL FRANK¹, GREGOR HLAWACEK², CHRISTIAN TEICHERT², and ADOLF WINKLER¹ — ¹Institute of Solid State Physics, TU Graz, Petersgasse 16, A-8010 Graz, Austria — ²Institute of Physics, University of Leoben, Franz Josef Straße 18, A-8700 Leoben, Austria

In this contribution we investigate the hexaphenyl (6P) monolayer formation on mica (001) by surface science methods. The 6P films were prepared by organic molecular beam deposition (OMBD). TDS was used to get information on the monolayer formation. XPS and LEED were used to characterize the mica surface before 6P thin film deposition. All measurements were carried out under UHV conditions. In addition, the grown films were investigated ex-situ by AFM. The TDS measurements show that there exists a monolayer of flat laying 6P molecules on the untreated mica surface. The main goal of this work was to tailor the monolayer formation and for this purpose surface modifications were applied on the mica sample. The modifications have been realized through a change in surface composition or by a change of the surface structure. For this purpose, the surface was covered with a carbon layer via X-ray induced dissociation of 6P (change of surface composition) or sputtered, using low energy Ar⁺ ion beams (change of surface structure). TDS and AFM investigations showed a significant change in the monolayer formation, from flat laying molecules on the untreated mica surface to upright standing molecules on the carbon covered as well as on the sputtered mica surface.

DS 2.6 Mon 12:30 H32

Sub-nm control of the inter-layer spacing in thin films of intercalated rod-like conjugated molecules — ●JÖRN-OLIVER VOGEL¹, RICARDA OPITZ¹, INGO SALZMANN¹, STEFFEN DUHM¹, BERT NICKEL², JÜRGEN RABE¹, and NORBERT KOCH¹ — ¹Humboldt-Universität zu Berlin, Berlin, Deutschland — ²Ludwig-Maximilians-Universität, München, Deutschland

We present evidence for the mutual intercalation of three rod-like

molecular materials, which are widely used as active layers in molecular electronics: α -sexithiophene (6T), its alkylated analogue α,ω -dihexylsexithiophene (DH6T), and p-sexiphenyl (6P). We co-deposited pairs of these molecular materials by organic molecular beam deposition on silicon oxide and Mylar (a polymeric gate insulator used in all-organic thin film transistors) and studied the properties of the resulting thin film samples by atomic force microscopy (AFM), X-ray diffraction (XRD), and infrared spectroscopy (IR). As a key result, we found evidence for mutual intercalation of the pairs 6T/DH6T and 6P/DH6T in thin films and no indications for phase separation. Furthermore, the inter-layer distance of neighbouring molecular layers could be varied almost linearly as function of the molecular mixing ratio in the range of ca. 2.3 nm to ca. 3.7 nm, which was brought about by the conformational flexibility of the DH6T hexyl-chains. Thus, vapour phase co-deposition of appropriate molecular material pairs appears to be a promising route towards controlling inter-layer spacing with sub-nm precision.

DS 2.7 Mon 12:45 H32

Influence of gas molecules on the electrical characteristics of organic semiconductors — ●HARALD GRAAF¹ and DERCK SCHLETTWEIN² — ¹Centre for nanostructured materials and analytics,

TU Chemnitz, 09107 Chemnitz — ²Institut für Angewandte Physik, Justus-Liebig-Universität Giessen, 35392 Giessen

The stability of the electrical characteristics of organic thin films under ambient conditions is one of the key issues on the way to a product. Gas molecules are an important factor to influence strongly the performance of a number of electronic devices.

We report here on the influence of some selected gas molecules on the electrical properties of organic thin films prepared from perylene dicarboxylic acid bis imides. Thin films of a crystalline (MePTCDI) and an amorphous representative (Cl₄MePTCDI) were prepared by physical vapour deposition. As gas molecules oxygen was chosen as a typical ambient gas and ethanol, acetone and n-butane were chosen as representatives of processing solvents as well as volatile organic compounds in air quality monitoring. All studied gas molecules led to a change in the observed conductivity of the semiconducting films. Field effect measurements served to differentiate between changes in charge carrier mobility and charge carrier concentration and hence increase the selectivity of the measurements. The charge carrier mobility was found to decrease in all cases. Gas molecules which diffused into the bulk effected the mobility at least 10 times more efficiently than molecules whose interaction was restricted to the surface.[1]

[1] H. Graaf, D. Schlettwein, J.Appl.Phys. accepted

DS 3: Metal Layers and Multilayers

Time: Monday 9:30–11:00

Location: H34

DS 3.1 Mon 9:30 H34

High Kinetic Energy Photoelectron Spectroscopy on Metal Heterostructures — ●MIHAELA GORGOI¹, OLOF KARIS², SVANTE SVENSSON^{1,2}, GUNNAR ÖHRWALL², GABRIELLA ANDERSSON², MORENO MARCELLINI², FRANZ SCHÄFERS¹, WALTER BRAUN¹, and WOLFGANG EBERHARDT¹ — ¹BESSY GmbH, Albert-Einstein-Str. 15, 12489 Berlin, Germany — ²Department of Physics, Uppsala University, PO Box 530 SE 751 21 Uppsala, Sweden

In the present work, results on different Cu/Ni heterostructures studied by high kinetic energy photoelectron spectroscopy are presented. Core level shifts are found as a function of the Cu layer thickness within the multilayer structure as well as a function of the interface type between the copper and nickel. While the thickness of the Ni layer was fixed at 5 ML, the thickness of the Cu layer varied. Three samples are studied for Cu thicknesses of 2 ML, 4 ML and 5 ML. The measured core level shifts are found to confirm theoretical calculations of these systems [1, 2]. We have been able to study the destruction of the layered structures from the core photoelectron chemical shifts. Thus we have developed a new non destructive tool to study the quality of deeply buried interfaces. This study may therefore have considerable technical and commercial applicability.

[1] W. Olovsson, E. Holmström, J. Wills, P. James, I.A. Abrikosov, A.M.N. Niklasson, Phys. Rev. B 72 (2005) 155419; [2] W. Olovsson, E. Holmström, I.A. Abrikosov, A.M.N. Niklasson, M. Gorgoi, O. Karis, S. Svensson, G. Öhrwall, G. Anderson, M. Marcellini, W. Braun, W. Eberhardt, accepted Phys. Rev. Lett.

DS 3.2 Mon 9:45 H34

Reactive Surfaces under Electrochemical Control: Cl/Cu(100) — ●HUBERT ZAJONZ¹, HELMUT DOSCH¹, PETER BROEKMANN², SASCHA HUEMANN², and KLAUS WANDEL² — ¹Max-Planck-Institut für Metallforschung, Heisenbergstr.3, 70569 Stuttgart, and Institut für Theoretische und Angewandte Physik, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — ²Institut für Physikalische und Theoretische Chemie, Universität Bonn, Wegelerstr. 12, 53115 Bonn, Germany

The surface structure of Cu(100) modified by chloride has been studied in an electrochemical environment by means of in-situ surface x-ray scattering with a particular focus on adsorbate and potential dependent surface relaxation effects. An extraordinary large Cu-Cl bond length of 2.63 Å is found for the c(2 × 2)-Cl phase on the basis of diffraction data analysis at positive potentials close to the on-set of the copper dissolution reaction. This finding points to a largely ionic character of the Cu-Cl interaction on Cu(100) with chloride particles likely retaining their full charge upon adsorption. In combination with the positive surface charging at these high potentials this ionic Cu-Cl bond is discussed as the origin of the observed 2.2% outward relaxation be-

tween the first two copper layers. These results indicate that the bond between the first and the second copper layer is significantly weakened which seems to be the crucial prerequisite for the high surface mobility of copper-chloride species under electrochemical annealing conditions at these high potentials.

DS 3.3 Mon 10:00 H34

Evolution of the Quantum Well States in Ag layers on Au(111) — FRANK FORSTER¹, EUGEN GERGERT¹, ●ANDREAS NUBER¹, AZZEDINE BENDOUNAN¹, LI HUANG^{2,3}, XINGAO GONG², and ZHENYU ZHANG³ — ¹Universität Würzburg, Experimentelle Physik II, Am Hubland, 97074 Würzburg — ²Surface Physics Laboratory and Department of Physics, Fudan University, Shanghai 200433, P.R. China — ³Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA

Electronic quantum well states (QWS) confined in ultrathin films are of great scientific interest. Outside the substrate energy gap the confinement is suppressed. They can couple with substrate states and form quantum well resonances (QWR). We present systematic studies on epitaxial layer-by-layer growing Ag films up to 45 ML on Au(111) using angular resolved photoelectron spectroscopy (ARUPS) ($\Delta E = 3$ meV, $\Delta\theta = 0.3^\circ$).

Our data in combination with density functional theory show the transition from QWR to QWS. We investigated the localization of the states in terms of their center-of-charge, peak position and line-shape. In contrast to comparable systems like Ag/W(110) QWS in Ag/Au(111) are formed not before a thickness of ≈ 8 ML. The center-of-charge and the peak position are localized within the Ag overlayer and Au energy gap, respectively, at the same film thickness and hence can be used as criteria for the formation of QWS. Further investigations on their lineshape close to the substrate gap edge allow access to further many-body characteristics of the QWS.

DS 3.4 Mon 10:15 H34

Self-organization of multilayers during the co-deposition of — ●DOMINIKA LYZWA¹, HAYO ZUTZ¹, INGA GERHARDS¹, CARSTEN RONNING¹, HANS HOFSSÄSS¹, MICHAEL SEIBT², WAN-YU WU³, and JYH-MING TING³ — ¹2.Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1,37077 Göttingen — ²4.Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1,37077 Göttingen — ³Department of Materials Science and Engineering, National Cheng Kung University, Tainan, Taiwan, ROC

Multilayers grown by simultaneous deposition of carbon and Fe, Au, Cu or Ni ions reveal a self-organization process with alternately metal-rich and metal-deficient layers. These layers are of the size of a few nanometers. The metal-rich layers consist of crystalline clusters while the metal-deficient ones of amorphous carbon. Concentration distri-

butions were analyzed by Rutherford backscattering (RBS) measurements while the structure induced by the ions was examined via transmission electron microscopy (TEM). A model of the multilayer formation can be described by an interplay of sputtering, surface segregation, ion induced diffusion, and the stability of small clusters against ion bombardment. First investigations on the optical and magnetic properties of such multilayers will be presented.

DS 3.5 Mon 10:30 H34

Triple junction and interface transport in nano-crystalline Cu/Ag bi-layers — ●HENNING GALINSKI and GUIDO SCHMITZ — Institut für Materialphysik der WWU Münster, Münster, Deutschland

Cu and Ag are distinguished by strongly repulsive chemical interaction. Thus no mixing or reaction between these two elements should be expected. We investigated the chemical stability of Cu/Ag bi-layers with state-of-the-art wide angle atom probe tomography (WATAP). This method provides an extended volume of analysis so that grain boundaries are reliably located and even minor chemical modifications are detected with improved statistical significance. Bi-layer samples were deposited on tungsten substrate tips and subjected to heat treatments up to 500°C/30 min. Two surprising observations are remarkable: i) In contrast to bulk thermodynamics an intermixing zone of 1.5 nm in thickness develops at the bi-layer interface. Since its apparent activation energy amounts to only 0.3 eV, we conclude that this intermixing is not controlled by diffusion kinetics. Instead, it may be understood quantitatively by the Cahn-Hilliard approach. Thus, our experiments allow a direct measurement of the gradient term in this theory. ii) One-dimensional, worm-like segregation zones develop at both sides of

the interface. The geometric analysis proves that these zones represent triple junctions of the grain boundary structure. In consequence, the measurements demonstrate that triple junctions are distinguished by remarkably large segregation factors and the triple junction diffusion coefficient can be determined in the type C kinetic regime.

DS 3.6 Mon 10:45 H34

Investigation of the Mechanical Properties of Thin Iron and Molybdenum Films — ●ANDREAS SCHNEIDER¹, GUNTHER RICHTER², THOMAS WÜBBEN², and EDUARD ARZT^{1,2} — ¹Universität Stuttgart, Institut für Metallkunde, Heisenbergstraße 3, 70569 Stuttgart — ²Max-Planck-Institut für Metallforschung, Heisenbergstraße 3, 70569 Stuttgart

The mechanical properties of thin films and small structures with dimensions in the range of microns or below differ fundamentally from their bulk counterparts. Many experiments have shown that flow stresses of thin films are inversely related to the film thickness. However, so far this size effect has only been observed in fcc metal thin films. To date there is no evidence that thin films with a bcc crystal structure also show this effect. In the current investigation we want to shed light on this open question by studying the mechanical properties of thin α -Fe and Mo films. The films were deposited in ultra high vacuum conditions via molecular beam epitaxy and magnetron sputtering on different substrates. They were tested with the substrate curvature technique as well as micro tensile tests. Additionally, bulge tests on freestanding films were performed to eliminate the influence of the substrate. Our results show that the mechanical behavior of the films depends on the film thickness and the microstructure.

DS 4: Nanoengineered Thin Films

Time: Monday 11:15–12:45

Location: H34

DS 4.1 Mon 11:15 H34

Dewetting of Ni thin films and formation of nanorods on ripple patterned substrates — ●JAN PETERSEN und S. G. MAYR — I. Physikalisches Institut, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Self-organisation processes are currently of particular interest due to the need of higher structure densities to increase the performance of electronic devices. They might also replace expensive and time consuming lithography processes. We investigated the dewetting process of thin Ni films during thermal annealing on smooth and ripple patterned silicon dioxide. The ripple pattern was created by ion etching under oblique incidence and has a corrugation wavelength of about 50nm. Scanning electron microscopy images show a faster decrease of Ni surface coverage on the ripple pattern with increasing temperature indicating an additional driving force of curvature induced diffusion. The ridges act as diffusion barriers trapping Ni in the valleys. Finding the adequate film thickness and annealing temperature this leads to the formation of nanorods or nanowires. Electrical resistance was measured to analyze the dynamics of the dewetting process.

Financial support by the DFG - SFB 602, TP B3 is acknowledged.

DS 4.2 Mon 11:30 H34

Tuning the structure of electrodeposited ZnO — ●THOMAS LOEWENSTEIN¹, CHRISTIAN NEUMANN², JOACHIM SANN², BRUNO K. MEYER², and DERCK SCHLETTWEIN¹ — ¹Institut für Angewandte Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — ²I. Physikalisches Institut, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany

Zinc oxide thin films were electrodeposited on (0001) GaN and (0001) ZnO from aqueous electrolytes. Electrochemical deposition of compound semiconductors is attractive because of a widely tuneable nanostructure, especially if molecular adsorbates serve as structure directing agents as shown in this study for ZnO/Eosin Y hybrid materials. Scanning electron microscopy (SEM) revealed the formation of domains with different crystal sizes pointing at a varying density of nucleation sites on the substrate. Crystalline ZnO was deposited as proven by X-ray diffraction (XRD). The intensity pattern showed the expected preferential orientation with the c- plane of ZnO parallel to GaN (0001). XRD rocking curves with FWHM = 0.25° indicated a surprisingly high level of in-plane orientation of the grown ZnO crystalline domains. The peak position of (0002) ZnO was shifted by $2\Theta = 1.3^\circ$. This difference

and the corresponding simultaneous shift of (0004) ZnO were explained by a lattice expansion by 3.6% in the c-direction. This clearly indicated the strong influence of the Eosin Y molecules adsorbed during the growth of ZnO and implications for the use of electrodeposited ZnO in practical devices are discussed.

DS 4.3 Mon 11:45 H34

Template-Directed Growth – When Control is Lost — ●FELIX KALISCHEWSKI¹, JIA ZHU², and ANDREAS HEUER¹ — ¹Institut für Physikalische Chemie, Universität Münster, 48149 Münster — ²Physikalisches Institut, Universität Münster, 48149 Münster

Template-directed aggregation/crystallization is widely used to build architectures of functional materials. In this technique, substrate surfaces are pre-patterned to define the places of aggregation for the functional material, which is then added to the substrate e.g. by molecular beam deposition. Ideally, the deposited material will diffuse along the surface until a pattern site is met and it is immobilized. If, however, the distance between the pattern sites is too large or the deposition flux is too high, it becomes likely that a critical number of molecules aggregates and a stable 2d-nucleus is formed on an off-pattern position. At this point the intended nucleation control is lost and structural errors occur.

We focus on the behavior of this transition point. Intuitively, one would expect the transition when the area-density of the pattern is equal to the saturated density of the 2d-nuclei on an un-patterned substrate. This is not exact however, because the maximum concentration of adsorbed molecules, which is responsible for the formation of new nuclei, strongly depends on the specific pattern. We model the resulting concentration field by a set of differential equations which are solved numerically as well as analytically. In addition, we apply off-lattice Monte-Carlo simulations and compare the results to experimental data.

DS 4.4 Mon 12:00 H34

Multi-Component Langmuir-Blodgett Transfers for Chemical and Structural Surface Patterning — ●MICHAEL HIRTZ¹, XIAODONG CHEN¹, MARION BRINKS², ARMIDO STUDER², HARALD FUCHS¹, and LIFENG CHI¹ — ¹Physikalisches Institut, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Straße 10, 48149 Münster, Germany — ²Organisch-Chemisches Institut, Westfälische Wilhelms-Universität, Corrensstraße 40, 48149 Münster, Germany

Self-assembly and self-organization are of great interest for the creation of micro- and nanostructured patterned surfaces by bottom-up approaches. By transferring mixed Langmuir monolayers of a phospholipid (DPPC) with small ad-mixings of other components onto solid substrates large area chemical patterns structured in the meso- up to the nanoscale can be created. These patterns can provide the basis for further chemical modification to form topographical or more complex chemical structures. We present the transfer of DPPC mixed with different dyes yielding luminescent stripe patterns as a proof of concept. Furthermore, transferred patterns composed of DPPC and alkoxyamines followed by polymerization of the pattern yield structured polymer brushes. The concept should be expandable to various other substances opening a wide field of possible applications in biological science and surface modification.

DS 4.5 Mon 12:15 H34

Organophosphonate Functionalized Silicon Nanowires for DNA Hybridization Studies — ●DANIEL PEDONE¹, ANNA CATTANI SCHOLZ¹, STEFAN BIRNER¹, MANISH DUBEY², JEFFREY SCHWARTZ², MARC TORNOW³, and GERHARD ABSTREITER¹ — ¹WSI, TU München — ²Princeton University, USA — ³IHT, TU Braunschweig

Semiconductor nanowire field effect devices have great appeal for label-free sensing applications due to their sensitivity to surface potential changes that may originate from charged adsorbates. In addition to requiring high sensitivity, suitable passivation and functionalization of the semiconductor surface is obligatory. We have fabricated both freely suspended and oxide-supported silicon nanowires from Silicon-on-Insulator substrates using standard nanopatterning methods (EBL, RIE) and sacrificial oxide layer etching. Subsequent to nanofabrication, the devices were first coated with an hydroxyalkylphosphonate monolayer and then bound via bifunctional linker groups to single stranded DNA or PNA oligonucleotides, respectively. We investigated DNA hybridization on such functionalized nanowires using a differ-

ence resistance setup, where subtracting the reference signal from a second wire could be used to exclude most non-specific effects. A net change in surface potential on the order of a few mV could be detected upon addition of the complementary DNA strand. This surface potential change corresponds to the hybridization of about 10^{10} cm^{-2} probe strands according to our model calculations that takes into account the entire hybrid system in electrolyte solution.

DS 4.6 Mon 12:30 H34

Nanopatterning by Phase Mask Projection Laser Ablation — ●MARISA MÄDER, THOMAS HÖCHE, JÜRGEN GERLACH, and RICO BÖHME — Leibniz Institute of Surface Modification, Permoserstrasse 15, 04318 Leipzig, Germany

Nanostructures attached to a substrate promise optical and electronic applications like LEDs or diodes. Moreover, for Nanodots applications in various probing techniques (including Surface Enhanced Raman Spectroscopy) are also aspired. So far, however, the fabrication process of most nanostructures is still very complex and often too costly for industrial use. An alternative, versatile, fast, and relatively easy process is the technique of laser ablation using phase-mask projection. Pulsed laser light with the wavelength of 248 nm is sent through a phase mask. The phase mask modulates the phase of the incident beam at defined positions. Using a Schwarzschild reflection objective, the resulting interference pattern is demagnified and projected onto a thin film. At positions where the intensity exceeds the ablation threshold of the film but not the substrate, material is ablated from the substrate. Different shapes of nanostructures can be fabricated this way, depending on the pattern of the phase mask. GaN nanowires were produced with a striped mask while Au nanodots were fabricated using a checkerboard mask. In principle, every combination of thin film and substrate material is possible, as long as the ablation thresholds are matching, respectively.

DS 5: Organic Interfaces (SYOE 1)

Time: Monday 14:30–15:45

Location: H32

DS 5.1 Mon 14:30 H32

Structural and morphological study of perylene films grown on different substrates — ●MARYAM BEIGMOHAMADI, PHENWISA NIYAMAKOM, AZADEH FARAHZADI, STEPHAN KREMERS, CHRISTIAN EFFERTZ, THOMAS MICHELY, and MATTHIAS WUTTIG — Institute of Physics (IA), RWTH Aachen University of technology 52056 Aachen, Germany

Recently, organic semiconductors have emerged as a technologically important class of electronic materials. Of particular interest is the morphology and the growth of organic films, deposited on insulating substrates, since this configuration is used in Organic Thin Film Transistors (OTFTs). Key elements for the device performance are the structure of the functional organic layer and the charge injection from the metallic contacts. Therefore, understanding of structural properties and the morphology of organic films deposited on metallic substrate is essential for applications in future devices. Also improved internal ordering of the organic thin film, together with increased electrical conductivity and with reduced activation energy for electrical conductivity could enhance field-effect carrier mobilities. The growth of highly ordered perylene films deposited on oxidized and metallic substrates is studied. By employing Atomic Force Microscopy (AFM) and X-ray Diffraction (XRD), the structure and the morphology of the films are characterized. AFM reveals the existence of dislocation in the grains. From XRD, it has been observed that the perylene films, deposited on Al₂O₃/Si, have fiber texture ordering in c-axis. However, for perylene films deposited on Au layer the crystalline structure is less developed.

DS 5.2 Mon 14:45 H32

A photoemission electron microscopy investigation of diindenoperylene thin films — ●MARIA BENEDETTA CASU¹, INDRO BISWAS¹, MATHIAS NAGEL¹, PETER NAGEL², STEFAN SCHUPPLER², and THOMAS CHASSÉ¹ — ¹University of Tübingen, Institute of Physical and Theoretical Chemistry, Tübingen, Germany — ²Forschungszentrum Karlsruhe, Institut für Festkörperphysik, Karlsruhe, Germany

Organic-based displays are widely present on the market, used for HIFI cars, mp3 player, and mobile phones, as well as in television screens, without mentioning e-paper, one of their most fascinating applications. It is very important to reach a deep general understanding of their electronic, structural, and morphological properties that despite the numerous investigations is still missing. We present the results of photoemission electron microscopy (PEEM) investigations on diindenoperylene thin films deposited on polycrystalline gold. The thin films were prepared by using organic molecular deposition and thickness-dependent investigations were performed. PEEM is a very powerful tool that can give a deep insight in in-situ growth. The opportunity to use a synchrotron radiation source allows the simultaneous investigation of morphology, structure, and electronic characteristics. All these aspects usually investigated by using separated techniques, often on differently prepared samples, are univocally related in our results with special attention to the molecular arrangement. This approach, in synergy with micro near-edge x-ray absorption fine structure, helps in gain a detailed knowledge also in case of critical phenomena like polymorphism in organic materials.

DS 5.3 Mon 15:00 H32

Molecular Orientation and Adsorption Energies of Pentacene: SiO₂ versus Metals — ●DANIEL KÄFER and GREGOR WITTE — Physikalische Chemie I, Ruhr-Universität Bochum, 44780 Bochum

Having a high charge carrier mobility, pentacene is still one of the most promising organic semiconductors for the fabrication of organic thin film transistors. Of particular interest is the interaction at the interface with noble metals and SiO₂ substrates since these materials are commonly used in field-effect devices. Because of the high anisotropy of the charge carrier mobility the molecular orientation of pentacene within the first layers of thin films plays a crucial role. Moreover, the subsequent film growth depends largely on this interface structure. By combining NEXAFS and XRD to determine the molecular orientation and crystalline phase with TDS to probe the interaction strength, pentacene films grown on SiO₂, gold and silver surfaces as

well as SAM covered Au substrates have been investigated in detail. Distinctly different desorption temperatures were obtained for the various crystalline phases grown on bare metal substrates and for the thin and thick film phases formed on SiO₂ and SAM covered gold.

DS 5.4 Mon 15:15 H32

Charge Transfer Across Hexyl Layers Driven by Thermodynamics — ●STEFFEN DUHM¹, HENDRIK GLOWATZKI¹, JÜRGEN P. RABE¹, ROBERT L. JOHNSON², and NORBERT KOCH¹ — ¹Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, D-12489 Berlin, Germany — ²Institut für Experimentalphysik, Universität Hamburg, D-22761 Hamburg, Germany

The energy level alignment of α,ω -dihexylsexithienyl (DH6T) on tetrafluoro-tetracyanoquinodimethane (F4-TCNQ) pre-covered Ag(111) and polycrystalline Au substrates was investigated with ultraviolet photoelectron spectroscopy (UPS). On both substrates DH6T exhibits a transition from flat lying molecules in the monolayer to inclined molecules in multilayers, accompanied by a shift of molecular levels. A transition from vacuum-level alignment to *molecular level pinning* - reminiscent of Fermi-level pinning - at the homo-interface between DH6T monolayer and multilayers was observed, which depended on the amount of pre-deposited F4-TCNQ. The measured shift in the vacuum level between monolayer and multilayer DH6T is direct evidence for interface dipoles and for thermodynamically driven charge transfer between molecular layers. The observed pinning behavior sug-

gests that hexyl chains are not appropriate insulating layers for the use in *molecular electronics*, and longer chains may be needed.

DS 5.5 Mon 15:30 H32

Determination of Transport Levels in Organic Semiconductors by UPS, IPES, and 2PPE — ●SÖNKE SACHS¹, STEFAN KRAUSE¹, CHRISTIAN SCHWALB², ULRICH HÖFER², ACHIM SCHÖLL¹, and EBERHARD UMBACH¹ — ¹Universität Würzburg, Experimentelle Physik II, Am Hubland, 97074 Würzburg — ²Universität Marburg, Fachbereich Physik, Renthof 5, 35032 Marburg

The determination of the energetic position of transport levels in organic semiconductors is crucial to answer fundamental and application related questions, e.g. about transport properties and exciton binding energies, which are important for the development of organic devices.

We present a systematic approach to determine transport levels of the model system PTCDA/Ag(111) using a combination of different photoelectron-spectroscopies (UPS, IPES, and 2PPE). The applied methods differ in their excitation mechanisms and thus provide information about electron relaxation dynamics. We classify the results on the one hand with respect to the optical gap, exciton binding energy and localization. On the other hand we discuss them with respect to common models on charge carrier localization and transport. The experiments yield results that show a rather unexpected behaviour of highly delocalized charge carriers and only weakly bound excitons.

DS 6: Organic Photovoltaics (SYOE 2)

Time: Monday 16:00–17:45

Location: H32

DS 6.1 Mon 16:00 H32

Exciton Diffusion length Measurements in Diindenoperylene Thin Films — ●TOBIAS ROLLER, DIETER KURRLE, PHILIPP NEUMANN, and JENS PFLAUM — 3. Physikalisches Institut, Universität Stuttgart

To accomplish large exciton diffusion lengths is a major task for the successful implementation of molecular thin films in organic photovoltaic cells. The exciton diffusion length determines the maximal useful thickness of the absorbing layer in excitonic photovoltaic (PV) cells, thus governing their internal quantum efficiency.

To analyse the exciton diffusion length in relation to the structural properties we have studied thin films of the organic semiconductor Diindenoperylene (DIP) prepared by MBE in HV at thicknesses up to 400nm. Due to its tapered ends this molecule provides long-range order in the direction normal to the surface of weakly-interacting substrates such as ITO. By XRD we were able to access the structural film parameters along the exciton diffusion path, namely their out-of-plane lattice spacing, crystallite size and average tilting angle. The exciton diffusion lengths were estimated from the spectral photocurrent of DIP PV-cells and, additionally, measured by quenched photoluminescence of Palladium Phthalocyanine capped DIP layers. The observed diffusion length in DIP exceeds 100nm for the thickest films and shows a direct correlation with the crystallite sizes along the surface normal. We will discuss these results and possible mechanisms of exciton trapping and annihilation with respect to the film structure of DIP.

Financial support by the DFG (PF385/2-3) and BASF is acknowledged.

DS 6.2 Mon 16:15 H32

Efficient photon harvesting strategies in ZnPc/PPV/Fullerene solar cells — ●ROBERT KOEPPE¹, PAVEL A. TROSHIN², RIMMA N. LYUBOVSKAYA², and N. SERDAR SARICIFTCI¹ — ¹LIOS, Altenbergerstr. 69, A-4040 Linz, Austria — ²Institute of Problems of Chemical Physics of RAS, Chernogolovka, Moscow region, 142432, Russia

A novel multicomponent organic solar cell architecture is suggested in order to expand the active layer absorption of organic solar cells by a combination of solution-processed bulk heterojunction polymer/fullerene cells with bilayer ZnPc/fullerene devices [1]. For this purpose, a blend of different fullerene derivatives with the conjugated polymer MDMO-PPV is spin-coated on an evaporated ZnPc film. Supramolecular complexation of the highly soluble pyrrolidinofullerene with ZnPc ensures a very efficient charge separation [2] and therefore a high contribution of the ZnPc to the overall photocurrent generation. This yields photovoltaic devices that demonstrate power conversion efficiencies above 2% and efficient photocurrent generation of up to

20% external quantum yield in the full range from 350 nm to 820 nm. [1] R. Koeppe et al., APL 87(24), 244102, [2] R. Koeppe et al., Full. Nanotub. Carb. Nanostruct. 14(2-3), 441-446

DS 6.3 Mon 16:30 H32

Efficient thin film organic solar cells containing low band gap oligothiophenes with tailored heterojunction level alignment — ●R. SCHÜPPEL¹, K. SCHMIDT², C. UHRICH¹, K. SCHULZE¹, D. WYNANDS¹, J. L. BRÉDAS², B. MÄNNIG¹, M. PFEIFFER³, K. LEO¹, E. BRIER⁴, E. REINOLD⁴, and P. BÄUERLE⁴ — ¹Institut für Angewandte Photophysik, Technische Universität Dresden, Germany — ²Georgia Institute of Technology, School of Chemistry and Biochemistry, Atlanta, Georgia, USA — ³Heliatek GmbH Dresden, Germany — ⁴Institut für Organische Chemie II und Neue Materialien, Universität Ulm, Germany

The recently demonstrated power conversion efficiency of 3.4% in a thin film solar cell (OSC), which utilized C₆₀ as acceptor (A) and a new acceptor-substituted oligothiophene (OT) as donor (D) [1], stimulated us to study the energy (ET) and electron transfer (CT) taking place at this D/A heterojunction along a homologous series of these OT. The HOMO is tuned using different OT chain lengths, while the LUMO is essentially fixed by the acceptor-type end-groups (dicyano-vinylene). We study electron transfer at the heterojunction to C₆₀ using photoinduced absorption. The observed transitions were unambiguously identified by TD-DFT calculations. With increasing the effective energy gap of the D/A pair, CT is eventually replaced by ET, which alters the OSC operation. Therefore, the optimum open circuit voltage between 1.0V-1.1V in our OSC has to be considered as a trade-off between an efficient charge separation and a maximized effective gap. [1] K. Schulze *et al.*, Adv. Mater. **18**, 2872 (2006)

DS 6.4 Mon 16:45 H32

Spin-Coated Hybrid Layers of Crystalline Silicon Nanoparticles and Semiconducting Polymers: Optical, Structural and Electronic Properties — ●ROLAND DIETMÜLLER¹, ROBERT LECHNER¹, ANDRÉ R. STEGNER¹, RUI N. PEREIRA¹, MARTIN S. BRANDT¹, HEIKO THIEM², MARTIN TROCHA², HARTMUT WIGGERS³, and MARTIN STUTZMANN¹ — ¹Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — ²Degussa AG, Paul-Baumann-Str.1, 45764 Marl, Germany — ³Universität Duisburg-Essen, Institute of Combustion and Gas Dynamics, Lotharstr. 1, 47048 Duisburg, Germany

Organic semiconductors have received a lot of attention for novel, low cost electronic applications (e.g. printable electronics). Silicon, in form

of nanoparticles, could be incorporated in such organic devices to tailor their physical properties. For example, hybrid organic-inorganic solar cells could benefit from the solution processing of polymer semiconductors and from the high electron mobility of the non-toxic silicon.

We have investigated the optical properties, in particular absorption spectra, of spin-coated layers of crystalline silicon nanoparticles, semiconducting π -conjugated polymers like poly(3-hexylthiophene-2,5-diyl) (P3HT), [6,6]-phenyl C-61-butyric acid methyl ester (PCBM) or poly[(9,9-dioctylfluorene-2,7-diyl)-co-bithiophene] (F8T2) and mixed layers of polymers and silicon nanoparticles. To further characterize the spin-coated layers, atomic force and optical microscopy has been employed. Also, the electrical properties of sandwich-like structures of polymers and crystalline silicon nanoparticles are discussed.

DS 6.5 Mon 17:00 H32

Preparation and Characterization of Colloidal ZnO:Al Nanoparticles for Organic-Inorganic Hybrid Solar Cells — JAN FRIEDMANN^{1,2}, DANIEL RAUH^{1,2}, VOLKER LORRMANN^{1,2}, CARSTEN DEIBEL², VLADIMIR DYAKONOV^{1,2}, and •INGO RIEDEL¹ — ¹Functional Materials for Energy Technology, ZAE Bayern e.V., Am Hubland, D97074 Würzburg, Germany — ²Experimental Physics VI, Faculty of Physics and Astronomy, Julius-Maximilians University of Würzburg, Am Hubland, D97074 Würzburg, Germany

Colloidal nanoparticles of non-capped ZnO:Al have been wet-chemically synthesized as functional materials for novel hybrid device concepts related to organic photovoltaics. The nanoparticles were characterized by means of optical spectroscopy, current-voltage characterization and magnetic resonance techniques. The material was found to fulfil the requirements to become a fullerene substitute in polymer-based organic solar cells and/or to serve as a wave guiding n-conducting buffer layer between the light absorber and the back-reflecting metal electrode. We fabricated polymer-fullerene bulk heterojunction solar cells with and without ZnO:Al layer. The effects of improved light absorption and enhanced selectivity of the metal electrode are discriminated by optical simulations and electrical interface characterization.

DS 6.6 Mon 17:15 H32

Nanomorphology of Poly[3-alkylthiophene] based Polymer/Fullerene Bulk Heterojunction Solar Cells — •HARALD HOPPE¹, LE HUONG NGUYEN², TOBIAS ERB¹, SERAP GÜNES², GERHARD GOBSCH¹, and N. SERDAR SARICIFTCI² — ¹Institute of Physics,

Ilmenau Technical University, Weimarer Str. 32, 98693 Ilmenau, Germany — ²Physical Chemistry - LIOS, Johannes Kepler University Linz, Altenbergerstr. 69, 4040 Linz, Austria

We report on nanomorphology evolution within poly[3-alkylthiophene]/[6,6]-phenyl C61-butyric acid methyl ester (P3AT/PCBM) blends upon film formation and subsequent thermal annealing. In detail, the influence of the P3AT side chain length on the extend of the polymer/fullerene phase separation is discussed for butyl, hexyl, octyl, decyl and dodecyl side groups. We apply atomic force microscopy (AFM), X-ray diffraction and optical spectroscopy to understand the underlying processes. Photovoltaic devices based on the different P3ATs have been processed and optimised. In conclusion a correlation between the achieved solar cell performance and the corresponding nanomorphology is drawn.

DS 6.7 Mon 17:30 H32

Inkjet Printing of Polymer based Solar Cells — •CLAUDIA KLEPEK, PAVEL SCHILINSKY, STELIOS CHOULIS, and CHRISTOPH BRABEC — Konarka Technologies GmbH, Nürnberg, Germany

A variety of approaches have been used to deposit organic semiconductors based on the nature of those materials. The commonly applied technique is the solution-processed deposition. Due to the low-cost roll-to-roll production, the printing technologies are attracting more and more attention. Inkjet printing is very promising because the polymer devices can be fabricated very easily in terms of no-mask patterning. We report an organic photovoltaic device depositing the photoactive layer, comprising P3HT blended with the fullerene PC61BM in a solvent mixture, by a piezoelectric inkjet printing system. We compared two P3HTs differing in the molecular weight distribution (MW). A lower MW of the P3HT has been suited for inkjet printing since the latency time until gelification of the solution occurs is longer. The device performance and limitation of an IJ printed cell were well-investigated and remarkable losses in the short circuit current have been assessed. Among other things, losses in the short circuit current can be attributed to the low deposition temperature for comparatively high-boiling solvents. The drying rate affects the device performance significantly. The morphology and surface roughness of IJ printed films have been examined by atomic force microscopy. The roughness has been controlled by a careful selection of organic solvents. Due to an adapted solvent mixture the short circuit current and the efficiency have been improved.

DS 7: Organic Film Aging (SYOE 3)

Time: Monday 18:00–19:00

Location: H32

DS 7.1 Mon 18:00 H32

In situ studies of gas influence on the transport properties of organic thin-film transistors — •SVEN ISSING, MARKUS MICHELFEIT, MICHAEL LEUFGEN, JEAN GEURTS, GEORG SCHMIDT, and LAURENS MOLENKAMP — Universität Würzburg, physikalisches Institut (EP3), Am Hubland, D-97074 Würzburg, Germany

The stability of organic thin-film transistors (OTFT) remains a critical issue for applications. Especially the influence of different ambient atmospheres needs systematic investigation. Therefore, we fabricated OTFTs with dihexylquaterthiophene (DH4T) as active material by organic molecular-beam deposition in ultra high vacuum (UHV) and performed in situ electrical characterization. Afterwards the OTFTs were exposed to different gases in the UHV-chamber: ambient air, dry air, oxygen, nitrogen or argon up to $1 \cdot 10^{-2}$ mbar-s ($= 10^4$ Langmuir). The charge carrier mobility μ and the threshold voltage V_{Th} were measured vs. exposure. Furthermore, we investigated the relaxation after termination of the gas flow. The onset of a change of μ and V_{Th} is observed at ≈ 100 L. μ (initially $\approx 10^{-2}$ cm²/V.s) shows a relative decrease between 51% (for argon) and 73% (for oxygen). In clear contrast to the other exposures, for oxygen a shift of V_{Th} towards less negative values is observed. Both μ and V_{Th} showed no reversibility after the exposure.

This work was supported by the EU Integrated Project NAIMO (No NMP4-CT-2004-500355)

DS 7.2 Mon 18:15 H32

Zinc-Tetraphenylporphyrin based field effect transistor — •DANIEL LEHMANN and DIETRICH R.T. ZAHN — Chemnitz University

of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany

Porphyrin derivatives are interesting molecules for organic electronics because of their low cost and interesting light emitting and absorbing properties. While already being used in organic light emitting diodes, Zinc-Tetraphenylporphyrin (ZnTPP) has never been considered as material usable for organic field effect transistors as well. We present a ZnTPP field effect transistor in top contact configuration. On a 100 nm SiO₂ gate oxide, a 30 nm film of ZnTPP was grown using organic molecular beam deposition. Gold electrodes were grown on top by thermal evaporation through a shadow mask. The organic field effect transistor was electrically characterized *in situ*. We show the effects of different gases, introduced into the vacuum by a leak valve, on the electrical characteristics.

DS 7.3 Mon 18:30 H32

Real-time observation of oxidation and photo-oxidation of rubrene thin films by spectroscopic ellipsometry — •MILAN KYTKA^{1,2}, ALEXANDER GERLACH¹, FRANK SCHREIBER¹, and JARO KOVÁČ² — ¹Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen, Germany — ²Faculty of Electrical Engineering and Information Technology, Slovak University of Technology, Ilkovičova 3, 812 19 Bratislava, Slovak Republic

We follow in real-time and under controlled conditions the oxidation of the organic semiconductor rubrene grown on SiO₂ using spectroscopic ellipsometry. We derive the complex dielectric function $\epsilon_1 + i\epsilon_2$ for pristine and oxidized rubrene showing that the oxidation is accompanied by a significant change of the optical properties, namely the

absorption. We observe that photo-oxidation of rubrene is much faster than oxidation without illumination.

By following different absorption bands (around 2.5 eV and 4.0 eV for pristine rubrene and around 4.9 eV for oxidized rubrene) we infer that the photo-oxidation of these films involves non-Fickian diffusion mechanisms.

DS 7.4 Mon 18:45 H32

Structural and desorption measurements on encapsulated rubrene thin films — ●MAXIMILIAN NOTHAFT¹, SILKE GOETTLING², GERHARD ULBRICHT³, and JENS PFLAUM¹ — ¹3. Phys. Inst., Univ. Stuttgart, 70550 Stuttgart, Germany — ²Inst. fuer Systemtheorie und Bildschirmtechnik, Univ. Stuttgart, 70569 Stuttgart, Germany — ³Max-Planck-Institut fuer Festkoerperforschung, 70569 Stuttgart, Germany

FET-measurements on the surface of rubrene single crystals yield high room-temperature hole mobilities in the order of 10 cm²/Vs. However,

it proves to be difficult to grow crystalline films by thermal evaporation because of molecular conformational changes [1]. As an approach to achieve a crystalline phase via thermal activation, structural properties of rubrene thin films capped by SiO₂, Al₂O₃ and PPX have been investigated by x-ray diffraction. Crystallisation of amorphous rubrene capped with SiO₂ was detected at about 155°C which is 50°C above the desorption point of uncapped rubrene layers.

In order to obtain information about the integrity of capped organic layers during heating, we performed thermal desorption studies on capped rubrene thin films. The data indicated different desorption mechanisms depending on the capping material. Desorption of rubrene in SiO₂ or Al₂O₃ capped samples is mainly dominated by cracks. In contrast, desorption of PPX capped samples is governed by a diffusion process. Developing a suited model we could estimate the diffusion constant of rubrene in PPX to $1.2 \cdot 10^{-10}$ cm²/s.

[1] Käfer et al., Phys. Chem. Chem. Phys. 7, 2850 (2005)

DS 8: Hard Coatings I

Time: Monday 14:30–15:15

Location: H34

Invited Talk

DS 8.1 Mon 14:30 H34

Processing, properties and application potential of nanostructured hard coatings — ●PAUL MAYRHOFER — Department of Physical Metallurgy and Materials Testing, Montanuniversität Leoben, 8700 Leoben, Austria

Nanostructural design strategies have attracted increasing interest in modern development of hard coatings for wear-resistant applications. Here, we demonstrate the correlation between microstructure (or nanostructure) and mechanical as well as tribological properties of hard ceramic coatings. The microstructure can be designed by choice of the deposition technique, either by sequential deposition of layers or by taking advantage of newly discovered self-organization processes

including segregation effects of the elements. Limited atomic assembly kinetics during the deposition process are responsible for the formation of defects (point-, line-, and area-defects), supersaturated, and metastable phases. Due to their particular structures, such coatings can exhibit superhardness ($H > 40$ GPa). The microstructural changes of hard ceramic coatings during a post-deposition annealing treatment are discussed in detail. The review clearly shows that nanostructure dependent hardness increase (compared to hardness of the bulk counterparts) sustains higher annealing temperatures than hardness increase which is obtained by and increased density of point- and/or line-defects. Tribological properties of hard thin films can be engineered by adding phases with lubricious properties at operation temperature (either room or elevated temperatures) and prevailing environment.

DS 9: Hard Coatings II

Time: Monday 15:15–17:00

Location: H34

DS 9.1 Mon 15:15 H34

High Quality Cubic Boron Nitride Films - A Starting Point for Doping Experiments — ●HONG YIN¹, IVAN PONGRAC¹, XUYANG WANG¹, HANS-GERD BOYEN¹, PAUL ZIEMANN¹, BASTIEN DOHUARD², LAURENT HOUSSIAU², and CARLA BITTENCOURT³ — ¹Institute of Solid State Physics, University of Ulm, D-89081 Ulm, Germany — ²LISE, University of Namur, B-5000 Namur, Belgium — ³Materia Nova, B-7000 Mons, Belgium

After the successful demonstration that c-BN films can be epitaxially grown at 900°C on top of (001)-oriented diamond substrates [1], such high quality samples serve as starting point for their doping with Si atoms. For this purpose, a small stripe of a Si-wafer is co-sputtered during the c-BN deposition and the resulting concentration of Si as well as of unintentionally incorporated contaminants are determined by XPS, AES for near surface concentrations and ToF-SIMS for depth profiling. These results will be related to first temperature-dependent resistance measurements.

[1] X.W. Zhang, H.-G. Boyen, N. Deyneka, P. Ziemann, F. Banhart, M. Schreck, Nature Materials 4 (2003) 312.

DS 9.2 Mon 15:30 H34

Residual Stress in Nanocrystalline Diamond Films — ●NICOLAS WOEHL and VOLKER BUCK — Thin Film Technology Group FB 7, University of Duisburg-Essen, Universitaetsstr. 3-5, 45141 Essen, Germany

Nanocrystalline films were deposited by microwave-plasma CVD at a pressure of 200 mbar from an Ar/H₂/CH₄ plasma where the hydrogen fraction in the process gas was varied between 2 and 7%. Residual stress is a critical parameter in thin film deposition and especially important for technical applications of nanocrystalline diamond because high residual stress can lead to cracking or even to delamination of the

film from the substrate. An ex-situ optical device was used to measure the residual stress of the substrate. It is shown that by controlling the process parameters the residual stress in the NCD films can be adjusted in a wide range even from compressive to tensile. The films were characterized by two wavelength scanning micro Raman spectroscopy and SEM. In this work a correlation is made between the intrinsic stress measurements and the Transpolyacetylene peaks (around 1120 cm⁻¹ and 1450 cm⁻¹) in the Raman spectra of NCD films. It is shown that the intensity and the FWHM of the peaks correlate with the tensile stress in the films. A model correlating the Raman spectra to the grain size and thus to the intrinsic stress measurements is given in this paper.

DS 9.3 Mon 15:45 H34

Kinetic modeling of BN deposition by PECVD — ●SARAH PANOWITZ, JENS MATHEIS, and ACHIM LUNK — Institut für Plasmaphysik, Universität Stuttgart, Pfaffenwaldring 31, D-70569 Stuttgart

We present kinetic modeling of BN deposition by PECVD in the system B-N-H-X where X represents the gases F, Cl, Br or O, respectively. In the first step the thermodynamic data as well as kinetic coefficients are collected from literature and compared with each others. The kinetic coefficients also include the most important plasma reactions. With data set up selected calculations were performed in the program "CHEMKIN". Kinetic modeling was executed with the perfectly stirred reactor model. This model requires modeling of volume reactions as well as reactions on the surface. The rate coefficients for the surface reactions are investigated through parameter studies. Results of these parameter studies are compared with data known from experiments to obtain the probably way of reaction mechanisms. Data from kinetic modeling are also compared with results from calculations in

thermodynamic equilibrium. Results of kinetic and equilibrium modeling show that the range where BN can be deposited is very sensitive to the mole fraction of the species X which is used. Using oxygen as well as fluorine there exist only few parameter compositions to deposit BN. These parameter sets are very important in relation to possible etching effects in PECVD of c-BN deposition.

DS 9.4 Mon 16:00 H34

Correlation of structural properties of DLC films to their mechanical and optical properties — ●OLEKSIY FILIPOV, ALEXEI POUKHOVOI, NICOLAS WOEHL, and VOLKER BUCK — Thin Film Technology Group, Dept. of Physics, University of Duisburg-Essen, Universitätsstr. 3-5, 45141 Essen, Germany

Diamond-like carbon films refers to a form of amorphous carbon a-C and hydrogenated amorphous carbon a-C:H containing a sizeable fraction of sp³ bonding, which makes them mechanically hard, infrared transparent and chemically inert. But DLC films have a big drawback high residual stress. In order to adjust stress and investigate properties of deposited films, DLC films were deposited onto different types of substrates like glass to investigate optical properties, Si and steel to investigate structural and mechanical properties, by using different deposition methods such as PVD DC-anodic arc and CVD RF-plasma. Both deposition methods allow us independently adjust substrate bias and gas admixture in order to influence the film properties. The structural properties of the films were characterized by Raman and FTIR spectroscopies. The optical properties of the films were ex-situ examined by UV-IR spectroscopy. The intrinsic stress was measured ex-situ by determining the substrate curvature using SSIOD method. It was shown correlation between structural and optical properties of deposited films and influence of deposition parameters onto intrinsic stress. The influence of hydrogen flow rate on film properties was also shown.

DS 9.5 Mon 16:15 H34

Electronic properties of graphite-like ion tracks in insulating tetrahedral amorphous carbon — ANNE-KATRIN NIX¹, DANIEL SCHWEN¹, CARSTEN RONNING¹, JOHANN KRAUSER², CHRISTINA TRAUTMANN³, and ●HANS HOFSSÄSS¹ — ¹II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — ²Hochschule Harz, Friedrichstrasse 57-59, 38855 Wernigerode, Germany — ³Gesellschaft für Schwerionenforschung, Planckstrasse 1, 64291 Darmstadt, Germany

We investigated the formation of quasi one-dimensional conducting filaments in diamond like carbon (DLC) films created by swift heavy ion irradiation. Various DLC films with thicknesses of about 100 nm were grown using mass separated ion beam deposition (MSIBD) on highly conducting Si and Ni substrates. After deposition the films were irradiated with 1 GeV ²³⁸U ions with fluences between 10⁹ and 10¹¹ ions/cm². Due to their high electronic energy loss of about 30 keV/nm the swift heavy ions graphitize the predominantly (80%) sp³-bound carbon film along their trajectories yielding conducting nanowires embedded in an insulating matrix. Using atomic force microscopy (AFM) with conducting cantilevers and applied bias voltage the presence of conducting tracks was confirmed and their conductivities were determined to be several orders of magnitude higher than of the host matrix. Temperature dependent electrical measurements

were performed on the irradiated samples at 300 K - 10 K with fields up to 5 V/μm. We will discuss the results with respect to contact resistances and possible one-dimensional conduction mechanisms within the tracks.

DS 9.6 Mon 16:30 H34

Synthesis of MAX Functional Coatings by PLD — ●PETER SCHAAF¹, CHRISTIAN LANGE¹, SALVATORE CUSENZA¹, and MICHEL BARSOUM² — ¹Universität Göttingen, II.Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — ²Drexel University, Department of Materials Science and Engineering, Philadelphia, PA, USA

MAX phases - short for M_{n+1}AX_n - constitute an exciting new class of materials. The prototype of this material class, Ti₃SiC₂, was first discovered and characterized in 1967 [1], but only in 1996 it was discovered that this material is stiff, lightweight, machinable, made from relatively inexpensive raw materials, resistant to oxidation and thermal shock, and capable of remaining strong up to temperatures in excess of 1300°C in air [2,3]. Since then, many MAX phases have been synthesized and characterized and first industrial applications occur [3]. Nevertheless, the potential of this material as a protective coating is not yet exploited. We report on experiments on the deposition of MAX coatings by PLD. The films were deposited at increasing substrate temperatures and subsequently analyzed by a variety of methods. Results on MAX coatings in the Ti-Si-C and the Ti-Al-N regime are reported. [1] W Jeitschko and H Nowotny. 1967. Monatschrift für Chemie 98:329-337.

[2] MW Barsoum and T El-Raghy. 1996. Journal of the American Ceramic Society 79:1953-1956.

[3] MW Barsoum and T El-Raghy, American Scientist 89, 334 (2001).

DS 9.7 Mon 16:45 H34

An empirical bond-order potential for simulating amorphous (hydro)carbon film formation — ●LARS PASTEWKA¹ and MICHAEL MOSELER^{1,2} — ¹Fraunhofer Institut Werkstoffmechanik, Wöhlerstraße 11, 79108 Freiburg — ²Freiburger Materialforschungszentrum, Stefan-Meier-Straße 21, 79104 Freiburg

Process simulation, and especially the modeling of amorphous carbon and hydrocarbon thin film formation, has been of scientific interest for decades. The length and time scales which have to be covered for meaningful simulations are, however, still out of reach for quantum simulation techniques. Only quite recently insight has been gained into thin film formation using empirical potentials [1,2]. Available empirical potentials on the other hand have their own deficiencies: They either fail to describe carbon hybridization correctly, do not include hydrogen interaction, or if reliable are still too expensive. Here we present a straightforward extension of the carbon potential of Erhart and Albe [3] building on the original ideas of Brenner [4]. By utilizing an extended fitting database our potential manages to describe hybridization correctly while not sacrificing execution speed. This enables large scale studies of hydrocarbon thin film formation.

[1] M. Moseler et al., Science 209, 1545 (2005) [2] H. U. Jäger and K. Albe, J. Appl. Phys. 88, 1129 (2000) [3] P. Erhart and K. Albe, Phys. Rev. B 71, 035211 (2005) [4] D. W. Brenner, Phys. Rev. B 42, 9458 (1990)

DS 10: Layers with Magnetic Properties

Time: Monday 17:15–19:00

Location: H34

DS 10.1 Mon 17:15 H34

Thermal stability of Py/Cu and Co/Cu giant magnetoresistance (GMR) systems — ●VITALIY VOVK¹, GUIDO SCHMITZ¹, and ANDREAS HÜTTEN² — ¹Institute of material physics, WWU Münster, Münster, Germany — ²Institute of nanotechnology, Forschungszentrum Karlsruhe, Karlsruhe, Germany

The long-term thermal stability in thin film functional materials often becomes a critical restriction regarding the technical application. GMR multilayer (ML) systems (Co/Cu and Py/Cu) are studied in this aspect since their automotive application requires operation in hot environments.

Tomographic atom probe analysis of Py/Cu system [1] conducted in our group has shown the minor broadening of the layer interfaces to

be the most probable reason for the GMR degradation. Comparable results are observed in Co/Cu system using wide angle atom probe tomography (WATAP), though the systems have rather different thermodynamics. Besides the atomic transport, another important transformation takes place at elevated temperatures. The broad <111>-changes to sharp <200>-texture during the recrystallization process. It is shown that this texture reorientation is due to the anisotropic energy terms competition in the multilayer system. Since the RKKY coupling length depends among other parameters on the crystallographic orientation of the system, the thermal stability of the GMR effect can be significantly improved by the control of texture reorientation.

[1] C. Ene, G. Schmitz, R. Kirchheim, A. Hütten, Acta Materialia 53, 3383, 2005.

DS 10.2 Mon 17:30 H34

Structural and magnetic characterization of Heusler multilayers — ●MIRIANA VADALA¹, ALESSIO LAMPERTI², ALEXEI NEFEDOV¹, GREGOR NOWAK¹, KURT WESTERHOLT¹, MAXIMILLIAN WOLFF¹, and HARTMUT ZABEL¹ — ¹Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, Germany — ²Departement of Physics, University of Durham, United Kingdom

Heusler alloys are attractive candidates for application in spin dependent electron transport devices such as Giant Magneto Resistance (GMR), and in magnetic high performing devices. - We have grown by rf-sputtering multilayers of Heusler phase Co_2MnGe on Al_2O_3 and MgO substrates. We performed hard X-rays measurements to determine the chemical density profile and the epitaxial orientation inside these systems and polarized neutron reflectivity to study the magnetization profile of thin $\text{Co}_2\text{MnGe}/\text{Al}_2\text{O}_3$ and $\text{Co}_2\text{MnGe}/\text{MgO}$ thin multilayers. X-ray scattering both at small and high angles showed intense Bragg peaks, respectively indicating high interface sharpness and crystallinity of the Heusler phase. Neutron maps, taken at room temperature and 10 K, both in saturated and remanence magnetization, evidenced a sharp magnetisation profile at the Heusler/Oxide interfaces with Bragg peaks detected up to the 4th order; the absence of diffuse scattering indicates that the magnetic roughness is very small.

Financial support provided through the EU RTN "ULTRASMOOTH", as well as the partial support by SFB 491 and by BMBF 03ZA6BC1 is acknowledged.

DS 10.3 Mon 17:45 H34

Geometry and magnetic structure of epitaxial metallic layers on substrates with a large misfit — ●STEPHAN SCHÖNECKER, CARSTEN NEISE, MANUEL RICHTER, KLAUS KOEPERNIK, and HELMUT ESCHRIG — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Modern electronic theory has provided a reliable theoretical procedure for finding total energies of crystalline materials for any configuration of atoms in the unit cell. Hence, we can look at epitaxial layers on substrates and perform total energy calculations for different geometries of layers in order to find metastable phases, that are locally stable against small perturbations.

Our calculations were done with the scalarrelativistic version of the full-potential local-orbital code FPLO. The method of fixed spin moment (FSM) was used to detect a possible magnetic ground state. We limit our discussion to crystals with body centered tetragonal (bct) Bravais lattice, and present results for palladium and cobalt. Both metals can be grown in a metastable but stress-free state on substrates, with a large misfit of up to 12%.

DS 10.4 Mon 18:00 H34

Multilayered Polycrystalline Iron Garnet Structure of $\text{Bi}_3\text{Fe}_5\text{O}_{12}$ and $\text{Y}_3\text{Fe}_5\text{O}_{12}$ grown on SiO_2 substrates by pulsed laser deposition — ●TIMO KÖRNER¹, ANDREAS HEINRICH¹, STEPHAN LEITENMEIER¹, MICHAEL HERBORT¹, BERND STRITZKER¹, JÜRGEN SIMON², and WERNER MADER² — ¹Universität Augsburg, EPIV, 86135 Augsburg — ²Universität Bonn, Institut für Anorganische Chemie, 53117 Bonn

Iron Garnet single crystals like $\text{Y}_3\text{Fe}_5\text{O}_{12}$ (YIG) are important ceramic systems with extensive applications in structural ceramics and optoelectronics. Currently, it is desirable to integrate such macroscopic components on a single chip (e.g. Si, SiO_2 , ...) as in the case of microelectronics (integrated optics). High quality magneto-optical (MO) active garnet films with high Faraday rotation are also needed for MO imaging and microscopy. In our work we studied the influence of parameters during the deposition of YIG films and developed a new way to grow polycrystalline $\text{Bi}_3\text{Fe}_5\text{O}_{12}$ (BIG) thin films on different SiO_2 substrates using the pulsed laser deposition (PLD) method. Therefore we deposited a YIG buffer which was annealed above 1000°C in order to form a polycrystalline phase. On top of this buffer layer we deposited a thermodynamical unstable BIG layer. We measured the Faraday rotation of the films and studied them with x-ray diffraction (XRD), Rutherford backscattering spectroscopy (RBS), Environmental Scanning Electron Microscopy (ESEM) and high-resolution transmission electron spectroscopy (HRTEM). Their Faraday rotation can be compared with epitaxial BIG films grown on garnet substrates.

DS 10.5 Mon 18:15 H34

Pulsed Laser Deposition and Growth Studies of $\text{Bi}_3\text{Fe}_5\text{O}_{12}$

on $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ — ●ANDREAS HEINRICH¹, TIMO KÖRNER¹, STEPHAN LEITENMEIER¹, MICHAEL HERBORT¹, BERND STRITZKER¹, JÜRGEN SIMON², and WERNER MADER² — ¹Universität Augsburg, EP IV, 86135 Augsburg — ²Universität Bonn, Inst. f. Anorganische Chemie

Magneto-optical garnets stand out because they exhibit a high Faraday rotation and low optical losses in the near infrared region. In this spectral range garnets are the only materials discussed in optical communications to realize nonreciprocal devices such as optical isolators. Such isolators are necessary to prevent reflected light caused by e.g. cable splices from irregularly entering optical components and hence to reduce the noise signal. Nowadays one wants to integrate such macroscopic optical components on a single chip leading to integrated optics. In order to achieve this, it is necessary to understand the principle growth mechanism, so that one can deposit high quality thin films of the optical active materials. We deposited $\text{Bi}_3\text{Fe}_5\text{O}_{12}$ on (100), (110) and (111) $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ by Pulsed Laser Deposition. Here we want to give details on the growth and preferential growth direction of the films. Our investigations have been carried out by utilizing an Environmental Scanning Electron Microscopy, Energy Dispersive X-ray Analysis, Rutherford Backscattering Spectroscopy, and X-ray Diffraction. We also report on the Faraday rotation of the films, which has been determined in a special setup polarization microscope.

DS 10.6 Mon 18:30 H34

Magnetization in homogenous ferrofluidic films — ●BIRGIT GRAF¹, GEORGE TZVETKOV¹, JÖRG RAABE², KONSTANTIN PETUKHOV³, and RAINER FINK¹ — ¹Universität Erlangen-Nürnberg, Lehrstuhl für Physikalische Chemie II, Erlangen, Germany — ²Paul Scherrer Institut, Villigen, Switzerland — ³Universität Erlangen-Nürnberg, Physikalisches Institut III, Erlangen, Germany

Ferrofluids are comprised of microscopic ferromagnetic nanoparticles, usually magnetite (Fe_3O_4), hematite (Fe_2O_3) or some other compound containing Fe^{2+} or Fe^{3+} suspended in a carrier fluid. The nanoparticles are typically of order 1-10 nm. Therefore and because of the fact that they are usually coated with a surfactant, most of the ferrofluids are stable. Since they do not retain magnetization in the absence of an externally-applied field they do not display macroscopic ferromagnetism.

As a model substance, we investigated thin films of APG L23 (from FerroTec, Nürtingen), which were prepared by spin-coating of the low viscous material. This material consists mainly of 10 nm magnetite particles. Using scanning transmission x-ray microscopy (STXM) at the SLS PolLux beamline we could monitor small inhomogeneities within the films, which show distinct variations in the Fe L-Edge spectra. These variations may be due to phase separated species with different oxidation states. Using XMCD spectra and SQUID measurements, we derive the magnetic properties of differently prepared films (funded by the BMBF, contract 05 KS4 WE1/6).

DS 10.7 Mon 18:45 H34

LCMO Films Deposited on (100) and (111) STO Substrates — ●GULGUN HAMIDE AYDOGDU¹, YENER KURU², and HANNS ULRICH HABERMEIER¹ — ¹Max Planck Institut für Festkörperforschung Heisenbergstraße 1, D-70569 Stuttgart, Germany — ²Max Planck Institut für Metallforschung Heisenbergstraße 3, D-70569 Stuttgart, Germany

Epitaxial LCMO thin films of various thicknesses were grown on (100) and (111) STO substrates by pulse laser deposition technique (PLD). Determination of epitaxial relationship between the film and the substrate, phase analysis were carried out by X-ray diffraction (XRD). It is understood by pole figures that films on (111) STO display three-fold symmetry however, four-fold symmetry is observed for the ones on (100) STO. Surface morphologies and roughnesses of the films were characterized by atomic force microscopy (AFM). Electrical resistivities and magnetization of the samples were measured within a temperature range between 5 K and 300 K. Films on (100) STO were found to behave as an insulator for all thicknesses while the films on (111) STO show metallic behavior when film thickness exceeds 145 nm. Structural variations induced by the (111) STO substrate cause the increase of the Mn-O-Mn angle and the equatorial Mn-O distances. Consequently, double exchange mechanism is enhanced and the Jahn-Teller distortion is decreased. This study is an example that shows how the substrate material can be used to modify the electronic and magnetic properties of the LCMO films although chemical compositions and the thicknesses of films remain unchanged.

DS 11: Symposium: New Materials for Nanoelectronics

Time: Tuesday 9:30–13:15

Location: H32

Invited Talk

DS 11.1 Tue 9:30 H32

Strained silicon for advanced nanotechnology — ●MICHAEL GORYLL¹, DAN BUCA¹, QING-TAI ZHAO¹, BERND HOLLÄNDER¹, SIEGFRIED MANTL¹, ROGER LOO², DUY NGUYEN², and MANFRED REICHE³ — ¹Institut für Bio- und Nanosysteme (IBN1) und cni, Forschungszentrum Jülich, D-52425 Jülich, Germany — ²IMEC, Kapeldreef 75, B-3001 Leuven, Belgium — ³MPI für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

Introducing strain into silicon layers has shown carrier mobility increase in CMOS devices. Two prevailing approaches, the global strain and the local strain platform, will be presented. While in case of local strain, small-area selective epitaxial SiGe growth is employed, global strain presents more challenges regarding layer deposition. We will discuss our approach towards global strain based on thin pseudomorphic SiGe layers, that are being strain relaxed using He⁺ ion implantation and thermal annealing. The morphology and crystallinity of the layers was investigated using optical microscopy, atomic force microscopy and transmission electron microscopy. Characterization methods employed to determine the residual strain in the silicon layers comprise angular ion beam scanning and Raman spectroscopy. Strained silicon on insulator (sSOI) layers were produced by layer transfer to an insulating substrate. This process includes wafer bonding as well as splitting performed by H₂⁺ ion implantation and annealing. Electrical measurements on n-channel MOSFETs fabricated on this sSOI material will be presented that exhibit the expected electron mobility enhancement.

Invited Talk

DS 11.2 Tue 10:00 H32

Integration of functional epitaxial oxides into silicon: From high-K application to nanostructures — ●H. JÖRG OSTEN — Institut für Materialien und Bauelemente der Elektronik, Leibniz Universität Hannover, Appelstr. 11A, 30167 Hannover

There are several attempts to increase the material variety that is compatible with Si technologies. The ability to integrate crystalline dielectric barrier layers into silicon structures can open the way for a variety of novel applications ranging from high-K replacements in future MOS devices to oxide/silicon/oxide heterostructures for nanoelectronic application in future quantum-effect devices. First, we will demonstrate and discuss the epitaxial growth of oxides on different oriented Si substrates based on surface and interface considerations. Here, we will present results for crystalline lanthanide oxides on silicon in the cubic bixbyite structure grown by solid state MBE.

Experimental results for Gd₂O₃-based MOS capacitors show that these layers are excellent candidates for application as very thin high-K materials replacing SiO₂ in future MOS devices. In addition, we will present a new approach for nanostructure formation which is based on solid-phase epitaxy of the Si quantum-well combined with simultaneous vapor-phase epitaxy of the insulator on top of the quantum-well. Ultra-thin single-crystalline Si buried in a single-crystalline insulator matrix with sharp interfaces was obtained by this approach on Si(111). Finally, the incorporation of crystalline Si islands into single-crystalline oxide layers will be demonstrated.

Invited Talk

DS 11.3 Tue 10:30 H32

Rare Earth based amorphous ternary oxide layers as alternative gate dielectrics — ●JÜRGEN SCHUBERT¹, TASSILO HEEG¹, MARTIN ROECKERATH¹, JOAO MARCELO JORDAO LOPES¹, UFFE LITTMARK¹, CHAO ZHAO², MATTY CAYMAX², VALERIE AVANASIEV³, LISA EDGE⁴, YUNFA JIA⁴, WEI TIAN⁴, and DARRELL SCHLOM⁴ — ¹IBN 1-IT and CNI, Forschungszentrum Jülich GmbH, 52425 Jülich — ²IMEC, Kapeldreef 75, B-3001 Leuven, Belgium — ³Department of Physics, University of Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium — ⁴Penn State University, 16802 University Park, Pennsylvania, USA

Rare Earth based oxide thin films are promising candidate materials to replace SiO₂ as a gate dielectric in MOSFETs of the next generation. So far most attention attracted HfO₂ and Hf-containing silicates but they have severe drawbacks such as too low recrystallization temperature ($T_{cr} = 600^\circ\text{C}$). Calculations on the thermal stability of ternary oxides in direct contact with silicon were resulted in a number of more appropriate oxides [1]. E.g. GdScO₃ single crystals showed excellent properties which could be reproduced for amorphous films. Permittivity of 22, a bandgap of 5.6 eV, band offsets larger than 2 eV and a

good thermal stability ($T_{cr} > 900^\circ\text{C}$) could be verified. Furthermore those oxides are not hygroscopic in contrast to most of the binary systems. Another promising system is LaLuO₃ which shows k-values of 32 combined with a high thermal stability ($T_{cr} > 900^\circ\text{C}$). Most recent results will be presented and discussed. [1] D.G. Schlom and J. Haeni, MRS Bulletin V. 27, No. 3 (2002)

Invited Talk

DS 11.4 Tue 11:00 H32

Advanced SOI CMOS transistors for high performance microprocessors — ●MANFRED HORSTMANN — AMD Saxony LLC & Co. KG, Wilschdorfer Landstrasse 101, 01109 Dresden, Germany

An overview of state of the art advanced Silicon on Insulator CMOS transistors used for high performance microprocessors will be given. For advanced SOI transistors stress engineering has become a standard feature since the 90 nm technology node due to gate oxide scaling limitations [1]. Especially techniques to induce local strain like compressive and tensile stressed over-layer films, embedded-SiGe, and stress memorization are keys to maintain transistor performance. With optimization, the different stressors are highly compatible and additive to each other, improving PMOS and NMOS saturation drive current by ca. 50 % and 30 %, respectively. This results in 40 % higher product speed. In addition to reduce the lateral and vertical device dimensions advanced Laser or Flash) annealing has been applied [2]. These anneal processes yield an improved dopant activation for active and gate regions resulting in lower source-drain resistance and gate depletion without any additional diffusion. These techniques have been applied and optimized for 90 nm and 65 nm volume manufacturing and are scaleable to 45 nm design rules. Technology options for future transistors like Strained Silicon directly bonded on SOI, fully depleted SOI, High K or FinFETs will be discussed.

[1] M. Horstmann, et al., IEDM 2005, p. 243 [2] Th. Feudel et al., RTP Conference, Kyoto, 2006

DS 11.5 Tue 11:30 H32

Herstellung und Charakterisierung von MOSFETs mit Gado-liniumsclandat als alternatives Gatedielektrikum — ●MARTIN ROECKERATH, JOACHIM KNOCH, JOAO MARCELO JORDAO LOPES, TASSILO HEEG, JÜRGEN SCHUBERT und SIEGFRIED MANTL — Institut für Bio- und Nanosysteme (IBN 1 - IT) und CNI, Forschungszentrum Jülich, D-52425 Jülich, Germany

Seltene-Erd-Scandate sind durch ihre herausragenden morphologischen und elektrischen Eigenschaften eine vielversprechende Materialklasse für die Verwendung als High-*k*-Dielektrikum in zukünftigen CMOS Anwendungen. Speziell GdScO₃ weist eine hohe thermische Stabilität sowie eine DK von ca. 23 auf. In dieser Arbeit wurde dieses Material nun in Feldeffekt-Transistoren (MOSFETs) als alternatives Gateoxid integriert. Besonderer Schwerpunkt der Untersuchung lag auf dem Einfluss der High-*k*-Silizium-Grenzfläche auf die elektrischen Eigenschaften der Bauelemente. Das Oxid wurde mittels Elektronenstrahlverdampfen von stöchiometrischem Quellenmaterial im Hochvakuum hergestellt. Um die Grenzfläche zu variieren wurde das GdScO₃ sowohl auf chemischem Oxid als auch auf wasserstoffterminierter Si(100)-Oberfläche abgeschieden und einige Proben außerdem nachträglich in Sauerstoff getempert. Die elektrische Charakterisierung der Bauelemente zeigt einen deutlichen Einfluss sowohl des Temperns als auch der Vorbehandlung auf deren Ströme sowohl im Aus- als auch im Anzustand. Außerdem kann eine Schwellspannungsverschiebung beobachtet werden. In diesem Beitrag wird auch der Einfluss der Grenzflächeneigenschaften auf die Ladungsträgerbeweglichkeit diskutiert.

Invited Talk

DS 11.6 Tue 11:45 H32

Graphene: A new Electronic Material — ●MAX CHRISTIAN LEMME¹, TIM ECHTERMEYER¹, MATTHIAS BAUS², and HEINRICH KURZ^{1,2} — ¹Advanced Microelectronic Center Aachen (AMICA), AMO GmbH, Otto-Blumenthal-Str. 25, 52074 Aachen, Germany — ²Institut für Halbleitertechnik, RWTH-Aachen, Sommerfeldstr. 24, 52074 Aachen, Germany

Carbon based electronics offer one of the most promising options to enhance silicon CMOS technology in the future. Great attention has been paid to carbon nanotubes (CNTs) because of their intriguing electronic properties. Their application in electronics, however, will depend strongly on the availability of self organizing processes. Graphene

films, monolayers of carbon, have only recently been identified as a new contender for carbon electronics. Graphene's planar form predestinates it as a booster for silicon technology. In this talk, field effect devices (FEDs) manufactured from few- and monolayer graphene are presented. Except for graphene deposition, only conventional top-down CMOS-compatible processes have been used. Raman spectroscopy is presented as the method of choice for distinguishing few-layer monolayer graphene. Electron and hole mobilities in graphene pseudo-MOS structures are compared to those obtained from double-gated Graphene-FEDs. Even when covered by silicon oxide, the values exceed the universal mobility of silicon and silicon-on-insulator MOS-FETs.

Invited Talk

DS 11.7 Tue 12:15 H32

Electronic Transport in Carbon Nanotube FETs — ●JOACHIM KNOCH — IBM Research GmbH, Zurich Research Laboratory, Säumerstrasse 4, 8803 Rüschlikon, Switzerland

Carbon nanotubes have recently attracted a great deal of interest due to their unique structural and electronic properties. In particular, carbon nanotube field-effect transistors have been widely investigated as an alternative for future nanoelectronics applications. In the present talk we will discuss the electronic transport properties of CNFETs.

Usually, contacts are formed by depositing metals on top of the nanotube. One focus of the talk will be the investigation of the role of these source/drain contacts on the device behavior. As it turns out, CNFETs behave similarly to ultrathin-body Schottky barrier MOS-FETs. Although the ultrathin diameter (body) allows for an excellent carrier injection through the Schottky-barrier, its presence prohibits the observability of multi-mode transport in such CNFETs. Details regarding multi-mode transport and the role of scattering for the visibility of multi-mode transport will be discussed. Furthermore, we will present CNFETs with 'doped' source/drain contacts and study the relevant phenomena occurring in such conventional-type devices. A charge pile-up in case of short channel devices deteriorates the device performance and leads to large off-state leakage currents. Finally, a new device architecture based on band-to-band tunneling is introduced which allows to combine an excellent on-state performance with a switching ability superior to any conventional FET. It will be shown that one-dimensional objects are ideally suited for the realization of such tunneling FETs.

DS 11.8 Tue 12:45 H32

Strukturierte Schichtsysteme für horizontal gerichtetes Wachstum von Kohlenstoff-Nanoröhren — ●MATTHIAS

BÜENFELD¹, BERND SCHRÖTER¹, FRANK SCHMIDL¹, MATTHIAS GRUBE¹, RENÉ GEITHNER², THOMAS PERTSCH¹, DETLEF SCHELLE², WOLFGANG RICHTER¹, ANDREAS TÜNNERMANN² und PAUL SEIDEL¹ — ¹Institut für Festkörperphysik, Friedrich-Schiller-Universität, Jena, Germany — ²Institut für Angewandte Physik, Friedrich-Schiller-Universität, Jena, Germany

Kohlenstoff-Nanoröhren ermöglichen durch ihre Form und Größe sehr interessante Anwendungen. Das gerichtete Wachstum ist für solche Anwendungen ein grundlegender Aspekt. Ziel ist es, die Nanoröhren gezielt horizontal auf Oberflächen wachsen zu lassen. Dabei bieten sich unterschiedliche Einflussmöglichkeiten. Für das Wachstum der Nanoröhren sind Katalysatorpartikel im nm-Bereich (im wesentlichen Eisen, Nickel oder Kobalt) notwendig. Vorstrukturierung dieser Materialien und die Größe dieser Partikel haben wesentlichen Einfluss auf den Durchmesser und das Wachstum der Nanoröhren. Durch Kombination unterschiedlicher, strukturierter Oxidschichten sind weitere Auswahlkriterien für Wachstumsort und Wachstumsrichtung gegeben.

DS 11.9 Tue 13:00 H32

Determination of the coefficient of thermal expansion (CTE) of porous dielectric films using x-ray reflectometry — ●SEBASTIAN TAUBE, HOLM GEISLER, ULRICH MAYER, INKA ZIENERT, MICHAEL HECKER, and EHRENFRIED ZSCHECH — AMD Saxony LLC & Co. KG, Wilschdorfer Landstr. 101, D-01109 Dresden, Germany

In advanced integrated circuits thin interlayer dielectric (ILD) films with reduced relative permittivity (k) will be used for reducing crosstalk and interconnect signal delay. It is the final goal to achieve as small as possible k -values which are close to the physical limitation ($k_{vacuum} = 1$). For reaching lowest possible k values, new materials or nano porous layers are potential candidates. However, these layers have many different properties in comparison with the traditionally used silica glass, e.g., considerably reduced mechanical stiffness. The CTE value is one important property of such an ILD layer. The advanced integrated circuits undergo during the fabrication and later in the practice permanent changing temperature cycles. Thin film stacks with relatively large differences in the CTE of the individual thin films are a reliability concern for microelectronic products. The thickness of a thin film as well as the variation of the thickness due to increased temperature can be measured very precisely with XRR. It will be shown here that the CTE of (ultra) low- k layers can be determined for relevant process and application temperatures with the XRR method. The measured CTE values are typically higher than for metals, e.g., copper.

DS 12: Thin Film Analytics I

Time: Tuesday 14:30–15:15

Location: H34

Invited Talk

DS 12.1 Tue 14:30 H34

Surface Analytics with Monolayer Resolution using Ions — ●PEDRO GRANDE¹, AGENOR HENTZ¹, RAFAEL PEZZI¹, ISRAEL BAUMVOL¹, and GREGOR SCHIWETZ² — ¹Instituto de Física da UFRGS, Porto Alegre, Brazil — ²Hahn-Meitner-Institut, Abteilung SF4, Berlin, Germany

Determining the depth distribution of the different chemical elements near and at the surface of solids is of major relevance for many aspects of nanotechnology. In principle, this can be accomplished quantitative with deep subnanometric depth resolution, using ion scattering at energies corresponding to the maximum ion energy loss and high-energy resolution detection systems. The method is called medium energy ion scattering (MEIS), and is currently used for near-surface

elementary profiling in amorphous thin films and to investigate surface crystallography and surface reconstruction and dynamics. However, the simple data analysis framework successfully used for other low-resolution backscattering techniques (such as RBS) is not applicable to MEIS, since the much higher energy resolution of MEIS reveals new spectral features. The most relevant one is that in the first few nanometers below the solid surface the ion energy loss departs from a symmetric, Gaussian distribution. We propose an analytical formula for the line shape to replace the usual Gaussian distribution widely used in low-resolution ion-beam analysis. Furthermore, we provide a simple physical method to derive the corresponding shape parameters. We also present a comparison with full coupled-channel calculations as well as with experimental data at nearly single collision conditions.

DS 13: Thin Film Analytics II

Time: Tuesday 15:15–16:30

Location: H34

DS 13.1 Tue 15:15 H34

Measurement of oxide layers with laser-assisted atom probe tomography (LA-TAP) — ●CHRISTIAN OBERDORFER¹, CARSTEN NOWAK², CHRISTOPH REINKE¹, PATRICK STENDER¹, and GUIDO SCHMITZ¹ — ¹Institut für Materialphysik, Universität Münster — ²Institut für Materialphysik, Universität Göttingen

Conventional atom probes use high voltage pulses of only a few nanoseconds pulse width to trigger the field-evaporation-process. Because of this approach, it is hard to investigate materials of low conductivity. In the past successful measurements of oxide layers were reported only with severe restrictions on the specimen geometry.

Laser-assisted atom probe tomography circumvents this limitation. By using very short laser pulses (< 1 ns) it is now possible to measure oxidic films of a few tens of nanometers in thickness.

The talk will present results obtained with the new atom probe at the university of Münster. Examples of measurements of nickel-oxide and tungsten-oxide will be presented.

DS 13.2 Tue 15:30 H34

Low-level hydrogen profiling with RNRA — ●JOHANNES BOSMAN, MICHAEL UHRMACHER, HOLGER SCHEBELA, CARSTEN RONNING, and HANS HOFSSÄSS — II. Institute of Physics, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Our intention is to detect hydrogen and its profile in thin films. We will use the resonant nuclear reaction analysis method (RNRA) to achieve this aim, because it is difficult or rather impossible with other methods like RBS, XPS, AES or SIMS. We utilise the nuclear reaction $^1\text{H}(^{15}\text{N}, \alpha\gamma)^{12}\text{C}$, which means, that an accelerator providing a ^{15}N -beam with energies up to 7 MeV is necessary. The tandem accelerator facility at the II. Institute of Physics includes a so called 'Amsel-deflector' system and a low-level measurement unit, whose combination affords the required non-destructive ion beam method, which enables H-profiling with RNRA. The depth resolution is 2 nm at the surface and 10 nm in the maximum analysing depth of 400 nm. A H-concentration of 450 ppm is detectable using a measuring time of 1 min per energy setting. We analysed ta-C:H layers with a thickness of 100 nm grown by mass separated ion beam deposition (MSIBD) using 100 eV C_2H_2 -ions. The optical properties, measured by Raman and FTIR, will be correlated to the H-content. These first experiments and results will be discussed.

DS 13.3 Tue 15:45 H34

High resolution Rutherford backscattering spectrometry for investigating interdiffusion of thin films — ●CHRISTIAN BORSCHHEL¹, MARTIN SCHNELL¹, MICHAEL UHRMACHER¹, CARSTEN RONNING¹, CHRISTIAN WENGER², and HANS HOFSSÄSS¹ — ¹II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen — ²IHP microelectronics, Im Technologiepark 25, D-15236 Frankfurt (Oder)

Rutherford backscattering spectrometry (RBS) is a widely used technique to measure concentration-depth profiles of thin films. Usually a semiconductor detector is used to measure the energy of the backscattered ions. The typical energy resolution of 10 to 15 keV of these detectors is the limiting factor for the achievable depth resolution. We use an electrostatic analyzer to measure the energy of the backscat-

tered ions which can improve the energy resolution (and along with that the depth resolution) by a factor of about 10. The enhanced depth resolution makes RBS utilizable to investigate the interdiffusion at the interfaces of thin films. As an example we present experiments on the interdiffusion at the interface of a high-k dielectric Pr_2O_3 film on SiO_2 . We show what information about the diffusion of Pr and Si could be extracted from the experimental results and compare the method with other characterization techniques.

DS 13.4 Tue 16:00 H34

Elemental Characterisation of Mn-, Mg- and Co-doped ZnO nanostructures — ●CHRISTOPH MEINECKE, ANDREAS RAHM, JÜRGEN VOGT, and TILMAN BUTZ — Universität Leipzig, Fakultät für Physik und Experimentelle Physik II, Linnéstrasse 5, D-04103 Leipzig, Germany

ZnO based nanostructures have attracted increasing interest in recent years due to their structural diversity. Furthermore, transition metal doping (e.g. by Co or Mn) of ZnO films has been shown to create a promising ferromagnetic material for spintronics.

We report on the high-pressure pulsed laser deposition (PLD) growth of zinc oxide nanowires (300 - 500 nm in diameter) containing Co, Mg and Mn grown with NiO and Au catalysts.

Elemental analysis (PIXE, RBS) was carried out using a 2.25 MeV scanning proton beam with a spot size of app. 500 nm. This high spatial resolution at beam currents of app. 100 pA is necessary for the elemental analysis of single nanowires using RBS and PIXE.

Scanning electron microscopy, RBS and Particle induced X-ray emission measurements revealed differences between the compositions of nanowires compared to simultaneously grown films.

DS 13.5 Tue 16:15 H34

The reflectometer ADAM at ILL - Perspectives for an angle dispersive instrument — ●MAX WOLFF, KYRILL ZHERNENKOV, and HARTMUT ZABEL — Lehrstuhl für Festkörperphysik/EP IV, Ruhr-Universität Bochum, 44780 Bochum, Germany

The angle dispersive neutron reflectometer ADAM at the ILL offers high flux combined with an excellent Q resolution and full polarization analysis with privileged access for the German user community. During the last ten years nearly all components of the instrument have been modified to remain a state-of-the-art instrument. We will give a brief overview on the most recent improvements and most outstanding results obtained during the last years.

To further improve the performance of the instrument we plan to reconstruct the reflectometer. ADAM-2 will again be an angle dispersive reflectometer. The challenging task is to offer both options high resolution and high intensity on a monochromator instrument. To account for this we plan to use an intercalated graphite monochromator in combination with focusing guide elements. In addition the instrument will feature different recent and new developments like, grazing incident small angle scattering, spherical polarisation analysis and pump probe experiments. Combined with an improved infrastructure for sample preparation and environment unique possibilities for the investigations of magnetic thin films, self assembling layers and biological systems will be provided due to the high flux, the low background and excellent polarization analysis.

We acknowledge financial support by the BMBF (ADAM ZAE8BO).

DS 14: Thin Film Analytics III

Time: Tuesday 16:45–18:00

Location: H34

DS 14.1 Tue 16:45 H34

Non-destructive speciation of deeply buried TiO_x nanolayers and their interfaces — ●BEATRIX POLLAKOWSKI¹, BURKHARD BECKHOFF¹, STEFAN BRAUN², PETER GAWLITZA², FALK REINHARDT^{1,3}, and GERHARD ULM¹ — ¹Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin — ²Fraunhofer Institut Werkstoff- und Strahltechnik, Winterbergstr. 28, 01277 Dresden — ³TU Berlin, Straße des 17. Juni 135, 10623 Berlin

Enabling high dynamics of depth information the analysis with grazing incident X-ray fluorescence combined with near edge X-ray absorption fine structure (GIXRF-NEXAFS) provides a tool to probe buried interfaces with an information depth in the range from a few to several hundreds of nanometers. In our study we focused on different oxidized titanium layers (thickness 30 nm) deposited with ion beam sputtering deposition on a standard 8" silicon wafer and buried with a 5 nm carbon layer to have an appropriate system and, in addition, to prevent

further oxidation processes.

The GIXRF-NEXAFS measurements were carried out at the plane grating monochromator (PGM) beamline for undulator radiation at the PTB laboratory at BESSY II. Distinguishing between different kind of chemical bonds GIXRF-NEXAFS at the O-K edge and respectively the Ti-L_{iii,ii} edges was employed for the speciation of the TiO_x layers.

Initial results confirm that GIXRF-NEXAFS has the potential of depth profiling of deeply buried interfaces with respect to layer composition and elemental speciation.

DS 14.2 Tue 17:00 H34

Self assembled Ge nanocrystals on high-k cubic Pr₂O₃(111)/Si(111) support systems — ●ALESSANDRO GIUSSANI¹, THOMAS SCHROEDER¹, CRISTIAN MOKUTA², TILL METZGER², DORIN GEIGER³, PETER FORMANEK³, and HANNES LICHTER³ — ¹IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany — ²European Synchrotron Radiation Facility, BP 220, 38043 Grenoble, France — ³Technical University of Dresden, Institute of Structure Physics, Zellescher Weg 16, 01062 Dresden, Germany

The stoichiometry, structure and defects of self-assembled heteroepitaxial Ge nanodots on twin-free type B oriented cubic Pr₂O₃(111) layers on Si(111) substrates is studied to shed light on the fundamental physics of nanocrystal based nonvolatile memory effects. XPS studies prove the high stoichiometric purity of the Ge nanodots on the cubic Pr₂O₃(111)/Si(111) support system. Synchrotron based X-ray diffraction, including resonant scattering techniques, were applied to determine the epitaxial relationship, showing that the heteroepitaxial Ge(111) nanodots crystallize in the cubic diamond structure with an exclusive type A stacking configuration with respect to Si(111). GISAXS was used in addition to analyse the average shape, size and distance parameters of the single crystalline Ge nanocrystal ensemble. Furthermore, TEM micrographs report that partial dislocations are the prevailing extended defect structure in the Ge nanodots, probably induced by surface roughness on the atomic scale of the cubic

Pr₂O₃(111) support.

DS 14.3 Tue 17:15 H34

Beitrag wurde abgesagt — ●XXX XXX —

DS 14.4 Tue 17:30 H34

Gitteranpassung von kristallinen, SE-dotierten PLD-Schichten am Beispiel YVO₄ — ●BILGE ILERI¹, GÜNTER HUBER¹ und SEBASTIAN BÄR² — ¹Institut für Laser-Physik, Universität Hamburg — ²Universität Tübingen

Die Herstellung epitaktisch gewachsener, kristalliner Schichten ist für eine Vielzahl von Anwendungen wie Wellenleiterschichten oder kristalline Coatings interessant. Entscheidend hierbei ist für die meisten Anwendungen die hochwertige Qualität der Schichten. Dabei entscheidend ist das unmittelbare Wachstum auf dem Substrat, die sogenannte Grenzschicht.

Bei der Schichtherstellung mittels Pulsed Laser Deposition wird gitterangepasstes, epitaktisches Wachstum untersucht und am Beispiel von Ortho-Vanadatschichten vorgestellt. Ausgehend von Eu-dotierten GdVO₄-Schichten auf Saphir mit einer Gitterfehlpassung von einigen Prozenten werden die strukturellen und spektroskopischen Auswirkungen bei gradueller Reduzierung der Fehlanpassung bis hin zu gitterangepasstem Schichtwachstum untersucht.

Dabei werden Strukturuntersuchungen mittels Röntgenbeugung und Spektroskopie von Al₂O₃-Eu:GdVO₄, YVO₄-Eu:GdVO₄ und YVO₄-Eu:(GdLu)VO₄ präsentiert und gitterangepasstes Schichtwachstum demonstriert. Ergänzende Untersuchungen mittels AFM und Oberflächenröntgenbeugung werden vorgestellt.

DS 14.5 Tue 17:45 H34

Characterization of GdScO₃ layers by Spectroscopic Ellipsometry — MARTIN ROECKERATH, ●JÜRGEN MOERS, JÜRGEN SCHUBERT, and SIEGFRIED MANTL — Institut of Bio- und Nanosystems, Forschungszentrum Jülich, D-52425 Jülich

This contribution has been appended to session DS 26.

DS 15: Poster Session

Time: Tuesday 15:00–17:00

Location: Poster B

DS 15.1 Tue 15:00 Poster B

The dielectric function of coronene studied by spectroscopic ellipsometry — ●DANIEL LEHMANN and DIETRICH R.T. ZAHN — Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany

Coronene is a planar molecule and a promising candidate to be used as organic semiconductor due to its similarity to anthracene and pentacene. Especially for a possible use in organic light emitting diodes and organic solar cells the knowledge of the dielectric properties is crucial. We present the dielectric function of coronene thin films in the energy range from 0.73 eV to 5.00 eV. Several films with different thicknesses were grown in high vacuum on oxidized silicon substrates using organic molecular beam deposition and characterized *ex situ* by spectroscopic ellipsometry. The measured data of all samples were coupled to simulate the dielectric function using a mathematical model of summed Gauss functions to describe the optical response of the organic material.

DS 15.2 Tue 15:00 Poster B

Optical Properties of Spiro-linked Organic Thin Films — ●SIMONA SILAGHI¹, TILL SPEHR², CHRISTOPH COBET¹, CHRISTOPH WERNER¹, JOSEF SALBECK², SVEN PETERS³, WALTER BRAUN⁴, and NORBERT ESSER¹ — ¹ISAS - Institute for Analytical Sciences, Department Berlin, D-12489 Berlin, Germany — ²Institut für Chemie, Universität Kassel, D-34132 Kassel, Germany — ³SENTECH Instruments GmbH, D-12489 Berlin, Germany — ⁴BESSY-GmbH, D-12489 Berlin, Germany

Spiro-linked organic materials are very stable candidates [1] for organic optoelectronics and can be employed in charge transport and emitting layers of organic light-emitting diodes [2] as well as solid-state lasers [3]. Particularly, information about the effective refractive index is needed in the case of spiro-linked organic solid-state UV-lasers based on distributed feedback resonators [3]. Therefore, spectroscopic el-

lipsometry method is employed here in the energy range from 1.4 to 9.5 eV to extract accurate information about the optical properties of such spiro-linked organic thin films of Octo1 (2,2',4,4',7,7'-hexaphenyl-9,9'-spirobifluorene) and Octo2 (2,2',4,4',7,7'-hexakis(biphenyl-4-yl)-9,9'-spirobifluorene) grown on silicon substrates. [1] J. Salbeck, N. Yu, J. Bauer, F. Weissörtel, H. Bestgen, *Synth. Met.* 91 (1997) 209 [2] D. Gebeyehu, K. Walzer, G. He, M. Pfeiffer, K. Leo, J. Brandt, A. Gerhard, P. Stöbel, H. Vestweber, *Synth. Met.* 148 (2005) 205 [3] T. Spehr, A. Siebert, T. Fuhrmann-Lieker, J. Salbeck, T. Rabe, T. Riedl, H.H. Johannes, W. Kowalsky, J. Wang, T. Weimann, P. Hinze, *Appl. Phys. Lett.* 87 (2005) 161103

DS 15.3 Tue 15:00 Poster B

IR mapping ellipsometry of ultrathin organic films on metallic and semiconducting substrates — ●DANA MARIA ROSU¹, MICHAEL GENSCH³, KAREN KAVANAGH⁴, WENJIE LI⁴, JULIA HSU⁵, NORBERT ESSER¹, ULLRICH SCHADE², and KARSTEN HINRICH¹ — ¹ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Str. 9, 12589 Berlin, Germany — ²Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung mbH, Albert-Einstein-Str. 15, 12589 Berlin, Germany — ³DESY - Deutsches Elektronen-Synchrotron, Notkestr. 85, 22607 Hamburg, Germany — ⁴Kavanagh Lab, Dept. of Physics, Simon Fraser University, 8888 University Dr., Burnaby, BC, V5A 1S6, Canada — ⁵Sandia National Laboratories, Albuquerque, New Mexico 87185- 1120

An infrared spectroscopic ellipsometer is used for analysis of organic films on metals or semiconducting substrates. Monolayer sensitivity is achieved and lateral resolution was improved by utilizing the synchrotron mapping ellipsometer at BESSY II. IR synchrotron ellipsometry enables investigation of sample areas from 0.0625 mm² to 1 mm². The organic compound is identified by specific vibrational bands. Evaluation of measured spectra with optical models gives information about coverage and molecular orientation.

DS 15.4 Tue 15:00 Poster B

Light induced oxidative switching of anthracene monolayers — ●BURKHARD STILLER¹, WERNER FUDIKER², FRED ALBRECHT¹, STEPHAN KATHOLY¹, TORSTEN LINKER², and DIETER NEHER¹ — ¹Universität Potsdam, Institut für Physik, Potsdam, Deutschland — ²Universität Potsdam, Institut für Chemie, Potsdam, Deutschland

We present studies on the reversible photooxygenation of anthracene monolayers. Dioxygen can reversibly be added to anthracene derivatives by the photoinduced self-sensitized formation of singlet oxygen affording the corresponding anthracene endoperoxides. A quantitative reconversion to the parent anthracene is achieved either by heating or irradiation with UV-light. Calculations suggest significant changes of the molecular geometry and the dipole moments of the used anthracene derivatives upon oxidation. This reversible light induced change of the molecular dipole moment was monitored on-line by Kelvin probe technique and ellipsometry on anthracene monolayers. We have further employed this approach to establish a new method for reversible light and air driven lithography.

DS 15.5 Tue 15:00 Poster B

Low temperature reflection anisotropy spectroscopy investigation of vanadyl phthalocyanine — ●MICHAEL FRONK, BJÖRN BRÄUER, DIETRICH ZAHN, and GEORGETA SALVAN — Chemnitz University of Technology, D-09107 Chemnitz, Germany

Magneto optical Kerr effect (MOKE) spectroscopy is often used to characterise metallic films but there are hardly any reports about investigations on organic layers. It would thus be interesting to prove whether MOKE spectroscopy is a suitable technique to detect magnetic phase transitions in organic materials. Here thin films of a paramagnetic metal phthalocyanine molecule, namely vanadyl phthalocyanine, are investigated. The films are grown on Si(111) by vacuum evaporation. The MOKE spectra are recorded in the spectral range from 1.5 eV to 5.5 eV with a home-made set-up that analyses the change in the polarisation state of the reflected light upon applying an external magnetic field perpendicular to the sample surface. In addition to MOKE, the optical anisotropy of the film can lead to a noticeable change in the polarisation state of the reflected light. The effect of the optical anisotropy, however, is independent of the applied magnetic field and in a first approach the two effects sum up. As a first step in this work the optical anisotropy of the films is investigated in the temperature range from 300 K to 7.5 K. With decreasing temperature all spectral features show slight changes in their relative intensity. The most pronounced changes are observed in the sub-structure of the Q band related feature when cooling down from 300 K to 100 K.

DS 15.6 Tue 15:00 Poster B

XPS and ARPES studies of azobenzene derivatives on HfS₂ — ●JAROSLAW IWICKI, SUSANNE KOBELT, CHRISTIAN HAMANN, KAI ROSSNAGEL, and LUTZ KIPP — Institut für Experimentelle und Angewandte Physik, Universität Kiel, D-24098 Kiel, Germany

The light induced isomerization of switchable molecules is of potential importance for several applications, e.g., molecular electronics. In this study derivatives of azobenzene (phenylazobenzoic acid, disperse orange 3) were evaporated onto the layered material HfS₂ under UHV conditions. As a consequence of the weak bonding to the inert surface of HfS₂ the molecules do not deform and should retain their switchability. XPS and ARPES measurements were carried out at the BW3 beamline at HASYLAB with a Specs Phoibos 150 analyzer. XPS measurements confirm the adsorption of the azobenzene derivatives on the substrate and XANES and EXAFS reveal the adsorption geometry. ARPES, XANES and EXAFS data will be presented and discussed. This work is supported by the DFG Forschergruppe 353.

DS 15.7 Tue 15:00 Poster B

Preparation of organic thin films from solution on metal templates — ●STEPHAN WENZEL, NORMAN SCHMIDT, GEORGE TZVETKOV, and RAINER FINK — Physik. Chemie 2, Universität Erlangen, Egerlandstr.3,91058 Erlangen

The preparation of well ordered organic nanostructures is an interesting topic with respect to potential applications in photonic crystals. We have started with a comprehensive study to investigate the formation of well-ordered and well-oriented organic nanostructures using metallic microstructures on inert surfaces when the organic substance is deposited from solution. Emphasis is lying on the effect of reduced template sizes on the growth of particular crystallites upon slow evaporation of the solvent. We employed various molecular substances which

are attractive for optical investigations. The formation of crystallites is characterized in-situ by light microscopy and ex-situ by UV photoelectron emission microscopy (PEEM) and scanning transmission x-ray microspectroscopy (STXM). The latter is used to investigate the orientation of the microcrystallites from the linear NEXAFS dichroism which is accessible at the recently installed PoLLux beamline at the Swiss Light Source. The project is funded by the BMBF under contract 05/KS4WE1/6.

DS 15.8 Tue 15:00 Poster B

Optical Investigation of Thin Photochromic Spiropyran Films — ●MARTIN SCHÜBBE, MICHAEL KARCHER, CELINE ELSÄSSER, CHRISTOPH RÜDT, and PAUL FUMAGALLI — Freie Universität, Berlin, Deutschland

Photochromic molecules, such as spiropyrans, can be reversibly switched between two different states, a so-called spiropyran and a merocyanine state, using ultraviolet and visible light. Hence, they can be read and addressed by a light source and thus be used for optical devices. Although this switching behavior is established for a series of photochromic molecules in an isotropic environment like, e.g., solutions [1,2], little is known about thin organic films on surfaces.

Here, thin films of spiropyran derivatives with a thickness between 10 and 40 nm have been prepared using thermal evaporation in UHV on quartz, MgO(100), Si(100), Si(111) and Au-coated Si as substrates. The photochromism of the molecules has been studied using optical absorption spectroscopy in the UV-VIS range. The films on quartz and MgO substrates were measured in transmission, the films on Si and Au-coated Si substrates in reflection. Absorption spectra indicate 80% reversible switching between the spiropyran and the merocyanine state induced by light irradiation. In addition, a setup for time-dependent absorption spectroscopy on a time scale of seconds is presented together with first experimental results.

[1] Berkovic et al., Chem. Rev., **100**, 1741-1753 (2000)[2] Görner, PCCP, **3**, 416-423 (2001)

DS 15.9 Tue 15:00 Poster B

Electrospray Ionization Mass Spectrometry and Vacuum Deposition — NICHIA THONTASEN, ●STEPHAN RAUSCHENBACH, YELIANG WANG, GIOVANNI COSTANTINI, NICOLA MALINOWSKI, and KLAUS KERN — Max-Planck-Institut für Solid State Research, Nanoscale Science Department, Heisenbergstr. 1, 70569 Stuttgart

Scanning Tunneling microscopy offers an atomic scale view of functional molecules and nanostructures at surfaces. In case of large biological molecules or inorganic nanoparticles, their controlled deposition on well defined surfaces under ultra-high vacuum conditions is hindered by their low vapor pressure.

To overcome this limitation electrospray ionization, a soft ionization technique, is used to create an ion beam for soft vacuum deposition. The developed apparatus employs RF- and electrostatic ion optics to control the beam's properties such as energy, focusing and temperature. The ion beam, generated at ambient pressure, is guided through several pumping stages into high or ultrahigh vacuum.

Using time-of-flight mass spectrometry the composition of the beam can be characterized before deposition. The deposition of clusters, large molecules and proteins was demonstrated for high vacuum conditions. Current studies are focusing on the destruction free deposition of molecules and clusters, so called soft landing.

S. Rauschenbach, F. Stadler, E. Lunedei, N. Malinowski, S. Koltsov, G. Costantini, K. Kern, *Electrospray Ion Beam Deposition of Clusters and Biomolecules*, Small **4** (2006)

DS 15.10 Tue 15:00 Poster B

Layer-by-layer growth of Metal-Organic Open Frameworks on a Functionalized Organic Surface — ●OSAMA SHEKHAH, HUI WANG, THOMAS STRUNSKUS, and CHRISTOF WOELL — Ruhr University Bochum, Lehrstuhl für Physikalische Chemie 1, Universitätsstr 150, 44780 Bochum

Using a novel layer-by-layer approach, Metal-Organic Open Frameworks (MOFs) based on benzenetricarboxylic acid (BTC) ligand and Zn(II)-ions were deposited on a COOH-terminated organic surface. The deposited layers were characterized using XPS, IRS, NEXAFS and AFM. AFM data showed the selective deposition of a BTC layer with a height of about 1.6 nm. XPS and IRS data showed the same increase in thickness per layer up to 8 layers. Considering AFM data and the fact that NEXAFS data reveal an orientation of the BTC-units which is mainly perpendicular to the surface, allowed to put a model, yielding a structure of almost vertical layers of the authentic

Zn(II)-BTC MOFs which are interconnected as in the bulk structure by water molecules. Attempts to obtain a powder XRD pattern for MOFs with a thickness of up to 8 layers were unsuccessful, as expected for organic adlayers of small thickness. We could, however, successfully demonstrate the gas-loading properties of a 8-layer MOF by an exchange experiment where the water in the BTC-layer is repeatedly and reversibly exchanged by Ammonia. This layer-by-layer deposition of MOFs on organic surfaces opens up the possibility to synthesize completely new types of MOFs with compositions and structures not accessible by bulk synthesis routes.

DS 15.11 Tue 15:00 Poster B

Creation of microstructured poly(glycidyl-methacrylate) surfaces — ●VIATCHESLAV GRUZDEV, ANTON KIRIY, and MANFRED STAMM — Leibniz Institute of Polymer Research Dresden, Hohe Str. 6, D-10069 Dresden, Germany

Here we describe a novel method for fabricating of microstructured polymer brushes based on grafting of monocarboxylated end-functionalized polymers to the microstructured poly(glycidyl-methacrylate) (PGMA) anchor layer. To achieve desirable morphology of PGMA layer two methods were applied. In the first method solutions of PGMA in different solvents spin-coated onto Si-wafer form porous, chainlike or patched PGMA surfaces. Type and size of PGMA structures depends on used solvent, modification of a substrate, concentration of PGMA and used add-ons. Addition of 1-0.5% (mass.) of 1,4-butandiol to solutions of PGMA greatly increases reproducibility of the method and gives possibility to obtain PGMA structures from different solvents. Second method is based on the phase separation of PGMA/PS blend in thin film. Upon spincoating, blend forms regions of PS and PGMA on the surface. Chemical or thermal fixation of PGMA structures on the surface followed by extraction of PS gives structured PGMA surface. Lateral dimensions of PGMA structures in both methods were in the range of 100-500 nm. Microstructured polystyrene brush and bicomponent PS/P2VP brush have been prepared. Combination of scanning probe microscopy, ellipsometry and contact angle measurements was used to study surface properties and morphology.

DS 15.12 Tue 15:00 Poster B

Sensing investigations of tungsten oxide nano-particle thin films using Impedance Spectroscopy — ●TIM HÜLSER^{1,2}, HARTMUT WIGGERS², SONJA HARTNER¹, and AXEL LORKE¹ — ¹Department of Physics, University of Duisburg-Essen, 47057 Duisburg, Germany — ²Institute of combustion and gas dynamics, University of Duisburg-Essen, 47057 Duisburg, Germany

Tungsten oxide nanoparticles particles are synthesized in a low pressure premixed H₂/O₂/Ar flame reactor using WF₆ as precursor material. The parameters can be adjusted to synthesize WO_x particles with 2.6 < x < 3. Thin films of particles in the size range from 5 nm to 9 nm deposited on interdigital structures are investigated. Impedance spectroscopy on the as-prepared WO_x thin films have been performed under synthetic air and synthetic air with 1000 ppm NO or CO in the range from 553 K to 583 K. The overall impedance data reveal sensitivities of S = 3.8 for CO at 553 K and a maximum of sensitivity S = 5 for NO at 573 K. Fits of the overall impedance data using equivalent circuit reveal two contributions to the overall impedance which are assigned to grain-boundary contacts on the surface of each particle and a semi-conducting core conductivity. Furthermore, we have been able to calculate the sensitivity for both processes separately. From this investigation we show that the sensitivity of the grain boundary contribution in presence of CO exhibits values up to S = 12, much higher than the core sensitivity with S = 2.6 at 553 K. A similar behaviour is observed under the presence of NO.

DS 15.13 Tue 15:00 Poster B

Adsorption of CdTe nanoparticles on Poly(acrylic acid) brushes — ●SMRATI GUPTA¹, PETRA UHLMANN¹, NIKOLAI GAPONIK², and MANFRED STAMM¹ — ¹Leibniz-Institut für Polymerforschung Dresden, 01069 Dresden, Germany — ²Technische Universität Dresden, Institut für Physikalische Chemie und Elektrochemie, 01062 Dresden, Germany

We report on the adsorption of amino functionalized CdTe nanoparticles on Poly(acrylic-acid) (PAA) polymer chains, tethered by one end to an underlying substrate in a polymer brush configuration. PAA brushes were prepared on silica substrate via *grafting to* method and 2-aminoethanethiol stabilized CdTe nanoparticles (2-4 nm) were prepared using the reaction between Cd²⁺ and NaHTe under specific reaction conditions. Functionalized particles were found to get ad-

sorbed on the brushes by the physical interaction between carboxylic groups of PAA polymer chains and amino groups of CdTe nanoparticles. Presence of CdTe nanoparticles on the polymer brushes was confirmed by the Atomic Force Microscopy (AFM), X-ray photoelectron spectroscopy (XPS) and Photoluminescence (PL) spectroscopy. Switching of the modified PAA brushes by changing the pH of surrounding media, explore the use of this system in the fabrication of the sensors.

DS 15.14 Tue 15:00 Poster B

The Growth of Carbon Nanotubes on Prestructured Substrates by Chemical Vapour Deposition — ●THOMAS REICHEL, MATHIAS STEGLICH, and BERND SCHRÖTER — Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Max-Wien-Platz 1, 07743 Jena, Deutschland

Today, carbon nanotubes (CNT) with various parameters like diameter and length, with single or multi walls can be produced using arc discharge, chemical vapour deposition (CVD) and laser ablation methods. A controlled growth of carbon nanotubes with particular properties like chirality at predefined positions is a prerequisite to utilize CNTs in electronic or nanooptical devices. CVD is the favoured fabrication technique to grow CNTs directly on substrates with prestructured catalysts.

Our CVD system allows to grow nanotubes in a large temperature range up to 2000 K with different process gases and gas mixtures. The Fe or Ni catalyst is vacuum evaporated as a thin layer onto the silicon oxide substrate. The nanotubes are characterized by scanning electron microscopy, photoelectron and raman spectroscopy.

DS 15.15 Tue 15:00 Poster B

Magneto-electrolysis of Co nanowire arrays grown in a track-etched polycarbonate membrane — JAIME SÁNCHEZ-BARRIGA^{1,3}, MANUEL LUCAS², ●FLORIN RADU³, GUILLERMO RIVERO¹, PILAR MARIN¹, and ANTONIO HERNANDO¹ — ¹Instituto de Magnetismo Aplicado (UCM-RENFE-CSIC), P.O. Box 155, 28230, Las Rozas, Madrid, Spain — ²Technische Universität Berlin, Institut für Theoretische Physik, Hardenbergstr. 36, D-10623, Berlin, Germany — ³BESSY GmbH, Albert-Einstein Strasse 15, D-12489, Berlin, Germany

Arrays of Cobalt nanowires with a controlled length of 6 μm have been fabricated by electrochemical deposition into the pores of track-etched polycarbonate membranes with a nominal pore diameter of 30 nm. The magnetic properties of Co-deposited nanowires and the effects of a magnetic field applied during electrodeposition of the arrays have been studied. An enhancement of the mass deposition rate due to the presence of a 50 Oe magnetic field along the nanowire axis has been observed by measuring the experimental development of the current in the electrochemical cell during the fabrication process. X-Ray diffraction measurements reveal a different polycrystalline degree for each deposition configuration, indicating that the crystalline structure of the deposited material has been substantially modified. Magnetic measurements show a clear dependence of the anisotropy directions on the orientation of the magnetic field applied during the electrodeposition.

DS 15.16 Tue 15:00 Poster B

Surface plasmonic properties in swift heavy ion (SHI) treated Au, Ag, and Cu based polymer-metal nanocomposite films — ●VENKATA SAI KIRAN CHAKRAVADHANULA¹, CHRISTIAN HANISCH¹, HENRY GREVE¹, DIETMAR FINK², VLADIMIR ZAPOROJTCHEKNO¹, and FRANZ FAUPEL¹ — ¹Chair for Multicomponent Materials, Technical Faculty of CAU Kiel, Kaiserstrasse 2, 24143 Kiel, Germany — ²Hahn-Meitner-Institut, Department SF4, P.O.Box 39 01 28, Glienicke Str. 100, D-14109 Berlin, Germany

Surface plasmonic properties of polymer-metal nanocomposites has gained interest in the field of nanocomposites for optical applications. In the present work, various Au, Ag, and Cu based polymer-metal nanocomposites were prepared by employing a vapor phase co-sputtering technique. Irradiation was performed of these nanocomposites by 350 MeV Au ions with fluences of 1 × 10¹¹, 5 × 10¹⁰, 2.5 × 10¹⁰ and 1.25 × 10¹⁰ at the HMI, Berlin. The characterizations of the optically functional nanocomposite materials were carried out by transmission electron microscopy, energy dispersive X-ray analysis, and UV-visible spectroscopy. The UV extinction spectra of the pristine samples show a sharp absorption maximum at the surface plasmon resonant wavelength according to their geometry and material properties. Depending on the variation in the SHI fluences, changes were observed

in the microstructure and the optical spectra. These will be discussed in terms of ion material interactions.

DS 15.17 Tue 15:00 Poster B

Structural properties of cobalt implanted TiO₂ rutile films — ●NUMAN AKDOGAN¹, ALEXEI NEFEDOV¹, WERNER BECKER², RUSTAM KHAIBULLIN³, LENAR TAGIROV^{3,4}, and HARTMUT ZABEL¹ — ¹Institut für Experimentalphysik IV, Ruhr-Universität Bochum — ²Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum — ³Kazan Physical-Technical Institute of RAS — ⁴Kazan State University

Recently we have reported room temperature ferromagnetism (FM) and in-plane magnetic anisotropy of single-crystalline rutile structures after high dose Co implantation [1]. From the observation of in-plane magnetic anisotropy we concluded that FM in this system results from incorporation of Co ions in the TiO₂ lattice, but co-existence with Co nanoclusters could not be excluded. To clarify this situation we studied the structural properties of Co-doped (100)-oriented rutile TiO₂ single crystals for different implantation doses. Co ions implanted into rutile TiO₂ substrates with energy of 40 keV and implantation dose in the range of 0.25-1.50·10¹⁷ ions/cm². The structural characterization was carried out using synchrotron radiation at the HASYLAB. The specular and off-specular reflectivity measurements probe the implanted Co density profile. In addition, with RBS the depth profile was determined and used for fitting the x-ray reflectivity data. This way a consistent and very good agreement of the fit to the x-ray reflectivity data could be achieved. - Partial support by SFB 491, by RFBR (grant 04-02-97505), and by TUBITAK (project 104T176) is acknowledged. N. Akdogan acknowledges a fellowship through IMPRS-SurMat. [1] N. Akdogan et al., J. Phys.: Condens. Matter. 17, L359 (2005)

DS 15.18 Tue 15:00 Poster B

A transmission electron microscopy study of TiO₂ thin films epitaxially grown on SrTiO₃ and yttria-stabilized zirconia substrates — ●ANDRIY LOTNYK, STEPHAN SENZ, and DIETRICH HESSE — Max Planck Institute of Microstructure Physics

Anatase and mixed (brookite and anatase) TiO₂ thin films deposited on SrTiO₃ (STO) and yttria-stabilized zirconia (YSZ) substrates, respectively, by reactive electron beam evaporation were investigated using high-resolution transmission electron microscopy (HRTEM) and electron diffraction analysis (ED). HRTEM and ED investigations showed that epitaxial anatase thin films were grown on the (100)- and (110)-oriented STO substrates. The anatase thin films consist of grains with low angle grain boundaries showing a rather perfect microstructure of the films. Defects, such as misfit dislocations were found near the anatase/STO interface. The anatase films were transformed into a cubic structure similar to TiO when extensively exposed to the 400 keV electron beam. The crystallographic reason for the epitaxy between anatase films and a perovskite substrate is given. On the other hand, HRTEM investigations showed that a film deposited on (100)-oriented YSZ substrates at a substrate temperature of 600°C consist of mixed epitaxial anatase and brookite grains. (112) anatase twins were found in the film.

DS 15.19 Tue 15:00 Poster B

Time dependent description of thermal effects during transmission of electrons through thin solids — ●WERNER KOCH¹, FRANK GROSSMANN¹, AXEL ROTHER², and RÜDIGER SCHMIDT¹ — ¹Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden — ²Institut für Strukturphysik, Technische Universität Dresden, 01062 Dresden

As it has been shown by Schmidt[1], the coherence length of projectile electrons propagating in Transmission Electron Microscopes (TEM) is of the same order of magnitude as the target thickness. Therefore the modelling of the processes involved in high resolution microscopy by means of a plane wave approach seems too crude an approximation. The purpose of this project is to develop a method to describe this process by propagating localized electron wave packets. A comparison of the incorporation of thermal effects is given between a full ensemble average of independent simulations in frozen lattice approximation and the modelling via the Debye-Waller factor.

[1]: Schmidt, H. 1985: Fakultät der Physik, der Eberhard-Karls-Universität zu Tübingen, Diss.

DS 15.20 Tue 15:00 Poster B

Relaxation effects in NiMnSb-Half-Heusler thin films — ●ANDREAS STAHL, CHRISTIAN KUMPF, and EBERHARD UMBACH — Universität Würzburg, Experimentelle Physik II

Due to its unusual half-metallic properties the Half-Heusler alloy NiMnSb is an important material which may be utilized for the fabrication of spintronic devices. It can be grown in high crystalline quality on InGaAs/InP substrates, however, as for all heteroepitaxial systems mechanical stress is an important factor which influences crystalline quality, film growth, and magnetic properties. One example is a magnetic anisotropy which depends on the thickness of the Half-Heusler layer [1].

It turned out that the properties of the NiMnSb layers are strongly influenced by air. Therefore we present results from two series of samples, one with, the other without an amorphous Au/Ti cap layer. Reciprocal space mapping and x-ray reflectivity measurements were performed at the six-circle-diffractometer at BW2, HASYLAB, Hamburg. Structural properties like the critical thickness for pseudomorphic growth, relaxation, interface roughnesses, and the influence of the capping on these parameters are discussed.

[1] A. Koveshnikov et al.: J. Appl. Phys. **97**, 073906 (2005).

DS 15.21 Tue 15:00 Poster B

Roughness of laser deposited metal / metal oxide layered structures — ●TOBIAS LIESE, ANDREAS MESCHKE, JOHANNA RÖDER, and HANS-ULRICH KREBS — Institut für Materialphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The roughness of laser deposited Ti/MgO and Ag/ZrO₂ layered thin films were investigated by atomic force microscopy (AFM) and X-ray reflectivity (XRR), which are sensitive on the surface and interface roughness, respectively. When depositing the metals, nucleation and island growth occur which first roughen the surfaces with increasing layer thickness. Then, coalescence and island zipping processes reduce the roughness again. Minimal roughness is reached, when the metal layers are just closed. In both systems, the deposition of the metal oxide leads to layer smoothing. The underlying growth processes for single and double layers as well as the reduction of roughness in multilayers are discussed.

DS 15.22 Tue 15:00 Poster B

In-situ surface sensitive X-ray investigations of quench condensed thin metal films — ●CHRISTIAN MARKERT, DIRK LÜTZENKIRCHEN-HECHT, SASCHA GERTZ, and RONALD FRAHM — Bergische Universität Wuppertal, Fachbereich C / Abteilung Physik, Gaußstraße 20, 42119 Wuppertal

We report of ultrahigh vacuum (UHV) experiments on ultra thin Au, Bi and Pb films (thickness less than 10 nm) deposited on atomically flat float-glass substrates which are held at cryogenic temperatures down to 10 K. For deposition temperatures below 100 K the formation of highly disordered or even amorphous metal films can be expected, because thermally activated diffusion of the ad atoms should be inhibited. An UHV chamber was constructed which is suited for grazing incidence X-ray experiments during the quench condensation of the metal films. Various X-ray methods were used for the in-situ investigation of the films growth and their structural evolution with the thickness and an subsequent annealing process. EXAFS (Extended X-ray Absorption Fine Structure) in reflection is used to study the local structure of the films. Furthermore specular and non-specular X-ray reflectivity measurements were performed to get information about the films density and surface roughness parameters (correlation length, hurst parameter etc.). In addition in situ resistivity measurements which are sensitive towards changes of the films microstructure were performed in parallel to the X-ray experiments.

DS 15.23 Tue 15:00 Poster B

Retardation correction for PEM based multi-channel reflectance difference spectroscopy — ●CHUNGUANG HU^{1,2}, LIDONG SUN¹, MICHAEL HOHAGE¹, J. FLORES-CAMACHO¹, PETER ZEPPEFELD¹, and XIAOTANG HU² — ¹Institute of experimental physics, Johannes Kepler University Linz, Linz, Austria — ²Key lab of precision measurement technology and instrument, Tianjin University, Tianjin, China

Reflectance difference spectroscopy (RDS) is a highly surface sensitive optical probe, providing information on the surface structure, morphology, and electronic properties. To realize the fast spectroscopy measurement, several photoelastic modulator (PEM) based multi-channel RDS systems have been developed [1, 2]. A general problem that arises in this type of RDS setup is the wavelength dependence of the PEM. Different from the more conventional setup, for a multi-channel RDS, PEM voltage must be held fixed while all the channels are detected

simultaneously. As a result, the retardation of PEM is unequal for different wavelengths and the optimized condition is only fulfilled for a single wavelength. Consequently, a retardation correction is necessary for other wavelengths. Here, we introduce two generalized methods for the retardation correction in which the wavelength dependence of birefringence coefficient has also been taken into consideration. The result is compared with that reported in [1, 2].

[1] C. Kaspari et al, Phys. Stat. Sol. (b) 242, 2561 (2005).

[2] P. Harrison et al, Meas. Sci. Technol. 12, 2185 (2001).

DS 15.24 Tue 15:00 Poster B

Structural Properties of CoFeB/MgO Magnetic Tunnel Junction Multilayers — ●MIRIANA VADALA, ALEXEI NEFEDOV, GREGOR NOWAK, ARNDT REMHOF, KURT WESTERHOLT, and HARTMUT ZABEL — Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, Germany

The focus of the spintronics community is presently on CoFeB/MgO based Magnetic Tunnel Junctions (MTJs). Tunnel Magneto Resistance values above 200 % at room temperature with a crystalline MgO barrier have already been reported. Depending on the boron content, annealing at low temperatures, typically in the range from 270°C to 360°C, leads to a re-crystallisation of CoFeB. We present results from the characterization of different series of CoFeB/MgO multilayers grown on a Si/SiO₂ substrate, synthesized by ion beam deposition. Key parameters for MTJs are the single-layer thickness, the growth process of the oxide barriers, and the annealing temperatures. They rule the degree of re-crystallization of the CoFeB/MgO together with the interface roughness. Three different growth procedures for the MgO spacer layers have been tested. Polarized neutron reflectivity data confirm that reactive deposition provides the proper stoichiometry for MgO. From X-ray specular and transverse diffuse reflectivities we obtain the structural parameters, namely the layer thickness and the interface roughness. Although the layer thickness does not vary with the annealing procedures, the roughness slightly changes before and after annealing. Financial support provided through the EU-RTN *ULTRASMOOTH*, support by SFB 491 and by BMBF 03ZA6BC1 is acknowledged.

DS 15.25 Tue 15:00 Poster B

Speciation of carbonitride nanolayers — OLAF BAAKE¹, PETER HOFFMANN¹, ANDREAS KLEIN¹, WOLFGANG ENSINGER¹, ●BEATRIX POLLAKOWSKI², BURKHARD BECKHOFF², JAN WESER², GERHARD ULM², NADESHDA FAINER³, MARINA KOSINOVA³, and VALENTINA TRUNOVA³ — ¹TU Darmstadt, Materials Science, Petersenstr. 23, 64287 Darmstadt, Germany — ²Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin, Germany — ³Nikolaev Institute of Inorganic Chemistry SB RAS, 630090 Novosibirsk, Russia

The aim of this work is the determination of the chemical bonds character of novel and technologically relevant layered systems of boron and silicon carbonitrides. Carbonitrides are mainly produced by plasma-enhanced chemical vapor deposition processes with various kind of precursor materials. Having yet not fully understood the behavior of these materials there are still important questions like whether the produced carbonitrides are new materials with well-defined bonds or simply mixtures of carbide and nitrides.

For their speciation, methods like total reflection X-ray fluorescence combined with near edge X-ray absorption fine structure (TXRF-NEXAFS) and X-ray photoelectron spectroscopy (XPS) were employed. Both techniques can substantially contribute to the clarification of the chemical bond structure of the given carbonitride samples.

DS 15.26 Tue 15:00 Poster B

Rauigkeitsanalyse von Cäsiumoberflächen über die Auswertung der Autokorrelationslänge — ●ARMIN FUBEL¹, MARTIN ZECH¹, PAUL LEIDERER¹, JÜRGEN KLIER¹ und VALERI SHIKIN² — ¹Universität Konstanz, Fachbereich Physik, D-78457 Konstanz — ²ISSP, 142432 Chernogolovka, Moskau, Russland

Cäsiumoberflächen, die bei tiefen Temperaturen durch abschreckende Kondensation erzeugt wurden, werden auf Nanometerskala mittels Rastertunnelmikroskopie untersucht. Es wird die Analyse der Oberflächenrauigkeit mit Hilfe der Auswertung der Autokorrelationsfunktion von den Cs-Oberflächen vorgestellt. Um die richtige Autokorrelationsfunktion zu extrahieren, zeigen wir die Bedingung für die laterale Auflösung von Rastersondenmikroskopie (RSM) im Allgemeinen. Dies wird durch ein 'numerisches Experiment' belegt. Darüber hinaus stellen wir einige Methoden vor, wie man höhere Ordnungen der Autokorrelationslänge ableitet, welche benötigt werden, um RSM Bilder

mit nichtzufälliger Verteilung der Rauigkeitsamplituden auszuwerten. Diese charakteristischen Größen der Autokorrelationsfunktion sollten die Schlüsselrolle in weiteren statistischen Berechnungen spielen, z.B. bei der Fragestellung, wie die Oberflächenrauigkeit das Benetzungsverhalten von flüssigem Helium, das auf der Cäsiumoberfläche adsorbiert ist, verändert.

DS 15.27 Tue 15:00 Poster B

Comparative study of PLD and sputtered Pr_{0,68}Ca_{0,32}MnO₃ films: Resistance switching effect at room temperature — ●JULIA FLADERER, PETER MOSCHKAU, SEBASTIAN SCHRAMM, CHRISTIAN JOOSS, and JÖRG HOFFMANN — Institut für Materialphysik, Universität Göttingen

PCMO thin films were grown on SrTiO₃ substrates with an average thickness of 330 nm via ion-beam sputtering and pulsed laser deposition (PLD). A temperature series was carried out to be able to control polycrystalline and epitaxial growth. It was found, that initial resistivity and film strain could also be controlled this way. Both types of films were analysed in via SEM, AFM and x-ray and a systematic comparison of the lattice parameters, twinning and resistivity was performed. The remanent resistance change after applying positive and negative voltage pulses was analyzed at room temperature. In order to study the impact of different preparation techniques on the colossal electro- and magnetoresistance, temperature dependent resistance measurements at different current and magnetic fields are presented for selected samples.

DS 15.28 Tue 15:00 Poster B

Herstellung mittels PLD und Charakterisierung der kristallographischen Eigenschaften von ZnO/YBa₂Cu₃O_{7-x}-Schichtsystemen — ●ROBERT PIETZCKER, VEIT GROSSE, GABRIEL ZIEGER, FRANK SCHMIDL und PAUL SEIDEL — Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Helmholtzweg 5, D-07743 Jena

Zinkoxid (ZnO) ist ein vielseitig einsetzbarer Halbleiter mit großer Bandlücke, dessen Leitfähigkeit durch Veränderung der Sauerstoffkonzentration um mehrere Größenordnungen variiert werden kann.

Im Rahmen der Untersuchung verschiedener Isolatoren für Hochtemperatur-Supraleiter-Dünnschichtsysteme wurden 200-1000 nm dicke ZnO-Schichten mittels PLD epitaktisch auf YBa₂Cu₃O_{7-x} (YBCO)-Schichten auf SrTiO₃ (STO)-Substraten abgeschieden. Der Schichtherstellungsprozess wurde durch Variation des Sauerstoffdrucks (1 - 10 Pa) und der Substrattemperatur (200 - 550°C) auf Kristallinität und Oberflächenmorphologie optimiert.

Oberflächenanalysen mittels SEM und AFM ergaben glatte Schichten mit Rauigkeiten um 8 nm. Mittels Röntendiffraktometrie wurde die Kristallinität der Schichtsysteme analysiert und Halbwertsbreiten der Rockingkurven von ZnO zwischen 1° und 6° ermittelt. Darüber hinaus wurde die Sauerstoffverarmung der YBCO-Schichten bei verschiedenen Abscheideparametern untersucht.

DS 15.29 Tue 15:00 Poster B

Characterisation of praseodymium-oxide films on Si(111) including SPALEED, XRD and GIXRD measurements — ●SEBASTIAN GEVERS¹, THOMAS WEISEMOELLER¹, THOMAS SCHROEDER², PETER ZAUMSEIL², LARS BOEWER¹, CARSTEN DEITER¹, and JOACHIM WOLLSCHLAEGER¹ — ¹Fachbereich Physik, Universität Osnabrück, Barbarastrasse 7, 49076 Osnabrück, Germany — ²IHP Microelectronics, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany

Materials with high dielectric constants k offer great potentialities to improve performance of semiconductor devices. In this context the investigation of praseodymium-oxide films leads to a deeper understanding of fundamental aspects of heteroepitaxial growth of oxide films on Si(111). Object of this research are Si(111) samples on which Pr₂O₃ films of thickness $d \leq 10$ nm have been deposited. The oxide films were produced using MBE, so that the Pr₂O₃ films have hexagonal structure. Afterwards they were annealed in N₂ to form Pr₂O₃ films of cubic structure. Several investigation methods like SPALEED and AES as well as (GI)XRD were used. (GI)XRD investigations were performed at beamlines BW2 and W1 at HASYLAB(DESY). Throughout these experiments a complete transformation of the crystallographic phase from hexagonal-Pr₂O₃ to cubic-Pr₂O₃ (B oriented) could be observed. This can be attributed to the annealing process. The thickness of the crystalline part of the oxide film annealed at higher temperatures decreases. Therefore silicate is formed at the interface. SPALEED investigation shows a 4 × 4 reconstruction at the cubic phase.

DS 15.30 Tue 15:00 Poster B

Infrared in-situ analysis of solid-liquid interfaces — ●KARSTEN HINRICHS¹, KATY ROODENKO¹, and JÖRG RAPPICH² — ¹ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany — ²Hahn-Meitner-Institut Berlin GmbH, Abt. Silizium-Photovoltaik, Kekuléstr. 5, 12489 Berlin, Germany

Polarisation dependent Infrared (IR) spectroscopy and I-V measurements were used for monitoring the etching of silicon oxide and the electrochemical grafting of nitrobenzene on H passivated silicon surfaces. A new type of in-situ cell is presented which allows nanometer thickness sensitivity for investigation of inorganic or organic films at the liquid-solid interface. The spectra taken in the mid infrared spectral range were simulated within an optical model and the etch rate was determined quantitatively.

DS 15.31 Tue 15:00 Poster B

Determination of intrinsic stresses in thin films by nanoindentation — ●OLENA CHKHRAI¹, NORBERT SCHWARZER², and FRANK RICHTER¹ — ¹Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz — ²SIO - Saxonian Institute of Surface Mechanics, Am Lauchberg 2, 04838 Eilenburg

Intrinsic stresses often occur in thin films as a result of the complex formation of the thin film structure. It is well known, that such stresses may influence not only the mechanical behaviour of thin films but - via band-bending - also electrical and optical properties. Therefore, knowledge of mechanical film stresses is desired in many cases.

The aim of this work is to determine intrinsic stresses by means of nanoindentation. One of us (N.S.) has shown [1], that intrinsic stresses can be derived from nanoindentation data by combination of "pure normal" and mixed (normal + tangential) loading, in particular, when the concept of the "effectively shaped indenter" is used.

In order to compare this theory with experiment, a experimental setup was constructed which allows to vary the film stresses in a defined way and then to do nanoindentation. Indentation experiments were performed using a novel device (UNAT, Asmec GmbH) which allows to utilise both normal and tangential loads.

[1] N. Schwarzer: "Determining of intrinsic stresses in layered materials via nanoindentation: the question of in principle feasibility", <http://archiv.tu-chemnitz.de/pub/2006/0018/index.html>

DS 15.32 Tue 15:00 Poster B

Development of a new software tool to characterize mechanical properties in layered structures — ●FERENC MOLNAR¹, NORBERT SCHWARZER², MATTHIAS HERRMANN¹, and FRANK RICHTER¹ — ¹Chemnitz University of Technology, Solid State Physics, 09107 Chemnitz, Germany — ²Saxonian Institute of Surface Mechanics, Am Lauchberg 2, 04838 Eilenburg, Germany

For complicated film structures such as multilayered systems (up to 10 single layers) or films with a gradient Young's Modulus we are developing a new software tool named FILMDOCTOR. It allows us to analyse the elastic stress fields inside these structures under a great variety of loading conditions. The software is based on the theory of image loads, leading to a complete analytical solution of the contact equations for almost arbitrary mixed loading conditions of normal, lateral, tilting and rotating loads together with a specimen definition including intrinsic stresses or gradient Young's Modulus structures. With the help of the effective indenter model we are also able to calculate the Young's Modulus of very thin films even if we get an inelastic response of the specimen during indentation experiments. To verify the analytical calculations we employ FEM-Simulations and experiments with respect to typical loading and specimen conditions. Measurements were done using the Nanotester UNAT which allows to utilise both normal and lateral forces. Results of these comparisons will be shown in this work. Based on the obtained Young's Modulus we are able to calculate the stress fields during indentation such as the Von-Mises stress.

DS 15.33 Tue 15:00 Poster B

Investigations of the mechanical loss of tantala films between 5 and 300 K — ●MATTHIAS HUDL¹, RONNY NAWRODT¹, ANJA ZIMMER¹, SANDOR NIETZSCHE¹, WOLFGANG VODEL¹, ANDREAS TÜNNERMANN², and PAUL SEIDEL¹ — ¹Friedrich Schiller University - Institute of Solid-State Physics, Helmoltzweg 5, D-07743 Jena, Germany — ²Friedrich Schiller University - Institute of Applied Physics, Albert-Einstein-Straße 15, D-07745 Jena, Germany

Mechanical losses in dielectric mirror coatings of interferometric gravitational wave detectors are a main issue for the proposed advanced

generation of gravitational wave detectors. Recent investigations have shown that the mechanical loss of the dielectric mirror coatings (tantala/silica stacks) is probably the main contribution to the detector noise. There are indications that among both coating materials tantala gives the major contribute to mechanical loss. Experimental details of a measuring setup and investigations of the temperature dependency of the mechanical dissipation in thin tantala films on different substrates are presented.

This work is supported by the DFG under contract SFB TR7.

DS 15.34 Tue 15:00 Poster B

Adhesion energy measurements by means of white-light microscopy and controlled-buckling technique — ●EUGEN NIKITIN, ASTRID PUNDT, and REINER KIRCHHEIM — Institut für Materialphysik, Friedrich-Hund-Platz 1, 37077 Göttingen

Adhesion energies determine the attachment of different materials to each other and therefore, are rather important for multi-material stack designs. However, there is a lack of data in this field and existing data vary from each other depending on the method. This can be usually attributed to plastic deformation which accompanies the measurement process. In this contribution, two methods were used to determine adhesion energies between an adhering film (Nb) and a rigid substrate (PC). Both methods use film buckling upon mechanical stress to calculate the adhesion energy. For the first method, applying the theory of Gille and Rau, the cross-sectional buckle-morphologies of straight sided buckles were measured by using a white-light interferometer. The second method, the controlled-buckling-technique, uses the critical hydrogen concentration above which film buckling sets in.[1-2] It will be shown that the two methods give similar results. But, it results also, that the Gille-and-Rau-method is very sensitive to shape variations occurring from local plastic deformations. [1] A. Pundt, P. Pekarsky, *Buckling of thin Nb-films on polycarbonate substrates upon hydrogen loading* Scripta Mat. 48 (2003) 419-423. [2] A. Pundt, E. Nikitin, P. Pekarsky, R. Kirchheim, *Adhesion energy between metal films and polymers obtained by studying the buckling of the film*, Acta Mater. 52 (2004) 1579-1587.

DS 15.35 Tue 15:00 Poster B

Nanocrystalline Diamond films: Morphology, Spectroscopy and Nano-Structuring — ●FREDERIK KLAUSER¹, XIANJIE LIU¹, NORBERT MEMMEL¹, ERMINDALD BERTEL¹, DORIS STEINMÜLLER², and ALEXANDER KROMKA² — ¹Institute of Physical Chemistry, LF University of Innsbruck, Austria — ²rho-BeSt company, Innsbruck, Austria

Raman spectroscopy, atomic force microscopy (AFM), x-ray diffraction (XRD), x-ray photoemission spectroscopy (XPS) and electron energy loss spectroscopy (EELS) were used for the investigation of nanocrystalline diamond films, produced by a modified hot filament CVD method (rho-BeSt process). For diamond deposition, sample pre-treatment is essential to enhance the rate of primary nucleation. The primary nucleation density affects future film roughness and morphology as shown by Secondary Electron Microscopy (SEM) and AFM images. Using specific deposition conditions, the rate of secondary nucleation can be tuned, yielding different diamond crystallite sizes and textures. Grain sizes were determined from XRD peak profiles and AFM images. Depending on the deposition conditions, the films show particle sizes ranging from several hundreds of nanometers down to approximately 5 nm. The change of crystallite size can also be observed by Raman Spectroscopy. However, for the most fine-grained films the Raman signal is determined by the sp² carbon in the grain boundaries, due to its higher Raman cross section. XPS still shows the characteristic diamond loss features and reveals for all films an sp² content below 5%. On Hydrogen-terminated surfaces, nanostructures were grafted using scanning probe methods.

DS 15.36 Tue 15:00 Poster B

Model Experiments concerning the transition from Nanocrystalline Diamond to Microcrystalline Diamond — ●NICOLAS WOEHRL, JUTTA MACK, and VOLKER BUCK — Thin Film Technology Group, Dept. of Physics, University of Duisburg-Essen, Germany

Since over 40 years now diamond films are deposited. Though a lot of work has been done to elucidate the mechanism, the process of diamond deposition - especially the role of surface reactions - is still not fully understood. Because recombination of radicals at the substrate holder - and thus the design of the substrate holder - can influence the properties of the growing film, a mask (3 mm thickness) was introduced on top of the sample for systematical investigation of this effect. Using

this experimental setup, a peripheral growth zone was discovered on the silicon substrates where a different form of diamond was growing. By SEM and Raman analysis of the peripheral zone it was found that the deposited film was nanocrystalline there, while it was microcrystalline at the centre. The dependence of the size of this peripheral zone on the substrate from process parameters such as pressure, gasflow and methane fraction in the process gas was investigated. Based on these experiments a model is proposed that explains the results by arguing with the depletion of hydrogen in the gas phase due to recombination effects at the side walls of the substrate holder.

DS 15.37 Tue 15:00 Poster B

Annealing behaviour of hydrogenated and oxidized nanocrystalline diamond — MAXIM EREMTCHENKO¹, JENS UHLIG¹, MARTIN FINSTERBUSCH¹, ●ROLAND KOCH¹, ANITA NEUMANN¹, SYED IMAD- UDDIN AHMED¹, JOSE A. GARRIDO², MARTIN STUTZMANN², and JUERGEN A. SCHAEFER¹ — ¹Institut für Physik und Institut für Mikro- und Nanotechnologien, Technische Universität Ilmenau, P.O. Box 100565, 98684 Ilmenau, Germany — ²Walter Schottky Institute, Technical University Munich, Am Coulombwall 3, D-85748 Garching, Germany

Hydrogenated and oxidized Nanocrystalline Diamond (NCD) is a very promising material for future electronic, especially bioelectronic applications. In the past it has been shown that hydrogen, oxygen, and gases from the ambient environment as well as water can be responsible for causing drastic changes in surface conductivity and wettability (hydrophobicity, hydrophilicity), friction, wear, etc. In this contribution we have investigated differently prepared NCDs as function of the annealing temperature under ultrahigh vacuum conditions (UHV) with various electron spectroscopies like UPS and XPS as well as High Resolution Electron Energy Loss Spectroscopy (HREELS). We were able to identify the thermal stability of a number of different species at the interface, which are related to different characteristics of C-H, O-H, C-O, and C-C bonding. Finally, a carbonization of the interface appeared at higher annealing temperatures.

DS 15.38 Tue 15:00 Poster B

Measuring and tailoring the intrinsic stress in amorphous carbon films — ●OLEKSIY FILIPOV, NICOLAS WOEHL, and VOLKER BUCK — Thin Film Technology Group, Dept. of Physics, University of Duisburg-Essen, Universitätsstr. 3-5, 45141 Essen, Germany

Amorphous hydrogenated carbon a-C:H and non-hydrogenated a-C films are DLC materials characterized by attractive mechanical, optical and chemical properties. One of the biggest problems that affect the application of the DLC films is a very high compressive stress developed during the film deposition. Intrinsic stress is a critical parameter in thin film deposition and very important for different applications of DLC films especially tribological and biomedical coatings.

In order to adjust DLC films properties, they were deposited in UHV chamber onto different types of substrates such as a glass, polished Si(100) and steel by using PVD DC-anodic arc deposition method. The intrinsic stress in the deposited DLC films was measured ex-situ by determining the substrate curvature using SSIOD method. The variation in process parameters such as substrate bias and gas admixture is used to investigate the influence onto the intrinsic stress of deposited films. The plasma parameters were monitored during deposition by ion energy analyser and mass-spectrometer. The structural properties of the deposited DLC films, mostly sp³/sp² ratio, were characterized by Raman Spectroscopy and by FTIR.

It is shown that the intrinsic stress in the DLC films can be varied in a wide range from compressive to tensile just by variation of the deposition parameters.

DS 15.39 Tue 15:00 Poster B

FEM Simulation of the Laser Plasma Interaction during Laser Nitriding — ●DANIEL HÖCHE¹, GERD RAPIN², and PETER SCHAAF¹ — ¹Universität Göttingen, II. Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — ²Universität Göttingen, Institut für Numerische und Angewandte Mathematik, Lotzestr. 16-18, 37083 Göttingen, Germany

Laser nitriding of materials is based on the interaction of short pulsed laser radiation with the treated material and the resulting laser plasma [1]. The process is very promising for the formation of surface coatings with superior properties. Due to the short interaction times and the thin surface films an experimental observation of the underlying processes is very difficult. In order to access the basic mechanism, FEM simulations of laser heating, evaporation, plasma formation and expansion, plasma composition and interaction with the materials sur-

face have been performed. As a result, evaporation and expansion velocities, pressure balances and dissociation degrees have been derived. The results give a better insight into the physical processes and dependencies of the coating formation. In addition, the adsorption of nitrogen into the surface can be described as a function of process parameters. This finally allows an optimization of the coating formation. The numerical results are compared with experimental results obtained by FEL laser nitriding of titanium in nitrogen atmosphere [2].

[1] P. SchAAF. Progress in Materials Science 42 (2002) 1-161.

[2] D. Höche, M. Shinn, G. Rapin, E. Carpena, P. SchAAF. J. of Physics D: Applied Physics (2006) in print.

DS 15.40 Tue 15:00 Poster B

Influence of different halides and oxygen on BN thin film deposition — ●SARAH PANOWITZ, JENS MATHEIS, and ACHIM LUNK — Institut für Plasmaforschung, Universität Stuttgart, Pfaffenwaldring 31, D-70569 Stuttgart

Cubic boron nitride (c-BN) is a material with various fields of applications due to its high hardness, chemical inertness and the possibility for p- and n-doping. c-BN can be produced by high-pressure-high-temperature process, plasma enhanced physical vapor deposition as well as by plasma enhanced chemical vapor deposition. With the last mentioned method c-BN films with low internal stress can be produced. Therefore modeling of the chemical route was performed with "CHEMFIN" to restrict the parameter compositions.

The contribution is divided into two parts. In part I deposition of boron nitride is calculated at conditions in thermodynamic equilibrium. In the equilibrium model we have studied the system B-N-H-X where X represents F, Cl, Br or O. While the flow B, N, H was kept constant according to experimental conditions the flow of the halides and oxygen was varied in a wide range. The formation of BN decreases sensitively going from bromine to fluorine. In the case of oxygen B₂O₃ will be produced additionally in a wide temperature range. Only in a small parameter range the formation of B₂O₃ can be prevented during BN deposition. Part II includes the comparison of the calculated results in the thermodynamical equilibrium with the experiments.

DS 15.41 Tue 15:00 Poster B

Spectroscopic ellipsometry study of thin diffusion barriers of TaN and Ta for Cu interconnects in integrated circuits — ●SUKUMAR RUDRA¹, MARION FRIEDRICH¹, SINDU LOUIS¹, OVIDIU GORDAN¹, THOMAS WÄCHTLER², and DIETRICH ZAHN¹ — ¹Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany — ²Chemnitz University of Technology, Centre for Microtechnologies, D-09107 Chemnitz, Germany

The objective of this work is to study the optical and electrical properties of tantalum nitride and tantalum barrier thin films against the copper diffusion in integrated circuits using spectroscopic ellipsometry in the VUV and UV-Visible range. Single layers of tantalum nitride, bilayer of Ta/TaN and tri-layer of Cu/Ta/TaN were produced on Si (111) substrates with a native oxide layer using the technique of sputtering. The dielectric functions were modelled using effective medium approximation (EMA) and Drude-Lorentz model to obtain informations regarding film thickness, film composition, surface roughness, mean free path and electrical resistivity. It was observed that for the thicker layer of Ta on TaN, contribution of α -phase is higher than that of the β -phase of Tantalum. Depositions of Cu on Ta were also done using other techniques of chemical vapour deposition (CVD) and atomic layer deposition (ALD) at different temperatures and ambient. It was observed that a small change in deposition temperature give rise to a pronounced change in the dielectric functions and hence in the film morphology.

DS 15.42 Tue 15:00 Poster B

Band Bending Investigation of Ag/S-GaAs(100) Schottky Contacts by Raman Spectroscopy — ●STEVE PITTNER and DIETRICH ZAHN — Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany

Raman spectroscopy is a powerful tool to study in situ the growth processes of Schottky contacts [1]. It also can be used to determine band bending changes in GaAs [1].

In this investigation the band bending changes of n- and p-doped GaAs are monitored a sulfur passivation with a S₂Cl₂ + CCl₄ (1:3) solution during the formation of a Ag/S-GaAs Schottky contact. The sulfur passivation changes the position of acceptor and donor levels in the band gap and the deposition of Ag on S-GaAs creates metal in-

duced gap states (MIGS) within the gap. The new charge distribution at the surface leads to change in the width of the depletion layer. This yields a change of the intensity of the longitudinal-optical phonon (LO-Phonon) in the depletion layer and the coupled Plasmon-LO-Phonon (PLP) mode in the bulk of GaAs. Thus the band bending can be calculated, using the ratio of both elementary Raman excitations [2].

This technique was used to determine the band bending induced by the sulfur passivation and the subsequent annealing process as well as the formation of a Ag/GaAs Schottky contact for both n- and p-doped GaAs substrates.

[1] Salvan G., PhD. Thesis TU Chemnitz (2003)

[2] Geurts J., Surf. Sci. Rep., 18, (1993), 1

DS 15.43 Tue 15:00 Poster B

Production and characterisation of bandwidth- and phase-optimised La/B₄C- and Cr/Ti-multilayer-mirrors for the reflection of ultra short XUV-pulses — ●STEFAN HENDEL¹, MARC D. SACHER¹, WIEBKE HACHMANN¹, ULF KLEINEBERG², and ULRICH HEINZMANN¹ — ¹Department of Physics, Bielefeld University, 33615 Bielefeld — ²Department of Physics, LMU Munich, 85748 Garching

The applicability of reflective optical components for the soft X-ray region depends upon the existence of multilayer-optics. In particular the optimisation of multilayers for the soft X-ray spectral range calls for new material combinations. For the photon energy range of about 180 eV Lanthanum (La) is favoured as the absorber material and Boroncarbide (B₄C) as the spacer material, for the region above 300 eV Chromium (Cr) and Titanium (Ti) are the preferred materials. Thin periodic layer systems of those materials with double layer periods of 3.5 nm (La/B₄C) and < 2 nm (Cr/Ti) have been produced by UHV Electron Beam Evaporation (combined with Ion Polishing) and Ion Beam Sputtering. The characterisation of the layer purity is done by ex-situ Sputter Auger Spectroscopy, whilst structural analysis is performed by X-ray Diffraction, Transmission Electron Microscopy and at-wavelength reflectivity measurements with Synchrotron radiation. A further goal is the production of aperiodic (chirped) multilayers which exhibit an optimised spectral bandwidth and spectral phase required for the reflection of ultra short soft X-ray pulses from High Harmonic Sources. We report on first experimental results as well as corresponding simulations.

DS 15.44 Tue 15:00 Poster B

The structure and composition of oxidized and reduced tungsten oxide films — ●CHRISTOPH RAMESHAN, SIMON PENNER, BERNHARD KLÖTZER, XIANJIE LIU, and FREDERIK KLAUSER — Institut für Physikalische Chemie Universität Innsbruck, Innrain 52a, A-6020 Innsbruck

The structure, morphology and composition of pure WO₃ thin films deposited onto vacuum-cleaved NaCl(001) single crystals were studied at substrate temperatures up to 580 K and under different oxidative and reductive treatments in the temperature range 373-873 K by transmission electron microscopy (TEM), selected-area electron diffraction (SAED) and x-ray photoelectron spectroscopy (XPS). A transition from an amorphous structure obtained after deposition at 298 K to a more porous structure with small crystallites at the highest substrate temperatures was observed. XPS spectra reveal the presence of W₆⁺ irrespective of the preparation procedure. Significant changes in the film structure were only observed after an oxidative treatment in 1 bar O₂ at 673 K, which induces crystallization of a monoclinic WO₃ structure. After raising the oxidation temperature to 773 K, the film shows additional reconstruction and a hexagonal WO₃ structure becomes predominant. This hexagonal structure persists at least up to 873 K oxidation temperature. However, these structural transformations observed upon oxidation were almost completely suppressed by mixing the WO₃ thin film with a second oxide, e.g. Ga₂O₃. Reduction of the WO₃ films in 1 bar H₂ at 723-773 K induced the formation of the β-W metal structure, as evidenced by SAED and XPS.

DS 15.45 Tue 15:00 Poster B

Optimization of optical properties of thermochromic VO₂ films — GANHUA FU, ●JENNIFER STIEBICH, ANGELIKA POLITY, NIKLAS VOLBERS, and BRUNO KURT MEYER — 1. Physikalisches Institut, Justus Liebig Universität Giessen

Vanadium dioxide shows a thermally induced semiconductor-metal phase transition at 68°C. Especially the related change in the optical properties enables many applications in infra-red light (IR)-switching or bolometric devices or as "intelligent" energy conserving window coating. For certain applications the transition temperature has to be

tuned and the transmittance in the visible and infra-red spectral range should be optimized. An appropriate way to achieve the required properties is doping. We studied a series of VO₂ layers prepared by radio frequency sputtering and doped by an additional solid in the target or by a reactive gas used in the deposition process. The optical switching properties were evaluated from wavelength and temperature dependent transmission measurements. The crystal structure of the films was studied by X-ray diffraction (XRD) and the composition of the layers was determined by energy-dispersive X-ray analysis (EDX) and secondary ion mass spectroscopy (SIMS).

DS 15.46 Tue 15:00 Poster B

First-principles characterization of charged oxygen vacancies in cubic HfO₂ — STEPHAN KREMERS¹, ●JÖRG NEUGEBAUER², MATTHIAS WUTTIG¹, and BLAZEJ GRABOWSKI² — ¹I. Physikalisches Institut (1A), RWTH Aachen, 52056 Aachen — ²Max-Planck-Institut für Eisenforschung, GmbH Max-Planck-Straße 1, 40237 Düsseldorf

HfO₂ is a prominent candidate for applications necessitating the use of high-k dielectrics. It could e.g. replace SiO₂ layers in small-sized metal-oxide semiconductor devices (MOS). Thus the electrical and structural properties of HfO₂ have to be investigated. Using first principles methods, the properties of charged oxygen vacancies in cubic HfO₂ have been analysed, because they are probably one of the major traps contributing to charge trapping in HfO₂. Although the cubic phase is the high temperature phase, it is frequently found in HfO₂ thin films. With the help of supercell calculations the formation energy of differently charged oxygen vacancies in this phase are determined. This will help to understand the nature of defects in this material and consequently to understand the electrical properties. Differently charged states (-2, -1, 0, +1 and +2) of the defect systems have been relaxed with an optimisation algorithm and a bandstructure calculation of HfO₂ bulk has been performed. With these calculations we intend to study the nature of the defect levels in the band gap, e.g. whether they show negative-U behaviour. This can help to understand the electronic transport mechanism in HfO₂.

DS 15.47 Tue 15:00 Poster B

Polarization coupled response of ZnO-BaTiO₃ heterojunctions: A model approach — ●VENKATA VOORA¹, TINO HOFMANN¹, MATTHIAS BRANDT², MATHIAS SCHUBERT¹, MICHAEL LORENZ², and MARIUS GRUNDMANN² — ¹Department of Electrical Engineering, University of Nebraska-Lincoln, Lincoln, Nebraska, USA — ²Institut für Experimentelle Physik II, Universität Leipzig, Leipzig, Germany

Heterojunctions composed of wurtzite-structure ZnO and perovskite-structure BaTiO₃ are very interesting because of the observed ionic lattice charge polarization coupling at their interface, which bears large potential for future device applications. Here we report on polarization hysteresis measurements on ZnO-BaTiO₃ heterostructures with Pt front and back contacts deposited by pulsed laser deposition on (001) silicon substrate. The electrical data are analyzed using a physical model that accounts for the switchable spontaneous polarization of BaTiO₃ and the non-switchable spontaneous polarization of ZnO. In this model we have implemented a polarization dependent net-interface-charge driven depletion layer, which represents the experimentally observed rectifying behavior of the heterostructure. We find a good agreement between our model generated data and our experiment, and we identify switching voltages and their conditions for the incompletely polarized ferroelectric ionic lattice polarization. We use our model to predict design of such heterostructures for switchable resistance and memory device structures. The influence of physical model parameters on the ZnO-BaTiO₃ heterojunction characteristics will be discussed.

DS 15.48 Tue 15:00 Poster B

Functional oxide films patterned by soft-lithography — ●OLE FRIDTHJOF GÖBEL, SAJID ULLAH KHAN, JOHAN EVERT TEN ELSHOF, and DAVID HERMANUS ADRIANUS BLANK — Inorganic Materials Science Group, University of Twente, the Netherlands

Soft-lithographic techniques, e.g. micromoulding in capillaries (MIMIC), have been applied to relief-pattern sol-gel precursor solutions for functional oxides such as TiO₂, BaTiO₃, or CoFe₂O₄. Subsequent heat treatment yields patterned oxide films, patterns being parallel lines or grids. The periodicities of the patterns amount typically a few micrometers. Unlike with standard micromoulding, with MIMIC the relief-patterned mould is in contact with the substrate before applying the precursor solution, such that the formation of a thin residue layer between the pattern features is avoided. Since, however, MIMIC

is restricted to patterns with interconnected features, inverse MIMIC must be applied to create patterns of isolated features: In a first step, a negative image of the final pattern is created in a fully organic polymer (e.g. poly(urethane)) by MIMIC, yielding a grid-patterned film with pits, the bottom of which is the substrate. In a second step, the isolated pits in the polymer film are filled with the precursor solution. To improve the patterning process in MIMIC, the physical properties of the surfaces of the elastomeric moulds have been modified. Besides sol-gel precursors, also suspensions of TiO₂ nanoparticles have been used to reduce film shrinkage.

DS 15.49 Tue 15:00 Poster B

Deposition of Metal-Oxide Particles by Spray Pyrolysis — ALEXANDRE SANTOS ABREU, ●MATTHIAS KNOLL, REINHARD TIDECKS, and SIEGFRIED HORN — Universität Augsburg, Institut für Physik, Lehrstuhl für Experimentalphysik II, Universitätsstraße 1, 86159 Augsburg

Metal-oxide coatings play a key role in state-of-the-art applications in optics and as diffusion barriers. For these applications, an adequate adhesion of the coating, a sufficient thermal and mechanical stability, as well as an excellent chemical stability is necessary. Most properties of the coatings are affected by their morphology and by the growth of the interface layer.

Yttria and alumina particles and coatings were deposited using the Spray Pyrolysis method. For this purpose, an ultrasonically nebulised metal-salt-solution is disposed by a carrier gas into a tubular furnace, in which the oxidation to the metal-oxide takes place. Spherical particles arising during this process are deposited on a soda-lime glass-substrate in the furnace or in a glass-fiber-filter at the outlet of the furnace. By oxidising the aerosol on the soda-lime glass-substrate, thin metal-oxide-coatings can be fabricated. The deposited particles and coatings were investigated using SEM, XPS, XRD and TEM.

The growth of the coating and the deposition mechanism of the particles are influenced by several parameters. By varying these parameters (e.g. the concentration of the solution, the mass flow of the carrier gas, the furnace and substrate temperature), the morphology of the coatings could be controlled.

DS 15.50 Tue 15:00 Poster B

Nanoscaled surface structures on Silicon induced by low energy sputtering under different angles — ●RAPHAEL NIEPELT, KLAUS JESIEK, KUN ZHANG, CARSTEN RONNING, and HANS HOFSAESS — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

The balance between surface roughening by sputtering and smoothing by atomistic diffusion leads to the formation of periodic nanoscaled ripples on surfaces upon ion irradiation. We investigated the surface morphology of Xe-irradiated Si(100) surfaces, using an ion energy of 2-5 keV under angles from 0° up to 85° and fluences between 2·10¹⁶ cm⁻² and 1·10¹⁸ cm⁻². Characteristic patterns were observed with different wavelengths for angles above 60°. Below this angle no ripples were detected, which is in contrast to existing literature. This discrepancy might be owing to different ion fluxes; therefore we will present first results obtained using a microbeam with varying fluxes over several orders of magnitude.

DS 15.51 Tue 15:00 Poster B

Ion induced self-organization on pre-patterned Si surfaces — THERESA LUTZ, ●BASHKIM ZIBERI, RENATE FECHNER, DIETMAR HIRSCH, KLAUS ZIMMER, FRANK FROST, and BERND RAUSCHENBACH — Leibniz-Institut für Oberflächenmodifizierung e. V., 04318 Leipzig

Due to the simplicity of the method, and the possibility to produce large-area nanostructured surfaces self-organization induced by low-energy ion beam erosion offers an alternative, simple and cost-efficient route for nanostructuring of surfaces. Especially the short-range order of the formed nanostructures can be quite high. However, usually this self-organization process lacks long-range order and positional control of the pattern. One possibility to improve this ordering is a appropriate choice of erosion conditions to achieve a long range ordering of the dot or ripple structures. Another possibility to influence the ordering of structures is by using pre-patterned substrates. In this way due to spatial limitations and guided by the lateral ordering of the pre-patterned templates the evolving topography shows an improved ordering. Additionally, an improved positional control can be achieved. In this work the fabrication principle also known as guided self-organization is applied to form ripple and dot pattern on pre-patterned Si surfaces during low energy (≤ 2000 eV) Kr⁺ and Xe⁺ ion beam erosion.

DS 15.52 Tue 15:00 Poster B

GISAXS and GID studies of ripple and dot pattern on Si and Ge surfaces by low-energy ion beam erosion — ●BASHKIM ZIBERI¹, FRANK FROST¹, GERADINA CARBONE², TILL METZGER², and BERND RAUSCHENBACH¹ — ¹Leibniz-Institut für Oberflächenmodifizierung e. V., 04318 Leipzig, Germany — ²ID 01, ESRF, Grenoble, France

Low-energy ion beam erosion of solid surfaces is a very effective alternative approach for the generation of self-organized nanostructures. Under certain conditions, sputtering can produce well-ordered patterns, like ripples or dots on Si and Ge surfaces. In this contribution GISAXS (Grazing Incidence Small Angle X-ray Scattering) and GID (Grazing Incidence Diffraction) techniques are used to study the periodicity, ordering and lateral correlation of nanostructures formed by low-energy ion beam erosion on Si and Ge surfaces ($E_{ion} \leq 2000$ eV). While GISAXS gives information about structures on the surface, GID enables us to study the crystalline structure of nanostructures. The beam spot (along the sample) for the experiments was few millimeters in size. The measurements indicate the high lateral ordering of nanostructures and the strong correlation between the amorphous part of nanostructures and the crystalline interface. The results show that the ripple are aligned perpendicular to the incoming ion beam and the orientational ordering of ripples increases with increasing ion fluence. Further, the results demonstrate the asymmetric shape of ripples. Additionally, the long range hexagonal ordering of dots covering the whole sample surface as observed with atomic force microscopy is verified.

DS 15.53 Tue 15:00 Poster B

Modification of Solid Surfaces by Slow Highly Charged Ions — ●RENE HELLER and STEFAN FACSKO — Inst. für Ionenstrahlphysik u. Materialforschung, Forschungszentrum Dresden/Rossendorf, Dresden, Germany

Due to their high amount of potential energy highly charged ions induce various changes in morphology and electronic structure of solid surfaces. The potential energy which is the sum of the ionization energies of all removed electrons, is released on a very small localized area of a few nm² and in very short times of tens of fs. Hence the power density deposited into the surface can reach values of up to 10¹⁴ Wcm⁻² depending on the ions incident charge state. The changes in surface topology depend strongly on the electronic excitation in the surface which is the main reason for the big differences in the hillock formation on insulators and on conductors. Focus of our investigations is to observe the influence of the incident ions charge state, the kinetic energy and ion species on the hillock formation process for both kinds of materials.

We present systematic scanning probe microscopy studies of surface modifications induced by single ion impact. Insulating and conducting samples were irradiated with ions of argon ($q = 1 \dots 16$) and xenon ($q = 1 \dots 40$). The diameter and the height of the created nano structures were investigated in dependence on the ion charge state and the kinetic energy.

DS 15.54 Tue 15:00 Poster B

Modifizierung von medizinischen CoCr-Legierungen mit PIII — ●JOHANNA LUTZ^{1,2}, ANTJE LEHMANN² und STEPHAN MÄNDL² — ¹Translationszentrum regenerative Medizin, Universität Leipzig, Leipzig — ²Leibniz-Institut für Oberflächenmodifizierung, Leipzig

Stickstoffimplantation in CoCr-Legierungen mit hohen Fluenzen bei erhöhter Temperatur führt zur Ausbildung einer dicken Oberflächenschicht mit Stickstoffgehalten bis zu 30 at.%. Als Verfahren wurde die Plasmaimmersionionenimplantation bei einem Hintergrunddruck von 0.1 bis 1 Pa bei einer Plasmadichte von etwa 5 - 10 × 10¹⁰ cm⁻³ verwendet. Unterhalb von 450 °C findet sich eine thermisch aktivierte Diffusion mit einer Aktivierungsenergie von ungefähr 0.6 eV. Für höhere Temperaturen beobachtet man jedoch eine Sättigung der Schichtdicke, unabhängig von Stickstofffluenz bzw. Behandlungszeit. Untersuchungen zur Menge des eingebauten Stickstoffs bzw. der Druckabhängigkeit legen den Schluss nahe, dass neben der Implantation eine erhöhte Stickstoffaufnahme aus der Gasphase vorhanden ist, die dann bei höheren Temperaturen die Prozesskinetik begrenzt.

DS 15.55 Tue 15:00 Poster B

Nitriding of Fe-Cr-Ni thin films by ion implantation — ●DARINA MANOVA and STEPHAN MÄNDL — Leibniz-Institut für Oberflächenmodifizierung, Leipzig

Nitriding of austenitic stainless steel is a process leading to the formation of thick modified layers by an unusual fast nitrogen diffusion, which is investigated and applied for many years. Additionally, a varying nitrogen diffusion by 4–5 orders of magnitude is reported in the literature, depending on the microstructure. However the investigations are performed predominantly on rolled samples or heavily distorted bulk samples. Here, thin Fe-Cr-Ni films with a thickness of 500 nm and more were synthesized using ion beam sputter deposition from an austenitic stainless steel target (AISI 304, respective DIN 1.4301). Low energy implantation and plasma immersion ion implantation were performed to insert the nitrogen ions into the films at different temperatures and ion energies. The modified layers were investigated by SIMS, TEM and XRD. The diffusion rate was calculated from SIMS measurements. The microstructural and phase composition changes were estimated from XRD and TEM measurements.

DS 15.56 Tue 15:00 Poster B

Controlled ion bombardment during sputter-deposition of thin films — ●EVELYN SCHEER, DOMINIK KÖHL, DANIEL SEVERIN, and MATTHIAS WUTTIG — I. Physikalisches Institut, RWTH-Aachen, D-52056 Aachen

We present a setup that enables the in-situ bombardment of growing films with ions from a broad-beam ion source. An additional ion source has been mounted to an existing sputter-chamber such that simultaneous bombardment during deposition is possible at an angle of incidence of 45° with respect to the substrate normal. The ion source can be operated with various gases. This allows a detailed study of the film growth. Thereby the ion energy can be varied between 100 eV up to 2 keV with ion current densities of up to 100 $\mu\text{A}/\text{cm}^2$.

Various techniques, such as x-ray diffraction, x-ray reflectometry, spectroscopic ellipsometry and electrical measurements, have been employed to investigate the effects of the bombardment. A correlation between film properties and the deposition parameters such as ion flux and ion energy provides the means for tailoring films with desired functionalities.

DS 15.57 Tue 15:00 Poster B

Structure modification of sputtered oxide films upon oxygen ion bombardment — ●CHRISTOPH ANGERHAUSEN, DOMINIK KÖHL, DANIEL SEVERIN, and MATTHIAS WUTTIG — I. Physikalisches Institut IA, RWTH Aachen, 52056 Aachen, Germany

Tailoring the structural properties of transition metal oxides is often fundamental to produce films with specific, desired functionalities. Frequently for such applications sputtering is used as the deposition technique of choice. Upon reactive sputtering of many transition metal oxides the generation of negatively charged oxygen ions at the target surface is observed. These ions are accelerated in the cathode dark space and bombard the growing film. J. Ngaruiya [APL] has shown that the resulting bombardment of the growing film leads to modifications in various film properties, in particular in the resulting film structure. While the flux of negative oxygen ions is related to the oxygen partial pressure it can not be controlled independently. To circumvent this shortcoming, an ion gun was implemented into a sputter chamber. This enabled a controlled bombardment by oxygen ions with well defined energy and current density.

In this presentation the effect of the impact of oxygen ion bombardment on the growing film is demonstrated. The flux of negative oxygen ions from the target surface to the substrate has been shielded. Hence the film is only bombarded by oxygen ions from the separate ion gun. Examinations of the structure allow the definition of thresholds in ion energy and current density above which a significant modification of the film structure is observed.

DS 15.58 Tue 15:00 Poster B

Ni-Filme in reaktiven Plasmen — MARION QUAAS¹, OXANA IVANOVA², CHRISTIANE HELM² und ●HARM WULFF¹ — ¹Institut für Biochemie, Universität Greifswald, Soldmannstraße 23, 17489 Greifswald — ²Institut für Physik, Universität Greifswald, Jahnstraße 16, 17489 Greifswald

20 nm dicke Ni-Filme mit einer mittleren Domänengröße von 7 nm werden in einem Mikrowellen-Plasma (SLAN, 700 W) abwechselnd im Ar/H₂ und Ar/O₂ Gasstrom behandelt. Die chemischen Umsätze und die kinetischen Prozesse bei der Plasma-Wand-Wechselwirkung werden durch die Kombination von Röntgenreflektometrie, Röntgendiffraktometrie im streifenden Einfall (GIXD) und Rasterkraftmikroskopie (AFM) untersucht.

Drei verschiedene Prozesse lassen sich bei der Plasmabehandlung

beobachten:

- partielles Verdampfen und Kristallwachstum der Ni Teilchen im Ar/H₂ Plasma
- Oxidation von Ni zu NiO im Ar/O₂ Plasma bis zu einem Massenverhältnis von 40/60 NiO/Ni
- Reduktion von NiO im Ar/H₂ Plasma.

Der Reaktionsschritt a) ist irreversibel, die Oxidations- und Reduktionsprozesse können beliebig oft wiederholt werden. Die Reduktionsprozesse verlaufen wesentlich schneller als die Oxidationsreaktionen. Allerdings verläuft die erste Oxidation deutlich langsamer als die nachfolgenden. Die kinetischen Prozesse werden quantifiziert und diskutiert.

DS 15.59 Tue 15:00 Poster B

Deposition von TiN_x-Schichten durch reaktives Sputtern in einer DC-Magnetronentladung — ●STEFAN WREHDE¹, MARION QUAAS², ROBERT BOGDANOWICZ³, HARTMUT STEFFEN⁴, HARM WULFF² und RAINER HIPPLER¹ — ¹Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, Felix-Hausdorff-Straße 6, 17489 Greifswald — ²Institut für Chemie und Biochemie, Ernst-Moritz-Arndt-Universität Greifswald, Felix-Hausdorff-Straße 4, 17489 Greifswald — ³Department of Optoelectronics and Electrical Systems, Gdansk University of Technology, ul. G. Narutowicza 11/12, 80-952 Gdansk, Polen — ⁴Institut für Niedertemperatur-Plasmaphysik, Felix-Hausdorff-Straße 2, 17489 Greifswald

In einem reaktiven DC-Magnetron-Plasma (Arbeitsgas Argon, Reaktivgas Stickstoff) wurden unter verschiedenen Bedingungen TiN_x-Schichten abgeschieden. Reaktivgasfluss, Entladungsleistung und Betriebsmodus des Magnetrons ("balanced" bzw. "unbalanced") wurden variiert. Die chemische Zusammensetzung und die Struktur der abgeschiedenen Schichten wurden mit Hilfe verschiedener Röntgenanalyseverfahren (XPS, GIXR, GIXD) untersucht. Hierbei wurde fest gestellt, dass vor allem der Betriebsmodus des Magnetrons wesentlichen Einfluss auf die Depositionsrate und den Stickstoffeinbau in die Schichten hat. Durch weitere Analyse mittels spektroskopischer Ellipsometrie (SE) und Fitten der hieraus erhaltenen Daten (optisches Modell mit Bruggemann-Näherung und Lorentzoszillator) konnten die Resultate der Röntgenverfahren bestätigt und um Informationen über die optischen Eigenschaften der Schichten erweitert werden.

DS 15.60 Tue 15:00 Poster B

The Influence of Cross-Magnetron Effect on the Functional Film Properties of ITO Thin Films — ●RONNY KLEINHEMPPEL, HARTMUT KUPFER, THORALF DUNGER, THOMAS WELZEL, BENJAMIN GRAFFEL, and FRANK RICHTER — Chemnitz University of Technology, Institute of Physics, D-09107 Chemnitz

For industrial applications reliable and lateral homogeneous properties of thin films are required. In the case of display applications of ITO films a high transparency and a constant low electric film resistivity are indispensable preconditions. Typically, these films are deposited by magnetron sputtering. This method, however, shows some inherent inhomogeneities in process properties. Using dual-magnetron sputtering and rectangular targets the Cross-Magnetron Effect (CME) occurs. This is an inhomogeneity of the plasma along the torus which results in an anomalous target erosion as well as modified film properties.

To characterise the CME more detailed the correlation between the distribution of the process parameters and the functional film properties was investigated. ITO films were deposited in a pulsed dual-magnetron discharge reactively from metallic In:Sn (90/10) targets in the transition mode. Statically deposited films show a lateral variation of the optical transparency and the electrical resistivity. The distribution could be correlated with results of plasma property and thermal load measurements. The investigations revealed that the main mechanisms influencing the film properties due to CME are the locally increased ion bombardment onto the growing film and the concentration of dissociated oxygen at substrate position.

DS 15.61 Tue 15:00 Poster B

The effect of target material and process parameters on the deposition rate of films grown by high power pulse magnetron sputtering — ●JULIA DUKWEN, KOSTAS SAKINOS, JONES ALAMI, and MATTHIAS WUTTIG — Institute of Physics (IA), RWTH Aachen University of Technology, 52056 Aachen, Germany

High power pulsed magnetron sputtering (HPPMS) is a novel ionized PVD (IPVD) technique, in which a high degree of ionization of the sputtered material is obtained resulting in thin films with superior

properties as compared to those achieved by other IPVD techniques, e.g. dc magnetron sputtering (dcMS). Moreover in HPPMS lower deposition rates (R_d) are obtained, in comparison to the dcMS ones, when a constant average target power is used. However, we have recently shown that at a constant average target current the HPPMS rates are equal to the dcMS rates up to a threshold peak target current (I_{Tp}) value. In this work we study the HPPMS and dcMS rates R_d for a number of materials (Cr, Cu, C) at a constant average target current and different I_{Tp} and target voltage (V_T) values. Time-resolved optical emission spectroscopy is employed in order to determine the plasma composition. It is shown that in the case of materials with a low ionization fraction (e.g. C) the HPPMS rates are higher by up to 40% in comparison to the dcMS ones, at all deposition conditions. On the other hand, for materials with a high ionization fraction (e.g. Cr and Cu) the HPPMS R_d values are higher up to 10% than the dcMS rates for $I_{Tp} < 10$ A and $V_T < 450$ V. A further increase of the I_{Tp} and V_T results in a drop of the HPPMS R_d values by up to 20%.

DS 15.62 Tue 15:00 Poster B

Herstellung und Charakterisierung piezoelektrischer Zinkoxid-Schichten für Biochipanwendungen — ●KERSTIN FRANZISKA WÄTJE¹, JENS EBEBECKE¹, JÖRG LINDNER², WALTER ASSMANN³ und ACHIM WIXFORTH¹ — ¹Universität Augsburg, Lehrstuhl für Experimentalphysik I, 86159 Augsburg — ²Universität Augsburg, Lehrstuhl für Experimentalphysik IV, 86159 Augsburg — ³Beschleunigerlaboratorium des MLL der LMU und TU München, 85748 Garching

Akustische Oberflächenwellen (SAW) finden unter anderem bei Hochfrequenzfiltern einen großen Anwendungsbereich; auch in der Biophysik werden solche Bauelemente zur gezielten Agitation bzw. Aktorik kleinster Flüssigkeitsmengen verwendet. Als Alternative zu piezoelektrischen Einkristallen, die zur Erzeugung von SAWs nötig sind, gilt polykristallines, c-Achsen-orientiertes Zinkoxid. Betrachtet wird die Deposition von ZnO-Schichten der optimalen Textur (002) auf Silizium- und Glassubstraten, wobei die Verfahren des RF-Magnetronsputterns und der gepulsten Laserablation gegenübergestellt werden. Der Einfluss der Prozessparameter auf die Schichteigenschaften wurde mit Hilfe von XRD, RBS, ERDA und TEM charakterisiert. Die resultierenden Unterschiede bezüglich Kristallinität und Schichtzusammensetzung werden hier dargestellt und diskutiert.

DS 15.63 Tue 15:00 Poster B

Electronic properties of amorphous and crystalline Germanium Bismuth Tellurides — ●MICHAEL AUSTGEN and MATTHIAS WUTTIG — Institute of Physics (IA), RWTH Aachen University of Technology, 52064 Aachen, Germany

In data storage applications such as CD-RWs, DVD-RWs or DVD-RAMs phase change materials are already commercially used. The information is stored in bits which can be switched between the crystalline and the amorphous state by a short laser pulse. Desired physical properties of these non-volatile memories are high optical contrast. For future applications in electronic memories such as PC-RAM's the high electrical contrast is an alternative feature.

In this study two different Germanium Bismuth Tellurium alloys were investigated. Both have a low crystallization temperature and were partially crystalline deposited. This is indicative for a low activation barrier against crystallization and could lead to very fast crystallization phenomena at elevated temperatures. To prepare amorphous films substrate cooling was invoked. This enabled the preparation of amorphous films. Subsequently the properties of the amorphous and crystalline state were investigated employing a variety of techniques including x-ray diffraction, x-ray reflectometry, van der Pauw measurements as well as spectroscopic ellipsometry. From these data the suitability of were investigated. Germanium Bismuth Tellurides as ultrafast storage materials has been accessed.

DS 15.64 Tue 15:00 Poster B

Crystallization kinetics in amorphous Tellurium alloys used for phase change recording — ●TOBIAS SONTHEIMER, MICHAEL

KLEIN, and MATTHIAS WUTTIG — Institute of Physics (IA), RWTH Aachen University of Technology, 52064 Aachen, Germany

Phase change materials perfectly meet all requirements expected from materials used for data storage. The long-term stability of the amorphous phase on the one hand and the ability to switch from one phase to the other within nanoseconds accompanied by a high change of reflectivity on the other hand paved the way to the commercial application of phase change materials in CD-RW, DVD-RW and DVD-RAMs. Even though various kinds of data storage devices based on these materials are commercially available neither their physical properties nor their kinetic behavior are completely understood.

In this study, the nucleation and growth process of Tellurium alloys were investigated, driven by the ambition to gain a fundamental understanding of the phase transformation. Differential Scanning Calometry measurements and annealing experiments followed by ex-situ AFM-measurements, which are based on exploiting the density difference between the crystalline and amorphous phase, are among the characterization techniques employed in this investigation. This combination of methods allows us to track the time- and temperature-dependent nucleation and growth process and gain insight into the crystallization mechanism.

DS 15.65 Tue 15:00 Poster B

In-Situ Observation of Electron Stimulated Eching of SiO₂ and the Initial Stage of Thermal Desorption — ●OLIVER SENTLEBEN, TANJA STIMPEL-LINDNER, IGNAZ EISELE, and HERMANN BAUMGÄRTNER — Universität der Bundeswehr München, Institut für Physik, Werner-Heisenberg-Weg 39, 85577 Neubiberg

Thermal desorption of SiO₂ under low oxygen partial pressure and elevated temperature due to the dissociation to SiO (g) is a well known process. Whereas electron irradiation causes dissociation of SiO₂ to elemental silicon and oxygen that partly desorbs. Combining these two processes leads to a very effective way for etching of SiO₂.

Therefore we investigated the etching effect on a thermally grown SiO₂ with a thickness up to 60 nm at temperatures between 700° and 900°C under electron irradiation in a UHV chamber. The etching process has been observed simultaneously via AES. The influence of temperature and carbon contaminations on the etching process can be shown.

We used this method to observe the initial stage of thermal desorption of SiO₂. Therefore a hole 300 μm in diameter was etched into a 60 nm thick SiO₂ layer right down to the silicon substrate which causes an inhomogeneity in SiO₂ thickness in the transition region. The initial stage of thermal desorption of SiO₂ can be observed very well utilizing this method.

DS 15.66 Tue 15:00 Poster B

Study of the carbon dioxide adsorption on silicon — ●DANIELA LIETZ, MICHAEL PAULUS, CHRISTIAN STERNEMANN, and METIN TOLAN — Exp. Physics E1a/DELTA, University Dortmund

In order to investigate the adsorption of carbon dioxide on a silicon wafer, the layer thickness and roughness are determined in dependence of the CO₂-pressure via X-ray reflectivity. Due to the use of a high pressure cell the experiment has been accomplished at a photon energy of 27 keV at BL9 of the synchrotron radiation source DELTA. In order to observe different degrees of adsorption, the gas pressure was increased in 17 steps from 0 bar to 34.4 bar (near condensation pressure of CO₂). For each pressure step an X-ray reflectivity was recorded. The measured reflectivities are refined with the use of the effective density model. The layers thickness, roughness and dispersion were determined. The adsorption isotherm (layer thickness vs. pressure) shows the anticipated increase of layer thickness with rising pressure. From the adsorption isotherm the Hamaker constant was determined in order to qualify the amplitude of the interaction between substrate and layer on a microscopic scale. The roughness shows an increase with the thickness which is due to the interaction between the substrate and the surface which smoothes the layers surface especially at low layer thickness.

DS 16: Organic Light Emitting Diodes (SYOE 9)

Time: Wednesday 14:30–16:30

Location: H32

DS 16.1 Wed 14:30 H32

Dynamics of the triplet state in Alq₃ — ●NILS A. REINKE, JOHANNES HÖCHTL, VALENTIN KAMM, and WOLFGANG BRÜTTING — University of Augsburg, Institute of Augsburg, Experimental Physics IV, Augsburg, Germany

As demonstrated by recent work, the organic electroluminescent material Alq₃ has a long-lived triplet state with a lifetime in the 10ms range [1]. Depending on the excitation density and the sample preparation delayed fluorescence and phosphorescence with varying relative intensities can be detected at low temperature. In order to get deeper insight into the underlying mechanism, we have combined different experimental techniques to study the triplet dynamics in Alq₃. Using time-resolved photoluminescence measurements on neat films, matrix-isolated molecules as well as films doped with phosphorescent emitters the direct observation of the excited states dynamics is possible in a broad time-window from the nanosecond to the millisecond range. Relatively intense phosphorescence can be observed in Alq₃ doped with phosphorescent molecules containing heavy metal atoms, such as Ir(ppy)₃[2]. A significantly reduced lifetime in such systems indicates that the transition rate of the triplet state to the ground state is strongly affected by the phosphorescent dopant. We will further demonstrate an indirect determination of the triplet lifetime in Alq₃ from singlet emission using a novel pump-probe technique. [1] M. Cölle et al., JAP 96 (2004) 6133-6141, [2] I. Tanaka et al., PRB 71 (2005) 205207

DS 16.2 Wed 14:45 H32

Charge trapping and triplet quenching in conjugated polymers — ●DIRK HERTEL and KLAUS MEERHOLZ — Institute of Physical Chemistry, University of Cologne, Luxemburgerstr. 116

According to spin statistics the formation of excited states in OLEDs from uncorrelated charge carriers yields 25% singlet and 75% triplet states, the latter do usually not contribute to electroluminescence. Little is known about triplet charge carrier (polaron) interaction in conjugated polymers. The quenching of triplets by polarons might play an important role for the degradation of OLEDs or for applications such as organic lasers, since triplets are accumulated in the device due to their long lifetime. From combined experimental investigations of time resolved emission and charge transport we are able to show that in a poly-spirobifluorene doped with PtOEP triplet polaron quenching is a major loss mechanism. We derived a triplet polaron quenching constant of about 10-13 cm³/s from direct measurements of the phosphorescence lifetime under space charge limited conditions. The influence of PtOEP concentration and film thickness on the quenching efficiency is studied. The investigation of charge transport by current voltage characteristics as a function of temperature yields hole mobilities of 10-4 cm²/Vs for the SCLC regime. Comparison with mobility measurements depending on temperature and electric field by time of flight technique shows that in the SCLC regime the mobility is trap limited.

DS 16.3 Wed 15:00 H32

Photophysical properties of deep blue emitting Iridium complexes — ●S. HANEDER¹, E. DA COMO¹, A. ROGACH¹, J. FELDMANN¹, P. ERK², E. FUCHS², K. KAHLE², O. MOLT², S. NORD², H. REICHEL², and G. WAGENBLAST² — ¹Photonics and Optoelectronics Group, LMU, 80799 München — ²BASF AG, 67056 Ludwigshafen

Improving the efficiency of lighting is imperative in optimizing the use of available energy resources. Electrophosphorescence based organic light-emitting diodes (OLEDs) have shown an internal efficiency of nearly 100% [1]. For lighting applications it is mandatory to produce OLEDs with white light emission, based on red, green and blue phosphors. Highly efficient green and red OLEDs have been successfully demonstrated. However, the development of blue emitting phosphors with reasonable photophysical stability and operational lifetime is a real challenge and still needs to be addressed.

Here we present results on a new family of phosphorescent Iridium carbene complexes [2] emitting in the blue. By a combination of steady-state and time-resolved spectroscopy techniques we study the photophysics of these complexes in thin films. The results demonstrate the influence of the ligand chemical structure in tuning the emission colour. Moreover, the nature of the non-radiative pathways involved in

the emission process is figured out on the basis of phosphorescence lifetime and quantum yield measurements. These non-radiative pathways are important in limiting the overall device efficiency.

[1] Y. Sun et al., Nature 440, 908 (2006) [2] BASF AG, PCT Patent Appl. WO 2005/019373, August 19, WO 2005/113704, May 18, 2004

DS 16.4 Wed 15:15 H32

Lifetime enhancement of organic top and bottom light-emitting diodes — ●MICHAEL HOFMANN, PHILIPP WELLMANN, TOBIAS CANZLER, and JAN BIRNSTOCK — Novald AG, Tatzberg 49, Dresden, Germany

Recent efforts regarding the development of organic light-emitting diodes (OLEDs) resulted in a major stability enhancement. Crucial factors are the improved metal electrodes and the introduction of an edge passivation layer preventing electrical shorts at the border of the anode contact. We present latest data on long-living top-emitting OLEDs with doped transport layers reaching 100.000 h for green and 12.000 h for blue devices at 500 cd/m².

Still the lifetime of blue OLEDs remains challenging because the stability of the emitter material itself is limited. Additionally, structures which generate high energy excitons place further demands on the adjacent transport and interlayer materials. A sensing layer method is applied to locate the position of the recombination zone. It contains a green emitter selected to quench blue excitons. The thin sensing layer is sandwiched in the predominantly electron-conducting emission layer (EML). In case of a high electron supply, the recombination zone is close to the EBL/EML interface and 6 nm wide. We conclude that this can be shifted away from the interface by an adjusted electron supply. The reduced stress on the surrounding organic materials and the broadening of recombination zone to 15 nm increases device stability. The presented blue bottom-emitting OLED with modified electron supply has a significantly increased lifetime of 18.000 h at 500 cd/m².

DS 16.5 Wed 15:30 H32

Polymer-based Optoelectronic Devices with Interlayers — ●D. NEHER¹, C. YIN¹, X. YANG¹, B. PIEPER¹, B. STILLER¹, TH. KIETZKE^{1,2}, and H.-H. HÖRHOLD³ — ¹Univ. Potsdam, Inst. Physics, 14469 Potsdam, Germany — ²Inst. Mater. Res. & Eng. (IMRE), 117602 Singapor — ³Univ. Jena, Inst. Org. Chem. & Macromol. Chem., 07743 Jena, Germany

Recently, a novel approach to insert ultrahigh polymer layers with well-controllable electronic properties into solution-processed optoelectronic device structures has been proposed [1]. This approach allows to establish property-function relationships, which are not accessible by the study of conventional blend device. Experiments on electrophosphorescent devices as well as Kelvin-probe experiments under illumination showed that these layers are dense and exhibit a strong electron-blocking function [2]. Upon proper choice of the HOMO and LUMO level of the interlayer material, efficient recombination of charges at the interface could be realized. Comparable studies on bilayer and solar cell devices based on poly(p-phenylene vinylenes) suggest that the performance of these devices is not determined by charge transport and free carrier recombination. This supports the view that the efficiency to form free carriers is the main limiting factor.

[1] J. S. Kim, R. H. Friend, I. Grizzi, J. H. Burroughes, Appl. Phys. Lett. 87 (2006) 023506.

[2] X.H. Yang, F. Jaiser, B. Stiller, D. Neher, F. Galbrecht, U. Scherf, Adv. Funct. Mater. 16 (2006) 2156

DS 16.6 Wed 15:45 H32

Metal organic-interfaces and their impact on inverted top-emitting organic light emitting diodes — ●QIANG HUANG¹, SEBASTIAN SCHOLZ¹, KARSTEN WALZER¹, KARL LEO¹, and MICHAEL HOFMANN² — ¹Institut für Angewandte Photophysik, TU Dresden, D-01062 Dresden — ²Novald AG, Tatzberg, D-01307 Dresden

In order to compete with other flat panel display technologies, amorphous silicon TFT (α -Si TFT) backplanes, which operate by n-channel transistors, are desired in active-matrix organic light-emitting displays (AMOLEDs). Thus, inverted top-emitting OLEDs with a bottom cathode and top anode have to be implemented. However, inverted top-emitting OLEDs reported so far show worse performance, e.g. increased operating voltage, than their corresponding non-inverted coun-

terparts. This is mainly due to a charge carrier injection problem at the metal/organic interface. We use single carrier devices to study the difference between the metal-organic and organic-metal interface, where asymmetric I-V characteristics demonstrate different interface effects. It is found that when thermal metal deposition is used, the topmost organic layer is destroyed or reacts with hot metal atoms forming a deteriorated organic interlayer which hinders hole injection. In contrast, this effect is beneficial for electron injection in the non-inverted case due to the formation of additional gap states. Based on the study, highly efficient inverted top-emitting OLEDs are presented with a current efficiency well above 80 cd/A at a brightness of 1000 cd/m².

DS 16.7 Wed 16:00 H32

Novel solution processable cathode structures for PLEDs — ●RIIKKA SUHONEN^{1,2}, ANDREAS KANITZ¹, WIEBKE SARFERT¹, RALPH PÄTZOLD¹, and ALBRECHT WINNACKER² — ¹Siemens AG, CT MM1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — ²Department of Material Science VI, University Erlangen-Nuremberg, Martensstraße 7, 91058 Erlangen, Germany

Polymer light-emitting diodes (PLEDs) have attracted much attention due to their potential use in large area, flat-panel displays. The key challenges related to the use in commercial applications are the device stability, device efficiency and the ease of fabrication.

The contacts between the inorganic and organic layers are known to play a crucial role in the PLED device performance. In general, low work function metals like barium or calcium are used to reduce the energy barrier height between the cathode and the polymer. Also the concept of a nanoscale thin interfacial layer of alkali halide salt, such as LiF, has been shown to increase the electron injection in OLEDs

and is being widely used. However, both low work function metals and alkali halides are reactive towards atmospheric moisture and oxygen and must be processed under vacuum conditions.

In this contribution, we replace the low work function metals with a thin layer of alkali salt. We show that comparable diode performance can be achieved independent of the deposition method of the thin salt layer. We compare the performance of solution processed and evaporated salt cathodes to the standard barium-aluminum cathode.

DS 16.8 Wed 16:15 H32

Organic light emitting diodes on ITO-free polymer anodes — ●KARSTEN FEHSE, GREGOR SCHWARTZ, KARSTEN WALZER, and KARL LEO — Institut für Angewandte Photophysik, TU Dresden, D-01062 Dresden

The high material cost of indium, being the main component of the commonly used indium-tin-oxide anodes (ITO) in organic light emitting diodes (OLEDs), is an obstacle for the production of efficient low-cost OLEDs. Therefore, new anode materials are needed for large scale OLED production. Recently, we demonstrated that the polymer PEDOT:PSS can substitute ITO as anode. Another highly conductive polymer is polyaniline (PANI) that provides 200 S/cm with a work function of 4.8 eV. In this study, we use PANI as anode for OLEDs (without ITO layer underneath the polymer) with electrically doped hole- and electron transport layers and intrinsic materials in between. Fluorescent blue (Spiro-DPVBi) as well as phosphorescent green (Ir(ppy)₃) and red emitters (Ir(MDQ)₂(acac)) were used for single colour and white OLEDs. Green single and double emission OLEDs achieve device efficiencies of 34 lm/W and 40.7 lm/W, respectively. The white OLED shows a power efficiency of 8.9 lm/W at 1000 cd/m² with CIE coordinates of (0.42/ 0.39).

DS 17: Contact Properties (SYOE 10)

Time: Wednesday 16:45–18:45

Location: H32

Invited Talk

DS 17.1 Wed 16:45 H32

Single grain contacts — ●GREGOR WITTE — Physikalische Chemie I, Ruhr-Universität Bochum, 44801 Bochum

Because of attractive features such as low-temperature processing and flexibility organic electronics is presently attracting significant attention. Of particular interest of current research is a detailed understanding and optimization of intrinsic charge transport mechanism present in these materials. Besides their technological relevance organic thin film transistors (OFETs) are frequently used to characterize the electronic properties of such organic semiconductors. However, due to structural imperfections like grain or domain boundaries within the films as well as contact related problems the intrinsic transport properties are masked and typically only effective parameters are obtained.

While these problems can be avoided by investigating organic single crystals they are difficult to grow and frequently are not available in the required purity and perfection. An alternative strategy is based upon investigation of films containing large single crystalline grains as compared to the channel length of the used OFET device thus allowing single grain studies. In this talk I will give an overview of experimental approaches to realize single grain devices and to deal with proper contacts.

DS 17.2 Wed 17:30 H32

Comparison of the charge injection barrier at realistic and ideal metal/organic interfaces: metals become faceless — ●MANDY GROBOSCH and MARTIN KNUPFER — Leibniz-Institut für Festkörper- und Werkstofforschung, Dresden, Germany

Most of the organic electronic devices are nowadays fabricated under poor vacuum conditions. In this regard, there is only little knowledge about the impact of contamination of the metal electrode on the charge injection barrier in this kind of electronic devices. In our study we have performed X-ray and ultra violet photoemission spectroscopy (XPS, UPS) on interfaces between the organic semiconductor α -sexithiophene and sputter cleaned (ideal) metals as well as contaminated (realistic) metals. As metal substrates we have used silver, gold, palladium, and platinum. These metals provide us a wide range of metal work functions from 4.2 eV for silver up to 5.5 eV for platinum. For all interfaces of α -sexithiophene and contaminated metals we have observed a reduction of the interface dipole and the hole injection bar-

rier. The charge injection barrier in all four cases is almost independent of the underlying metal (within an error of 0.2 eV) and the interface dipole remains a finite size. We could demonstrate that the injection barrier of realistic interfaces is very different from that of the respective clean interfaces. Moreover, a loss of the individual characteristic of the metal upon contamination is observed - it becomes faceless.

DS 17.3 Wed 17:45 H32

Influence of film thickness on contact resistance in nanoscale oligothiophene field effect transistors — ●ARNE HOPPE¹, TORSTEN BALSTER¹, GÜNTHER GÖTZ², PETER BÄUERLE², and VEIT WAGNER¹ — ¹School of Engineering and Science, International University Bremen, Campus Ring 8, 28759 Bremen, Germany — ²Department Organic Chemistry II, Ulm University, Albert-Einstein-Allee 11, 89081 Ulm, Germany

Nanoscale organic transistors for high switching frequencies are often limited by contact resistances. We report on a study of those contact resistances in nanoscale organic field-effect transistors (OFETs) by a systematic variation of the bandgap of the organic semiconductor. We use high mobility alkyl-substituted oligothiophenes (Dihexyl-n-thiophenes, DHnT) with n, the number of thiophene rings, ranging from four to seven. The bandgap variation also shifts the HOMO-level by almost 0.5 eV, which is expected to modify contact properties. Generally we find increasing mobilities up to 0.12 cm²/Vs towards larger molecules and at the same time decreasing contact resistances. We find for all materials a systematically decreasing mobility with decreasing channel length while the contact resistance remains fairly constant with channel length. We also report on thickness dependent in-situ electrical measurements on those nano OFETs, which are in agreement with the fact, that one monolayer is sufficient for electronic transport. Furthermore, we demonstrate monolayer-oscillations not only in the mobility, but also on the contact resistance. In contrast to the mobility, the contact-resistance shows minimal values with any closed monolayer.

DS 17.4 Wed 18:00 H32

Electrode - molecular semiconductor contacts: work-function-dependent hole injection barriers versus Fermi-level pinning — ●NORBERT KOCH¹ and ANTJE VOLLMER² — ¹Humboldt-

Universität zu Berlin, Institut für Physik, Berlin, Germany — ²BESSY GmbH, Berlin, Germany

Contacts between two molecular organic semiconductors [p-sexiphenyl (6P) and pentacene] and conducting polymers based on poly(3,4-ethylenedioxythiophene)/poly(styrenesulfonate) (PEDT:PSS) were investigated with photoemission spectroscopy. The dependence of the hole injection barrier (HIB) at 6P/CP interfaces on substrate work function (WF) exhibited a transition from almost Schottky-Mott limit-like behavior to Fermi-level pinning. For pentacene, no significant variation of the HIB as function of WF was observed, despite the large range of work function spanned by the conducting polymers (4.4 eV to 5.9 eV). The results on contacts with conducting polymers are compared to those with metals, where none of the two limiting cases for HIBs as a function of WF were observed. In addition, we present clear-cut relations between residual water incorporation in PEDT:PSS layers and the resulting surface morphology and work function. These results are of direct relevance for organic opto-electronic device fabrication processes.

DS 17.5 Wed 18:15 H32

Structure and growth of organic-organic heterojunctions elucidated by in-situ X-ray diffraction studies — ●ESTHER BARRENA^{1,2}, DIMAS G. DE OTEYZA¹, JUSEP OSSÓ³, STEFAN SELLNER¹, and HELMUT DOSCH^{1,2} — ¹Max-Planck-Institut für Metallforschung — ²Institut für Theoretische und Angewandte Physik, Universität Stuttgart — ³Institut de Ciència de Materials de Barcelona

Although numerous studies have been devoted to the characterization and optimization of the performance of p-n organic-organic heterojunctions-based devices, the present-day knowledge on the physical principles of the growth of organic heterostructures is still poor. By combining atomic force microscopy with surface-sensitive X-ray diffraction, we have been able to get a detailed in-situ insight into the microscopic processes which take place during the growth of p-conducting di-indenoperylene (DIP) molecules onto n-conducting copper-hexadecafluorophthalocyanine (F16CuPc) thin films. We demonstrate the self-organization of well-ordered DIP nanodots

with high crystallinity and show that their growth is intimately related to a novel type of interface reconstruction of the underlying F16CuPc film which affects three monolayers adjacent to the organic p-n interface. In spite of the close resemblance to the formation of semiconductor nanostructures for inorganic heteroepitaxy, the present results conclusively demonstrate a distinctly different growth mechanism for organic heteroepitaxy whose understanding demands further theoretical studies.

E. Barrena, D. G. de Oteyza, S. Sellner, H. Dosch, J. O. Osso, and B. Struth Physical Review Letters 97, 076102-1-4 (2006)

DS 17.6 Wed 18:30 H32

Fabrication and temperature-dependent conductivity studies of conducting polymer nanowires — J.H. FRANKE, B. DONG, H. FUCHS, and ●L. CHI — Physikalisches Institut, WWU Münster, Wilhelm-Klemm-Str. 10

We describe a general approach to pattern conductive polymer nanowires, e.g. polypyrrole (PPy), at pre-defined areas on insulating surfaces and to address the wires with external microelectrodes. E-beam lithography and AFM lithography were used to create defined surface patterns. The successful construction of PPy structures (10-120 nm in thickness and down to 80 nm in width) was achieved by employing a random copolymer strategy combined with self-assembly. The process can also be applied to structures of substituted thiophene, aniline and their derivatives. Furthermore, surface patterns created by parallel processes like nanoimprint lithography (NIL) can be combined with this method to construct large area polymer nanowire devices. Temperature-dependent conductivity studies on polymer structures were carried out to check for a metal-insulator transition. Results indicate an increasingly 'insulating' behaviour with decreasing thickness, e.g. a steeper rise in conductivity with increasing temperature.

1. B. Dong, N. Lu, M. Zelsmann, N. Kehagias, H. Fuchs, C.M. Sotomayor Torres, L. Chi Adv. Funct. Mater. 16,1937 (2006).

2. B. Dong, D. Zhong, L. Chi, H. Fuchs, Adv. Mater. 2005, Adv. Mater. 17 (2005) 2736.

3. B. Dong, M. Krutschke, X. Zhang, L. Chi, H. Fuchs, Small, 1 (2005), 520-524.

DS 18: Symposium: In situ Optics I

Time: Wednesday 15:00–17:00

Location: H34

Invited Talk DS 18.1 Wed 15:00 H34

Analysis of protein layer structure using real-time ellipsometry — ●HANS ARWIN — Laboratory of Applied Optics, Department of Physics, Chemistry and Biology, Linköping University, SE-581 83 Linköping, Sweden

A thickness resolution in the sub-nm range and its in situ capability make spectroscopic ellipsometry (SE) suitable for studies of thin organic layers. Here SE used in internal reflection mode is reviewed and it is shown that SE exhibits pm-sensitivity for protein adsorption on thin metal layers if used at surface plasmon resonance conditions. With such large sensitivity a determination of the microstructure of adsorbed protein layers, e. g. in terms of mass distribution perpendicular to a surface, is within reach. Another implication is an increased sensitivity in biosensor applications.

The molecular structure of surface-bound proteins can be analyzed with SE in the infrared spectral region by determining the refractive index $N=n+ik$. In this way thermally induced structural changes can be monitored. This is of importance for future devices containing protein layers for which thermal stability is important. Studies on protein multilayers show that heating above 100 degrees influences the amide bands and at 200 degrees layer degradation seen as irreversible changes in n and k occur. Methodology and results from recent studies of effects of heating proteins monolayers are presented and possibilities to perform real-time in situ infrared SE is discussed.

Invited Talk DS 18.2 Wed 15:30 H34

Optical Spectroscopy with high Spatial Resolution — ●WOLFGANG RICHTER, EUGEN SPEISER, BENJAMIN BUICK, and SILVANO DEL GOBBO — U Roma2 "Tor Vergata", Roma, Italy

Optical spectroscopy, energetically and interactionwise, is one of the ideal experimental tools to study the physical properties of materials. On the other hand, the properties of such materials are modified

nowadays in a controlled manner by reducing the physical size in one or more dimensions down into the nanometer scale. For such a situation, standard optical equipment has a non-sufficient spatial resolution, because it detects the secondary radiation from the sample in distances much larger than the wavelength (Far-Field) which gives at best (confocal microscope) a spatial resolution of several 100 nm using visible light. The reason for this limited resolution is that finer details of the sample are carried only in the evanescent fields, detectable only in subwavelength distance from the sample (Near-Field). By putting, however, a Nano-sized structure (small aperture, sharp metallic tip) within wavelength distance near the sample the evanescent waves can be converted into propagating waves which then can be detected in far field. This is the scope of Near Field Optics or Nano-Optics. While this secondary radiation is widely used for nanoscale imaging (Near Field Optical Microscopy) we will concentrate here on optical spectroscopy with nanoscale spatial resolution. We will focus especially the apertureless techniques, with their definite intensity advantage and concentrate mainly on Raman scattering. The experimental considerations and measurements on semiconductor nanorods will be discussed.

Invited Talk DS 18.3 Wed 16:00 H34

Surface enhanced Raman spectroscopy as a probe for studying metal/organic interfaces — ●GEORGETA SALVAN and DIETRICH ZAHN — Chemnitz University of Technology, D-09107 Chemnitz, Germany

The physical and chemical properties of the interfaces between metallic contacts and organic semiconductor films in hybrid devices such as organic light emitting diodes, organic solar cells or organic field effect transistors influence significantly the device performance. In this work the metal film growth is assessed by in situ monitoring of the Raman scattering by the internal and collective vibrational modes in crystalline organic semiconductor layers. As model systems molecular lay-

ers of two perylene derivatives, viz. 3,4,9,10-perylene-tetracarboxylic dianhydride (PTCDA) and dimethyl 3,4,9,10-perylene-tetracarboxylic diimide (DiMe-PTCDI) grown on sulfur passivated GaAs(100) substrates were investigated. Silver, known to form rather inert contacts, magnesium, known as a very reactive metal, and indium, a metal with intermediate reactivity, were deposited each by thermal evaporation under ultra-high vacuum conditions. The experiments benefit from a strong enhancement of the scattering intensity of internal molecular modes induced by the metals layers, known as Surface Enhanced Raman Scattering (SERS). The analysis of the spectral evolution with the metal thickness allows to extract information on the chemical aspects of the interface formation, on the diffusion length of the metal atoms into the organic layers as well as on the morphology of the growing metallic layers.

Invited Talk DS 18.4 Wed 16:30 H34
In-situ monitoring of stress evolution in growing group-III-nitride layers — ●ALOIS KROST, ARMIN DADGAR, RAINER CLOS, GUNTHER STRASSBURGER, and FABIAN SCHULZE — Institute of Ex-

perimental Physics, Otto-von-Guericke-University Magdeburg
 Strains and stresses in heteroepitaxy are omnipresent but until recently, due to a lack of in-situ access, the potential problems were often not observed at the source: Stress can lead to misfit dislocations or cracking of layers as well as strongly curved wafers after epitaxy, which has to be avoided for high quality devices. An in-situ sensor monitoring stress is not only useful for monitoring strain during the growth of highly mismatched systems as Group-III-Nitrides, which are usually grown on heterosubstrates, but also for strain balanced Quantum-Wells or Bragg mirrors. It is a very useful tool, especially in difficult to control systems as GaN-on-Si, where tensile thermal strain leads to cracking for layers even below 1 μm in thickness. Therefore to apply strain engineering methods and optimize growth an in-situ stress sensor is prerequisite. We will show how stress can be determined during epitaxy and that not only film stress but also the composition of ternary alloys can be determined exactly. We will discuss the limits of Stoney's equation, usually applied to calculate film stress, and present an analytical method for the determination of wafer curvature and elastic stress also in the non-linear range.

DS 19: Symposium: In situ Optics II

Time: Wednesday 17:15–18:45

Location: H34

Invited Talk DS 19.1 Wed 17:15 H34
Optical in-situ diagnostics of device growth in MOVPE — ●MARTIN ZORN¹, FRANK BRUNNER¹, THOMAS ZETTLER², and MARKUS WEYERS¹ — ¹Ferdinand-Braun-Institut für Höchstfrequenztechnik (FBH), Gustav-Kirchhoff-Str. 4, 12489 Berlin, Germany — ²LayTec GmbH, Helmholtzstr. 13-14, 10587 Berlin, Germany

Metal-organic vapour phase (MOVPE) growth of semiconductor device structures is the fundamental technique for the fabrication of today's micro- and opto-electronic devices. The monitoring and control of these growth processes in gas phase environment is highly desired and can only be done by optical technologies.

Here, we report on *in-situ* diagnostics in MOVPE using normalized reflectance (R), reflectance anisotropy spectroscopy (RAS), optical curvature measurements and emissivity-corrected pyrometry.

In GaAs-based layer structures crucial layer properties like composition, doping, and strain can be determined *in-situ*. For example, the optical RAS fingerprint of a laser structure includes information about doping and composition. Growth of lattice matched material like Al-GaInP on GaAs can be controlled by a combination of reflectance and curvature measurements.

For GaN-based epitaxy *in-situ* temperature and strain measurements play a crucial role in optimizing the growth process. Sensor based strain engineering of the layer structures is state-of-the-art for yield-enhancement. Recently, reflectance measurements at 400 nm and 950 nm have shown to give direct insight into the growth of (Al,In,Ga)N heterostructures.

Invited Talk DS 19.2 Wed 17:45 H34
In-situ investigations of electronic and structural properties of Si surfaces during electrochemical surface functionalization — ●JÖRG RAPPICH¹, FLORENT YANG¹, KATY ROODENKO², ALEX GÜELL³, CARL MATTHIAS INTELMA¹, THOMAS DITTRICH⁴, and KARSTEN HINRICHS² — ¹Hahn-Meitner-Institut Berlin GmbH, Abt. SE1, Kekuléstr. 5, 12489 Berlin — ²ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Str. 9, 12489 Berlin — ³Department of Physical Chemistry, University of Barcelona, C/Martí i Franquès, 1, E-08028 Barcelona (Spain) — ⁴Hahn-Meitner-Institut Berlin GmbH, Abt. SE2, Glienicke Str. 100, 14109 Berlin

In-situ investigations of Si surfaces are of high scientific relevance in order to understand the electrochemical surface processing during oxide formation and etch-back, the transformation towards H-termination and grafting of organic molecules on (111) and (100) oriented surfaces. These surface modifications have an impact on the electronic surface properties such as surface recombination velocity and band-bending. For characterisation of electronic properties and identifica-

tion of changes in the type of surface species pulsed photoluminescence, pulsed photo-voltage and infrared spectroscopic measurements (multiple and single reflection geometry) have been applied. Experimental results are discussed with respect to surface passivation, structural modification and functionalization.

Invited Talk DS 19.3 Wed 18:15 H34
Water at model membranes: structure, dynamics and biomolecular sensing — ●MISCHA BONN — FOM-Institute for Atomic and Molecular Physics, Kruislaan 407; NL- 1098 SJ, Amsterdam

Lipids form the basic building blocks of cell membranes. Thanks to their bipolar nature (lipids consist of a polar head group and a long apolar tail), they possess the ability to self-organize and thus form the boundary of living cells. The interaction of lipids with water drives the self-assembly process and water is therefore an essential ingredient of a biological membrane. It has been a challenge to elucidate the role of water in biomolecular processes, including those occurring at the membrane surface.

Vibrational spectroscopies have been shown to be very useful for the study of water, as the O-H stretch vibration of water is a very sensitive reporter of the local environment of the water molecule. The non-linear vibrational spectroscopic technique of sum frequency generation (SFG) further allows us to distinguish bulk water near the membrane from water physically bound to the membrane. This unique surface specificity enables the detailed study of membrane-bound water. Moreover, we can investigate the femtosecond dynamics of interfacial water molecules, as we use femtosecond laser pulses in our experiments.

We find that, although the SFG spectra of interfacial water at the membrane-water interface very closely resembles that of interfacial water at the air-water and air-quartz interfaces, the vibrational dynamics are markedly different. Whereas for both the air-water and air-quartz interfaces, the surface water molecules exchange energy very rapidly with the bulk, this is not the case for membrane-bound water. This is the first direct experimental evidence that membrane-bound water is an inherent part of the membrane: water at the membrane interface does not just terminate the bulk.

We further show that the preferential adsorption of DNA to a lipid monolayer on water, results in dramatic changes in the interfacial water structure. In this way, the water molecules, which are interrogated with SFG, act as highly sensitive reporters for the presence of DNA, constituting a novel, non-invasive method for label-free detection of DNA with very high (picomolar) sensitivity. The approach we present is very simple and it can easily be extended to be specific towards unique DNA sequences.

DS 20: Symposium: Real Time Growth Studies I

Time: Thursday 9:30–11:00

Location: H32

DS 20.1 Thu 9:30 H32

Real-time studies of MBE growth using electron and synchrotron x-ray diffraction — ●WOLFGANG BRAUN¹, DILIP KUMAR SATAPATHY², VLADIMIR KAGANER¹, BERND JENICHEN¹, LUTZ DÄWERITZ¹, and KLAUS PLOOG¹ — ¹Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7, 10117 Berlin — ²Paul Scherrer Institut, Swiss Light Source, CH-5232 Villigen PSI, Switzerland

Using reflection high-energy electron diffraction (RHEED) and synchrotron x-ray diffraction, we can study epitaxial growth phenomena in great detail under realistic growth conditions. Whereas RHEED has a superior surface sensitivity, but is hampered by usually strong multiple scattering effects, x-ray diffraction allows a straightforward quantitative analysis using kinematical scattering theory. In addition, x-rays can penetrate deeply into the material, allowing us to follow the formation of a heteroepitaxial interface even as it is buried by continued deposition.

The growth of MnAs on GaAs(001) by molecular beam epitaxy serves as an example to demonstrate the synergy of both methods. Whereas RHEED offers a detailed view of the initial nucleation phase, x-ray diffraction allows us to follow the formation of a strongly anisotropic, periodic array of misfit dislocations at the heterointerface that is governed by the misfit and the bonding between film and substrate. A fascinatingly rich and complex sequence of growth stages unfolds, taking us beyond the standard classification of Volmer–Weber and Stranski–Krastanov growth.

DS 20.2 Thu 9:45 H32

X-ray in-situ investigations of growing SiGe nanostructures on nominal substrates and patterned templates — ●TOBIAS SCHULLI¹, MARIE-INGRID RICHARD¹, GILLES RENAUD¹, GANG CHEN², and GUENTHER BAUER² — ¹CEA Grenoble, DRFC/SP2M 17 rue des martyrs, 38054 Grenoble, France — ²Institut für Halbleiterphysik, Johannes Kepler Universität Linz, 4040 Linz Austria

A challenge for the development of nano-electronics is to elaborate semiconductor quantum dots that are homogeneous in shape, size, strain and composition, thus resulting in well-defined electronic and optical properties. Recently the growth of highly monodisperse Ge islands on prepatterned Si substrates has been obtained by a combination of lithography and self-assembly techniques [1]. The complexity of such growth modes calls for in-situ studies of the kinetics of epitaxy on patterned surfaces. On BM32 at the ESRF in Grenoble, we have developed in-situ x-ray scattering methods giving access to the evolution, of size, shape, faceting, strain relaxation and interdiffusion during the growth. Utilizing grazing incidence small angle x-ray scattering and diffraction these tools were used to track the facet size evolution for growing Ge domes on nominal Si (001) surfaces, as well as in the determination of material transport from the wetting layer during the transition from two dimensional to island growth [2,3].

References

- [1] Z. Zhong et al. Appl. Phys. Lett. 84, 1922 (2004).
- [2] T.U. Schüllli et al., Appl. Phys. Lett. 89, 143114 (2006).
- [3] M.-I. Richard et al., submitted to Phys Rev. Lett. (2006).

DS 20.3 Thu 10:00 H32

Layer-by-layer growth of thin epitaxial iron silicide films on GaAs — ●BERND JENICHEN, VLADIMIR KAGANER, WOLFGANG BRAUN, JENS HERFORT, ROMAN SHAYDUK, CLAUDIA HERRMANN, and KLAUS PLOOG — Paul-Drude-Institut, Hausvogteiplatz 5-7, 10117 Berlin

The layer-by-layer growth mode during molecular beam epitaxy allows the controlled fabrication of epitaxial layer sequences with very sharp interfaces between them. The aim of the present work is the in-situ characterization of the Fe₃Si epitaxial growth process in the layer-by-layer growth mode by x-ray surface diffraction methods in order to achieve high-quality interfaces. The long range ordering in the films is monitored by measuring different Fe₃Si superlattice reflections. The Fe₃Si layers were grown under x-ray control on the As-rich GaAs surface at different substrate temperatures near 200°C which is the optimum growth temperature with respect to structural and interfacial perfection and a high degree of long range atomic order. The Si and the Fe cell temperatures were tuned in order to achieve perfect lattice match of the Fe₃Si to the GaAs substrate and at the same time full sto-

ichiometry of the films. An anneal of the surface at 310°C for about 1h together with the growth of one ML of Fe₃Si improved the surface quality considerably, which is determined in situ by the increasing intensity of the x-ray surface reflections. X-ray intensity oscillations were obtained after such an annealing procedure. Fe₃Si grows indeed layer-by-layer. The measured curves exhibit damping, indicating that several terrace levels contribute to the diffracted intensity.

DS 20.4 Thu 10:15 H32

In Situ X-ray Diffraction during Pulsed Laser Deposition — ●VEDRAN VONK¹, MARK HUIJBEN², KURT DRIESSEN³, GUUS RIJNDERS³, DAVE BLANK³, SYBOLT HARKEMA³, and HEINZ GRAAFSMA⁴ — ¹Max-Planck-Institute for Metals Research, Stuttgart, Germany — ²University of California, Berkeley, USA — ³University of Twente, Enschede, The Netherlands — ⁴Deutsches Elektronen-Synchrotron, Hamburg, Germany

The use of in situ X-ray diffraction for the study of thin film growth enables in a straightforward way to derive the atomic structure, because the kinematical scattering approximation holds. Here we present the results of studying the heteroepitaxial growth by Pulsed Laser Deposition of complex oxides such as the High-T_c superconductor YBa₂Cu₃O_{7-x} [1] and the insulator LaAlO₃ [2] on SrTiO₃(001) substrates. A special sample chamber has been constructed to be used with synchrotron X-rays [3]. Detailed pictures of the growth kinetics and of the atomic interface structure at deposition conditions result from fitting quantitatively both the intensity growth oscillations and the crystal truncation rods. The growth of the complex oxide thin films presented here is characterized by substantial interlayer-mass transport and large deviations from the bulk room-temperature atomic structure. The results show the effects of the interplay between formation and diffusion energies on the processes of nucleation and kinetics during heteroepitaxial growth. [1] V.Vonk *et al.* ESRF Highlights 2004 (2005) [2] V.Vonk *et al.*, Phys. Rev. B (submitted) [3] V.Vonk *et al.*, J. Synchr. Rad. **12** (2005) 833

DS 20.5 Thu 10:30 H32

Pressure Dependant in-situ Investigations on the Rapid Thermal Processing of CuInS₂ Thin Films — ●HUMBERTO RODRIGUEZ ALVAREZ, IMMO MICHAEL KÖTSCHAU, ALFONS WEBER, and HANS WERNER SCHOCK — Hahn Meitner Institut, Glienicke Str. 100. 14109 Berlin

The solid state transformations taking place during the rapid thermal processing (RTP) for the sulfurization of metallic precursors (Cu,In) were monitored using in-situ energy dispersive X-ray diffraction (EDXRD) experiments at the EDDI beamline of BESSY II (Berlin). The new reaction chamber allows an RTP type processes at high pressure (~1 mbar) and short heat-up time (550°C, ~200 K/min), which is considerably different from the process conditions (p_{max} ~ 10⁻³ mbar) of a complementary experiment available at HASYLAB (Hamburg). The time resolved analysis of the EDXRD spectra gives information on the reaction pathway leading to the formation of the CuInS₂ thin film. The first experiments show a strong pressure dependence of the formation of binary sulfides prior to the formation of the ternary chalcopyrite. The changes in the reaction pathway under variation of the maximum sulfur partial pressure will be discussed.

DS 20.6 Thu 10:45 H32

Coarsening kinetics of faceted 2D islands: theory and Monte Carlo simulations — ●VLADIMIR KAGANER¹, WOLFGANG BRAUN¹, and KARL SABELFELD² — ¹Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7, 10117 Berlin — ²Weierstraß-Institut für Angewandte Analysis und Stochastik, Mohrenstr. 39, 10117 Berlin

Two coarsening mechanisms, Ostwald ripening and dynamic coalescence, are studied by means of kinetic Monte Carlo simulations. Ostwald ripening is the leading coarsening mechanism in absence of a step edge barrier, while dynamic coalescence takes place if an exchange of atoms between islands is prohibited by a step edge barrier. We find that the coarsening laws qualitatively change at large bond energies or low temperatures, when the 2D islands become faceted. Ostwald ripening proceeds through a sequence of 'magic' sizes corresponding to square or rectangular islands and becomes attachment-limited, but the Wagner's asymptotic law is reached after a very long transient time.

The unusual coarsening kinetics obtained in Monte Carlo simulations are well described by the Becker-Döring equations of nucleation kinetics. We show that these equations can be applied to a wide range of coarsening problems. Dynamic coalescence is a result of the Brownian motion of the islands. For large bond energies, the island diffusion co-

efficient becomes size-independent and the size distribution becomes monotonously decreasing. The results of the kinetic Monte Carlo simulations are supported by numerical solutions of the Smoluchowski equations.

DS 21: Symposium: Real Time Growth Studies II

Time: Thursday 11:15–12:45

Location: H32

Invited Talk

DS 21.1 Thu 11:15 H32

Growth morphology evolution in real time and real space — ●JOACHIM KRUG — Institut für Theoretische Physik, Universität zu Köln, Zùlpicher Strasse 77, 50937 Köln, Germany

Understanding morphology evolution during thin film growth requires the combination of real time probes, which provide information about the layer coverage distribution and derived quantities such as the surface roughness, and real space imaging which gives insight into the lateral (regular or irregular) structure. The talk will summarize the state of the art that has been achieved in the study of simple model systems, such as homoepitaxial metal films. Starting from the statistical growth limit, where interlayer transport is completely suppressed, we will sketch the quantitative theory of mound formation based on the analysis of nucleation of new layers. We will discuss the relevance of this mechanism for organic thin film growth, and argue that information on the possible suppression of interlayer transport in these systems can be obtained from the shapes of growth spirals. Stochastic roughening mechanisms giving rise to self-affine morphologies will then be briefly reviewed, and the phenomenon of rapid roughening in organic films, where roughness builds up faster than in the statistical growth limit, will be discussed in the context of available theories.

Invited Talk

DS 21.2 Thu 12:00 H32

Growing metals on silicon surfaces - STM study in-vivo —

●IVAN OŠTÁDAL, PAVEL SOBOTÍK, PAVEL KOCÁN, and JAN PUDL — Faculty of Mathematics and Physics, Department of Electronics and Vacuum Physics, Charles University in Prague, V Holešovičkách 2, 180 00 Praha 8, Czech Republic

Scanning tunneling microscopy (STM) was used for direct imaging early stages of heteroepitaxial growth of Ag and In on silicon surfaces during deposition by vacuum evaporation. An experimental arrangement used for such STM in-vivo measurements is presented and discussed. Image sequences showed the behavior of single metal adatoms after arriving on the Si(111)7 × 7 surface and formation of metal clusters at room and higher temperatures. The data revealed a kind of long range interaction among metal adsorbate [1]. STM cannot image individual, highly mobile, metal adatoms on the the Si(100)2 × 1 surface at room temperature but dynamics of metal chains growth and decay can be recorded with a single atom resolution. The chains composed of metal adatom dimers form surface structures with morphology given by a type of metal. In-vivo measurements indicate substantial role of surface C-type defects at metal adatom nucleation [2]. The STM data are discussed with respect of models used for kinetic Monte Carlo simulations of the growth.

[1] I. Ošťádal, P. Kocán, P. Sobotík, J. Pudl, Phys. Rev. Lett. 95 (2005) 146101

[2] P. Kocán, I. Ošťádal, P. Sobotík, Surf. Sci. 600 (2006) 3928; P. Kocán, P. Sobotík, and I. Ošťádal, Phys. Rev. B 74 (2006) 037401

DS 22: In situ STM

Time: Thursday 9:30–10:00

Location: H34

Invited Talk

DS 22.1 Thu 9:30 H34

Grain Growth and Film Growth observed with Real-time, in-situ STM — ●MARCEL J. ROST — Kamerlingh Onnes Laboratory, Leiden, The Netherlands

The ever-growing variety of applications of film and thin film technology clearly demands fundamental research that links well known atomic processes, such as diffusion and nucleation, with the mesoscopic evolution of film properties, both during film growth and during a post deposition treatment (heating, stress, coating,...). We present the first *real-time, in-situ* movies on polycrystalline gold films that contain observations of film growth and grain growth obtained with a variable-temperature Scanning Tunneling Microscope (STM).

Atomic step resolution all over the film allowed us to identify the in-

dividual grains and, thus, also the grain boundaries. As we heated the film, we directly observed grain boundary diffusion and grain growth and found unexpected changes in surface roughness: an initial decrease of the roughness was followed by a later increase.

In order to further elucidate film growth, we evaporated several tens of monolayers of gold under grazing incidence on top of a well annealed polycrystalline gold film, *while* measuring with the STM. This enabled us to visualize film growth in real time. Analyzing the intermediate and developing film structures we succeeded in classifying the growth mode within the empirical film-growth structure-zone model introduced by Mochvan and Demchishin in 1969. Moreover, the direct observation provides us with atomic-scale insight in this classical growth mode: columnar grain growth is based on step-flow and spiral growth.

DS 23: Symposium: In situ Optics III

Time: Thursday 10:00–11:00

Location: H34

DS 23.1 Thu 10:00 H34

Optical and electronic properties of the interface between small organic ring molecules and GaAs(001) surfaces — ●T. BRUHN¹, R. PASSMANN^{1,2}, M. KROPP¹, W. BRAUN³, M. KNEISL¹, W. RICHTER^{1,4}, N. ESSER^{1,2}, and P. VOGT¹ — ¹TU Berlin, Institute of Solid State Physics, Hardenbergstr. 36, 10623 Berlin, Germany — ²ISAS Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany — ³BESSY GmbH, Albert-Einstein-Str. 15, 12489 Berlin, Germany — ⁴Universita Tor Vergata, Via della Ricerca Scientifica 1, 00133 Roma, Italy

Organic functionalization of semiconductor surfaces represents one of the most promising aspects in recent years. For a systematic installation of functional organic units in semiconductor devices, however, a detailed understanding of the interface formation is crucial. Due to the important role of III-V semiconductors in optoelectronics, we have investigated small ring molecules (cyclopentene (C₅H₈) and 1,4-cyclohexadiene (C₆H₈)) on different GaAs surface reconstructions. The samples were investigated with reflectance anisotropy spectroscopy (RAS), soft X-ray photo electron spectroscopy (SXPS) and scanning tunnelling microscopy (STM). For all reconstructions RAS measurements show that the adsorption of the molecules significantly

changes the spectral line shape where surface related transitions of the clean surfaces contribute. Also a clear influence on the linear electro-optical effect (LEO) was observed. Additional molecular components were identified in the valence band spectra. A bonding to the arsenic atoms is supported by STM measurements and core-level spectroscopy.

DS 23.2 Thu 10:15 H34

Infrared in-situ analysis of solid-liquid interface of a mixed polymer brush — ●Y. MIKHAYLOVA¹, L. IONOV², M. GENSCHE¹, N. ESSER¹, J. RAPPICH³, M. STAMM², S. MINKO⁴, K.-J. EICHHORN², and K. HINRICH¹ — ¹ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Str. 9, 12489 Berlin — ²Leibniz-Institut für Polymerforschung Dresden e.V., Hohe Str. 6, 01069 Dresden — ³Hahn-Meitner-Institut Berlin GmbH, Abt. Silizium-Photovoltaik, Kekuléstr. 5, 12489 Berlin — ⁴Chemistry Department, Clarkson University, Potsdam, New York 13699, USA

Mixed polymer brushes [1,2] find applications for control of wettability and adhesion because surface properties can be changed by external stimuli (pH, solvent, light, electric field). A mixed poly(2-vinylpyridine)-poly(acrylic acid) polymer grafted layer (mixed P2VP-PAA brush) with 50/50 composition was prepared via two subsequent "grafting to" reactions. The film was characterized in-situ by polarization dependent infrared (IR) spectroscopic measurements in single reflection geometry. During those measurements the brush was exposed to different solutions at varying pH, where conformational rearrangements in the brush and an inversion of the charge of the film occur. The reversible switching of the brush was analyzed in-situ via the component specific vibrational bands of P2VP and PAA. The polarization dependent spectra are interpreted quantitatively by optical simulation procedure. [1] S. Minko, D. Usov, E. Goreshnik, M. Stamm, *Macromol. Rapid Commun.* 2001, 22, 206; [2] L. Ionov, A. Sidorenko, K.-J. Eichhorn, M. Stamm, S. Minko, K. Hinrichs, *Langmuir* 2005, 21, 8711

DS 23.3 Thu 10:30 H34

Vibrational sum frequency spectroscopy studies of poly(lactic acid) films — ●MAGNUS JOHNSON¹, ALBERT SUGIHARTO¹, MARC SMITS², JOHANNES NIJSEN³, and SYLVIE ROKE¹ — ¹Max-Planck Institute for Metals Research, Stuttgart, Germany — ²FOM-Institute AMOLF, Amsterdam, The Netherlands — ³Department of Nuclear Medicine, University Hospital, Utrecht, The Netherlands

In the search for biodegradable polymers with versatile applications, poly lactic acid (PLA) has proven to be a fruitful option. This polymer

has successfully been used in the treatment of liver cancer [1] and in the repair of blood vessels, for example. [2]

In order to increase the knowledge of the complex bulk and surface structures of PLA, vibrational sum frequency spectroscopy (VSFS) has been employed on PLA films with varying crystallinity and stereo regularity. The structure of the films can be determined by mapping both the well understood stretching modes of the methyl groups as well as the skeletal modes that have vibrational energies far down into the fingerprint region. From these studies we are able to obtain a detailed image of the interface and the bulk, and experiments performed with different polarizations of the laser beams have enabled a deeper understanding of the orientation of various functional groups of the polymer. Additionally, we are able to track the changes in crystallinity in the films, initiated by annealing.

[1] Zielhuis, S.W. et. al. *Biomaterials*, 26, 925 (2005) [2] Postema, A.R.; Pennings, A.J. *J. Appl. Polym. Sci.*, 37, 2351 (1989)

DS 23.4 Thu 10:45 H34

In-situ Spectroscopic Ellipsometry studies of MOVPE grown new materials: InN and InGaN — ●MARTIN LEYER¹, MASSIMO DRAGO¹, MARKUS PRISTOVSEK¹, WOLFGANG RICHTER², and MICHAEL KNEISSL¹ — ¹Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, Germany — ²Univ. di Roma "Tor Vergata", Dip. di Fisica, Via Ricerca Scientifica 1, 00133 Italy

Indium rich nitride semiconductors are especially challenging to grow, resulting in yet unresolved discussions on some of their basic properties, i.e. the fundamental bandgap energy. Our investigations have shown that spectroscopic ellipsometry is a very powerful tool for in-situ growth analysis of InN and related alloys. We have characterized in-situ several MOVPE grown InN layers of varying structural qualities in the energy range between 1.6 eV and 6.5 eV prior to contamination due to exposure to air. In this work we present a model for the dielectric function of InN. Analysis of the shift of the critical points of InN with the temperature allowed the determination of the temperature dependence of the InN optical properties between 300 K and 900 K. Such model could be used quantitatively to determine in-situ the InN growth rate as well as to determine surface effects such as roughening and accumulation of metallic Indium on the surface of the growing layer. The now known optical properties of the binary systems InN and GaN are used to approximate InGaN layers. Since we have found that ellipsometry is extremely sensitive to the formation of metallic Indium surfaces we are also investigating Indium segregation in InGaN quantum wells.

DS 24: Ion Beam Techniques

Time: Thursday 11:15–13:15

Location: H34

DS 24.1 Thu 11:15 H34

Ion Beam induced Glancing Angle Deposition of silicon nanostructures — ●CHRISTIAN PATZIG¹, WILFRIED ERFURTH², ALEXEY MILENIN², and BERND RAUSCHENBACH¹ — ¹Leibniz Institute of Surface Modification, Permoserstraße 15, 04318 Leipzig, Germany — ²Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle, Germany

Silicon nanostructures such as chevrons, four-fold spirals, screws and vertical posts are grown on Si substrates using ion-beam induced Glancing Angle Deposition (GLAD) at room temperature. GLAD is a deposition technique developed in recent years. Based on a self-shadowing process of particles that reach the substrate under a highly oblique angle (the particle flux typically reaches the substrate under an angle $\beta > 80^\circ$ as measured to the substrate normal), slanted posts will grow in the direction of the incoming flux. Combined with suitable substrate rotation, unique structures can be grown. The structures are grown on bare Si substrates as well as on templates made with Electron Beam Lithography (EBL) and are analyzed by Scanning Electron Microscopy (SEM). The effect of different rotation schemes and the influence of period and size of the template pattern on the growing structure will be discussed. It will be shown that the period of the template pattern, compared to the natural dimension of the structure on the bare substrate, dominates both dimension and periodicity of the grown structures.

DS 24.2 Thu 11:30 H34

Energy dependence of the surface topography on Si and Ge during ion beam erosion: Change of ripple orientation — ●BASHKIM ZIBERI, FRANK FROST, THERESA LUTZ, and BERND RAUSCHENBACH — Leibniz-Institut für Oberflächenmodifizierung e. V., 04318 Leipzig

Under certain conditions, induced by self-organization processes, low-energy ion beam erosion can lead to the formation of well ordered nanostructures on surfaces. The formation, ordering and size of nanostructures depends on different process conditions. The underlying mechanism is an interplay between curvature dependent sputtering that roughens the surface and smoothing by different relaxation processes. In the case of ripple formation current theories predict a ripple orientation perpendicular to the projection of the incoming ion beam for not too oblique angles of ion incidence and an increase of the ripple wavelength with ion energy if the relaxation process is not a thermal activated surface diffusion process. In this contribution the ripple surface topography emerging on Si and Ge surfaces during low energy Xe⁺ ion beam erosion at oblique ion incidence is investigated (ion energy ≤ 2000 eV). The results show that there is a much more complex behavior of the surface topography with ion energy, that contradicts the predictions of the theoretical models. For example a change in ripple orientation from perpendicular to parallel with decreasing ion energy was found, and the ripples formed at lower ion energies have a wavelength two times larger than the ripples at higher ion energies.

DS 24.3 Thu 11:45 H34

Biaxially textured polycrystalline Ag films on amorphous Si by ion beam assisted deposition — ●DANIEL FÖRSTER, SEBASTIAN BLEIKAMP, and THOMAS MICHELY — II. Physikalisches Institut, Universität zu Köln, Zùlpicher Str. 77, 50937 Köln

Controlling the texture of polycrystalline thin films is crucial for their performance, i.e. in integrated circuits or as IR-reflective coatings.

We studied the early growth stages of Ag thin films on amorphous silicon as a model system by scanning tunneling microscopy. If grown by physical vapour phase deposition, these films develop a <111> fiber texture.

In order to obtain biaxially textured films, ion beam assisted deposition is performed using 4 keV Argon ions. Three channeling directions, corresponding to ion beam angles of 20°, 35° and 85° with respect to the surface normal are tested at different ion-to-atom arrival rates. For the grazing incidence angle of 85° at an 1/10 arrival rate a pronounced biaxial texture is found.

Details of the texture may be understood by considering the different interaction of the grazing ion beam with terraces and step edges.

DS 24.4 Thu 12:00 H34

Selektive Diffusion durch Ionenbestrahlung: Gold in amorphem Silizium — PETER KÄCHLER¹, ANDREAS KLIMMER¹, HANS-GERD BOYEN¹, CHRISTIAN PFAHLER¹, MORITZ TRAUTVETTER¹, ●PAUL ZIEMANN¹, JOHANNES BISKUPEK², UTE KAISER² und PAUL WALTHER² — ¹Institut für Festkörperphysik, Universität Ulm, 89069 Ulm, Germany — ²Zentrale Einrichtung Elektronenmikroskopie, Universität Ulm, 89069 Ulm, Germany

Bestrahlt man 60 nm dicke Goldfilme auf Si(100)-Substraten mit 230 keV Ar⁺ Ionen, so reicht diese Energie aus, dass die Projektile in einer mittleren projizierten Tiefe von 80 nm im Silizium zur Ruhe kommen. Simulationen (SRIM) wie auch TEM-Messungen zeigen, dass eine Gesamtfluenz von 4·10¹⁵ Ionen/cm² genügt, um eine Si-Schicht mit scharf definierter Dicke (230 nm) direkt an der Grenzfläche Au-Si vollständig zu amorphisieren. Erfolgt eine solche Bestrahlung durch geeignete Masken, kann man bei anschließendem Tempern ein Temperaturfenster mit selektiver Au-Diffusion finden. So diffundiert Gold, wie Rutherford-Rückstreuxperimente (RBS) zeigen, zwischen 290° - 350°C in das amorphisierte Si-Substrat ein, während in den kristallinen Teilen noch keine merkliche Diffusion stattfindet [1]. Es wird über kombinierte RBS-, TEM- und SEM-Experimente berichtet, welche Aufschluss über die sich einstellenden Au/Si-Tiefenprofile liefern und die durch Nutzung geeigneter Bestrahlungsmasken eine Bestimmung der so erreichten elektrischen Leitfähigkeitskontraste zwischen bestrahlten und unbestrahlten Bereichen erlauben.

[1] J. Ehrhardt *et al*, J. Appl. Phys. 100, 063534 (2006).

DS 24.5 Thu 12:15 H34

Messung der winkelabhängigen Sputterrate und der Sekundärelektronenausbeute bei der FIB-Bearbeitung von ein- und polykristallinen Metallen — ●YULIYA STARK, ROBERT FRÖMTER und HANS PETER OEPEN — Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

Das direkte Bearbeiten von Metallfilmen zur Herstellung von Nanostrukturen erfreut sich wegen der Verfügbarkeit hochauflösender FIB Quellen zunehmender Beliebtheit. Während es relativ einfach ist, anhand einer Monte-Carlo Simulation [1] eine Abschätzung für die Sputterrate bei der Bearbeitung eines bestimmten Metalls zu erhalten, sind experimentelle Werte hierfür in der Literatur rar. Wir haben daher Messungen der Sputterrate von 30 kV Ga Ionen an polykristallinen Fe, Co und Permalloy Schichten, sowie den Substratmaterialien Si, GaAs und Graphit durchgeführt. Winkelabhängige Messungen an einkristallinem Fe zeigen, dass der Einfluss der Kristallstruktur (channeling), der in [1] nicht berücksichtigt wird, bis zu einer Größenordnung beitragen kann. Auffälligerweise fallen hier nicht alle niedrig indizierten Kristallrichtungen mit Minima der Sputterrate zusammen.

Die Sekundärelektronenausbeute spielt ebenfalls eine Rolle bei der Bearbeitung, da sie beispielsweise die Bildqualität bei der Ionenmikroskopie und damit die zur Abbildung notwendige Grenzdosierung bestimmt. Wir haben mittels eines sphärischen retarding-field Spektrometers den Ertrag sowie die Energieverteilung der Sekundärelektronen für eine Reihe von Materialien bestimmt.

[1] James F. Ziegler; <http://www.srim.org>

DS 24.6 Thu 12:30 H34

Mechanical stress in low-energy ion-irradiated germanium: Experiments and simulations — ●TOBIAS EDLER and S.G. MAYR — I. Physikalisches Institut, Friedrich-Hund-Platz 1, Georg-August-Universität Göttingen, 37077 Göttingen, Germany

In the present contribution we focus on the origins and impacts of the swelling anomaly in amorphous germanium during ion bombardment. Experimentally, amorphous germanium thin films were grown from vapor, and subsequently bombarded with Ar⁺ ions with energies of up to 3 keV. Stress generation is monitored by a laser beams deflection method. In order to identify the underlying mechanisms of stress generation, molecular dynamics simulations were performed, in which crystalline and amorphous germanium films of different densities were irradiated.

We find a good agreement between experiments and simulations, which both clearly show the generation of compressive stresses, which saturate at 200 MPa. These stresses can be attributed to the generation of voids with sizes of approximately 1 nm several nanometers below the surface.

This work was financially supported by the DFG – SFB 602 TP B3.

DS 24.7 Thu 12:45 H34

Nanoporous carbon thin films manufactured by ion beam treatment of self-assembled block-copolymer nanotemplates — ●VALERIY LUCHNIKOV¹, MANFRED STAMM¹, ALEXEY KONDUYRIN², and MARCELA BILEK² — ¹Leibniz-Institut of Polymer Research Dresden, Hohe Str. 6, 01069 Dresden, Germany — ²School of Physics, University of Sydney, New South Wales 2006, Australia

Well-defined nanoporous carbon materials are explored for a number of advanced applications such as separation media, energy storage/conversion systems, catalyst supports, nano-electronic devices. Self-assembled block-copolymer thin films constitute a promising precursor material to formation of highly-ordered nanoporous carbon thin films via carbonization reactions. One of the carbonization techniques is ion beam implantation that transforms a polymer to insoluble electrically conductive carbonized structure, which can operate under aggressive media, high energy irradiations, mechanical load and high temperature. We have shown that a nanoporous BC-film can be completely carbonized by high-energy ion beam implantation, while preserving highly-ordered morphology. Thickness and structure of the carbonized nano-template are analyzed. Ion-beam induced carbonization does not require high temperatures and permits delicate modification of only the top 100-200 nm thick layer. This opens up new possibilities, such as formation of ordered carbon thin films on plastic and fusible metal substrates for flexible electronics. The method is also perspective for manufacture of free-standing nanoporous carbon membranes for different applications.

DS 24.8 Thu 13:00 H34

Transport von Ionen durch dünne Filme und Membrane — ●EVA UNGER, THOMAS KOLLING, SHUTAO SUN und KARL-MICHAEL WEITZEL — Fachbereich Chemie, Universität Marburg, Hans Meerweinstr., 35032 Marburg

Dünne Filmschichten und Membrane spielen in Forschung und Technik eine grosse Rolle, z. B. in der Mikroelektronik, Medizintechnik aber auch allgemein in der Oberflächenbearbeitung und -veredelung.

Ausgehend von Studien zur reaktiven Streuung von Ionen an filmbelegten Grenzflächen, u.a. an PPX-Filmen, haben wir in diesem Beitrag den Transport von Ionen durch freistehende PPX-Membrane studiert. Dazu wurden dünne PPX - (Poly-Para-Xylene) Schichten und PPX-Membrane variabler Dicke (100 nm bis 2 µm) durch Plasma-Dampfabscheidung (CVD) präpariert. So erzeugte Membrane wurden anschließend in einer Ultrahochvakuumkammer "freistehend" positioniert und mit Cs⁺ Ionen beschossen. Durch die Membran hindurchtretende Teilchen wurden mit einem Mikrokanalplattendetektor nachgewiesen und bezüglich ihrer kinetischen Energie analysiert.

Wir können den Durchtritt von Cs⁺ Ionen nachweisen, finden jedoch auch deutliche Hinweise auf das Austreten von Elektronen und im geringen Umfang auch neutraler Cs Atome. Diese Teilprozesse werden vor allem als Funktion der Aufschlagsenergie (impact energy) und der Schichtdicke untersucht.

DS 25: Symposium: Real Time Growth Studies III

Time: Thursday 15:00–18:30

Location: H32

Invited Talk DS 25.1 Thu 15:00 H32
Pentacene thin film growth — •GEORGE MALLIARAS — Cornell University, Ithaca, NY, USA

Organic thin film transistors (OTFTs) are being developed in academic and industrial labs for "disposable" plastic electronics such as radio-frequency identification tags. Among the most promising organic semiconductors is pentacene, which yields transistors with performance similar to that of amorphous silicon. The interfaces of pentacene films with dielectric materials (gate oxide) and conductors (electrodes) play a major role in determining OTFT performance. X-ray scattering has proved to be superb tool for the study of crystalline organic films such as pentacene. My talk will focus on the interface of pentacene films with dielectric materials. Recent studies of growth of pentacene films on silicon oxide has revealed interesting new physics: For example, layer-by-layer growth can be obtained despite the fact that the interaction of pentacene with itself is stronger than that with the substrate. I will discuss our current understanding of how the kinetics of growth affects film morphology. A second topic that will be overviewed is the evolution of structure of organic films with film thickness. As organics are highly polymorphic, they usually adopt a *thin-film* phase at the substrate, with the bulk phase not seen until film thickness has exceeded a certain thickness. I will show that the nucleation of the bulk phase begins at the substrate, but it remains undetected due to the fact that bulk crystallites scatter incoherently. Implications of this phase co-existence on the electrical properties of organic films will be discussed.

DS 25.2 Thu 15:45 H32

Real-time and in-situ study of organic semiconductor growth: using X-ray growth oscillations beyond the anti-Bragg point — •STEFAN KOWARIK^{1,2}, ALEXANDER GERLACH^{1,2}, STEFAN SELNER¹, FRANK SCHREIBER¹, LEIDE CAVALCANTI³, and OLEG KONOVALOV³ — ¹Institut für Angewandte Physik, Universität Tübingen, 72076 Tübingen, Germany — ²Physical and Theoretical Chemistry Laboratory, University of Oxford, Oxford OX1 3QZ, United Kingdom — ³ESRF, 6 Rue Jules Horowitz, Boîte Postale 220, 38043 Grenoble Cedex 9, France

In-situ and real-time X-ray scattering experiments during organic molecular beam deposition (OMBD) have been performed at the ESRF. Using an optimised setup and the high X-ray photon flux at a synchrotron, we show that a wide region in reciprocal space (i.e. many Fourier components of the real-space structure) can be monitored in real-time. In particular we manage to simultaneously acquire X-ray growth oscillations not only at the anti-Bragg condition but in a broad q -interval and in particular at the $2/3$, $3/4$, $4/5$ etc. Bragg points. We will also discuss a simplified scheme for direct data analysis. The real-time measurements allow studying the growth kinetics of organic semiconductors such as pentacene, perfluoropentacene, and diindenoperylene in great detail. We find marked transitions from layer-by-layer growth to roughening, changes in molecular orientation during the growth process, as well as transient strain [1].

[1] S. Kowarik, et al. PRL 96, 125504 (2006).

DS 25.3 Thu 16:00 H32

Real-Time Observation of Organic Growth on metals - a SMART Investigation — •PIERRE LEVESQUE¹, HELDER MARCHETTO¹, ULLRICH GROH², FLORIAN MAIER², THOMAS SCHMIDT², RAINER FINK³, TOMÁS SKÁLA¹, EBERHARD UMBACH², and HAJO FREUND¹ — ¹Fritz-Haber-Institut der Max-Planck-Gesellschaft, 14195 Berlin, Germany — ²Universität Würzburg, Experimentelle Physik II, 97074 Würzburg, Germany — ³Universität Erlangen-Nürnberg, Physikalische Chemie II, 91058 Erlangen, Germany

The growth of two similar molecules - PTCDA and NTCDA - on Ag(111) and Au(111) surfaces has been studied in situ by the SMART, using PEEM with UV-light and polarized monoenergetic synchrotron radiation and LEEM. Above room temperature both systems grow in the Stranski-Krastanov mode: first two closed layers of molecules are formed, followed by three dimensional (3D) growths of islands. Strong differences are observed in the molecular orientations: whereas the PTCDA molecules are always flat-lying on the substrate, the NTCDA behaves differently: the molecules are also flat-lying in the double layer but tilted by about 45° in the islands. We report on surprising ob-

servations like reduced sticking coefficient, metastable layers, internal crystal structures, and dynamic changes within the layers. Differences in the growth and the temperature dependence of the two systems are discussed. Contrast mechanisms leading to the presented results will also be addressed. Project funded by BMBF under contract no. 05 KS4WWB/4.

Invited Talk DS 25.4 Thu 16:15 H32
Growth, Interface Formation and Electron Dynamics of Pentacene Thin Films — •FRANK MEYER ZU HERINGDORF — Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg

Pentacene has attracted significant attention lately, as it is an extremely promising candidate for organic field effect transistors in organic displays and radio frequency identification (RFID) tags. We studied the growth and interface formation of Pentacene on various Si surfaces. The initial interaction between the molecule and the substrate is covalent and the molecules are forced to "lie down" on the substrate. Subsequent layers stand upright on top of this flat lying layer and exhibit a fractal shape. As the flat layer remains between the interface and the standing-up molecules, it shields the film from the surface. Consequently, the growth behaviour is independent of the orientation, reconstruction or symmetry of the initial Si surface. The combination of PEEM with pulsed fs-laser sources allows the observation of the decay of electronic excitations in the films with spatial resolution via two photon photoemission. Here, a first photon is used to generate an excitation in the film, while a second photon initiates photoemission. The time-delay between the two (pump- and probe-) photons then allows observation of the decay of the excited intermediate state. The change in the molecular orientation between the initial layer and the fractal islands is also reflected in the decay of electronic excitations in the thin films.

DS 25.5 Thu 17:00 H32

Real-time growth investigations by means of reflectance difference spectroscopy — •MICHAEL HOHAGE, LIDONG SUN, RICHARD DENK, GÜNTHER WEIDLINGER, JOSE MANUEL FLORES-CAMACHO, and PETER ZEPPENFELD — Institut für Experimentalphysik, Johannes Kepler Universität Linz, A-4040 Linz, Austria

Reflectance difference spectroscopy (RDS) has been proven to be a versatile tool to study growth processes on crystalline substrates in-situ and in real-time. RDS measures the difference in the reflectivity of light polarized along two orthogonal directions. Since RDS uses light with normal incidence, it measures the in-plane anisotropy of a sample. For crystals with cubic symmetry the bulk is not contributing to the optical anisotropy, so that the RDS signal is only introduced by an anisotropic surface. The growth on an anisotropic substrate may influence the optical anisotropy signal either by changing the anisotropy of intrinsic surface transitions (e.g. scattering of surface states), by modifying substrate transitions due to anisotropic strain fields beneath the growing structures, or by introducing specific transitions of the deposited material (e.g. HOMO-LUMO transitions of orientated organic molecules). Simultaneously to the investigation of the morphology, the out of plane magnetization of a growing film may be studied by RDS via the polar magneto-optical Kerr effect (MOKE). The capabilities of RDS regarding the real-time investigation of growth will be demonstrated by introducing growth systems where the mentioned effects have been identified.

DS 25.6 Thu 17:15 H32

Optical Spectroscopy of Ultrathin Stacked Nanolayers Grown by Multiple Organic Heteroepitaxy — •ROMAN FORKER¹, THOMAS DIENEL¹, KLAUS MÜLLEN², and TORSTEN FRITZ¹ — ¹Institut für Angewandte Photophysik, TU Dresden, 01062 Dresden, Germany — ²MPI für Polymerforschung, Ackermannweg 10, 55128 Mainz, Germany

Highly ordered quaterylene (QT) films in the (sub-) monolayer regime were examined by means of differential reflectance spectroscopy (DRS) while being epitaxially deposited on various substrates. This *in situ* technique provides unsurpassed sensitivity for the thickness-dependent optical analysis during film growth. From the DR spectra, the optical constants were extracted using a novel numerical algorithm [1]. Rather broad and structureless spectra were obtained on Au(111). This be-

haviour changes drastically by depositing a closed monolayer of hexabenzocoronene (HBC) on the Au(111) surface before growing the QT film on top: Well-resolved QT-monomers become visible up to one QT-monolayer, followed by a physical monomer-dimer transition [2, 3] indicated by the appearance of isosbestic points in the spectra. The results are discussed in terms of the different molecular orbital hybridization on Au(111) and on HBC. Structural characterization was done by means of STM and LEED showing closed layers of flat lying molecules.

- [1] R. Nitsche et al., Phys. Rev. B **70** (2004), 195432.
 [2] H. Proehl et al., Phys. Rev. Lett. **93** (2004), 097403.
 [3] H. Proehl et al., Phys. Rev. B **71** (2005), 165207.

Invited Talk

DS 25.7 Thu 17:30 H32

Charge Injection across Self-Assembly Monolayers in Organic Field Effect Transistors: Odd-Even Effects — ●FABIO BISCARINI¹, PABLO STOLIAR¹, RAJENDRA KSHIRSAGAR¹, MASSIMILIANO MASSI¹, PAOLO ANNIBALE¹, CRISTIANO ALBONETTI¹, and DAGO DE LEEUW² — ¹CNR-Istituto per lo Studio dei Materiali Nanostrutturati, Bologna, Italy — ²Philips Research Labs, Eindhoven, The Netherlands

We investigate the role of self-assembly monolayers of chain length n , with n ranging between 3 and 18, in modulating the charge injection in pentacene field effect transistors.

The charge carrier mobility exhibits large fluctuations correlated with odd-even n . For $n < 8$, increases by one order of magnitude. For $n > 8$, charge mobility decays exponentially with an inverse decay length $\beta = 0.6 \text{ \AA}^{-1}$.

Charge injection across the interface occurs by tunneling of holes mediated by the alkanethiol layer. At short chain length, decreasing of both interfacial morphological disorder and pentacene-surface interactions dominates over the increasing thickness of the alkanethiol monolayer. At long chain length, the charge injection across the alka-

nethiol monolayer governs the transistor response.

The odd-even effect is ascribed to the anisotropic coupling between the alkanethiol terminal sigma bond and the HOMO level of ordered pentacene molecules. Our results show that the pentacene transistor is a sensitive gauge for probing charge transport across single monolayers.

DS 25.8 Thu 18:15 H32

In-situ measurements to analyze the intermolecular coupling and film growth of organic semiconductor thin films — ●DERCK SCHLETTWEIN, CHRISTIAN KELTING, HARRY BRINKMANN, WILFRIED MICHAELIS, and KARSTEN HESSE — Institut für Angewandte Physik, Justus-Liebig-Universität Gießen, 35392 Gießen

Intermolecular coupling of electronic pi-systems in thin films of organic semiconductors is of fundamental relevance for both the understanding of physical characteristics and their utilization in electronic devices. Optical absorbance is well-suited to probe them already during film growth, in particular when backed up by electron diffraction studies. Subtle changes in the film structure can be detected in changes of the observed band splitting. Thin films of modified phthalocyanines are a good example since spectra could already be obtained in the monolayer thickness range. Also, the average orientation relative to the substrate surface was extracted from relative intensities and the conclusions are supported by independent measurements of (ex-situ) spectral ellipsometry [1]. Aside from intermolecular coupling but not independent from it, microscopic growth characteristics of the films are of high relevance for technical applications. Measurements of the electrical conduction during film growth turned out very useful to discuss the formation of conduction pathways and hence the growth mode of films. Thus we could distinguish between layer vs. island growth. In a number of cases we observed the formation of ultrathin conductive channels in the monolayer range, interesting for technical application. [1] cooperation with the group of D.R.T. Zahn, TU Chemnitz.

DS 26: Oxides

Time: Thursday 15:00–17:45

Location: H34

DS 26.1 Thu 15:00 H34

XPS study of Pr-aluminate high-k dielectric layers on titanium nitride — ●GRZEGORZ LUPINA, THOMAS SCHROEDER, CHRISTIAN WENGER, GUNTHER LIPPERT, JAREK DABROWSKI, and HANS-JOACHIM MÜSSIG — IHP, Im Technologiepark 25, 15236 Frankfurt/Oder

To extend the scalability of deep trench capacitor-based dynamic random access memories (DRAM), the introduction of high-k dielectrics-based metal-insulator-metal (MIM) storage capacitors is required. Pr-enriched Al_2O_3 dielectrics with TiN electrodes appear as a promising materials system for this application. Electrical measurements performed on this materials combination show that the development of a capacitor with a very high capacitance density and low leakage current requires a very careful control of the electrode/dielectric interface. For this purpose, we carried out a synchrotron radiation x-ray photoelectron spectroscopy (SR-XPS) study to non-destructively investigate interface reactivity of the $\text{Pr}_x\text{Al}_{2-x}\text{O}_3$ ($x = 0, 1, 2$) dielectrics with TiN metal electrodes. The depth profiling study using SR-XPS shows that the TiN substrate is covered with a native TiO_2 . Additionally, a thin interfacial TiON layer is present between these compounds, resulting in a TiN/TiON/ TiO_2 materials stack. Molecular beam deposition of Al_2O_3 onto substrates of this structure leads to the reduction of the native TiO_2 . In contrast, in the same way deposited PrAlO_3 and Pr_2O_3 dielectrics are significantly less reactive towards TiO_2 .

DS 26.2 Thu 15:15 H34

Structural Determination of thin Manganese Oxide Films on Ag(001) — ●CHRISTIAN LANGHEINRICH¹, ANGELIKA CHASSÉ¹, FRANK MÜLLER², and STEFAN HÜFNER² — ¹Martin-Luther-Universität Halle-Wittenberg, Institut für Physik, D-06099 Halle/Saale — ²Universität des Saarlandes, Institut für Experimentalphysik, D-66041 Saarbrücken

X-ray photoelectron diffraction (XPD) has been applied to study thin manganese oxide films ($\sim 7 \text{ ML}$) on an Ag(001) surface. Calculations with the multiple scattering cluster model (MSCM) show that the film grows in a high crystalline order. At least the top 5 MLs have to be in such a crystalline order to reproduce the experimental spectra properly.

Furthermore, it is insufficient to analyze the spectra with a simple forward scattering picture, which usually dominates the XPD spectra for high kinetic energies (here $\sim 850 \text{ eV}$ for Mn-2p excitation and $\sim 970 \text{ eV}$ for O-1s excitation). Due to the small next-neighbour distance in a NaCl-like lattice interference effects change the peak form drastically. Thus a combination of forward scattering and interference is necessary to understand these XPD spectra.

In order to find optimized lattice constants, both the lattice constant in the surface and the lattice constant in perpendicular direction have been varied independently. An r-factor analysis of these spectra indicates that the system is close to pure MnO bulk within a small tetrahedral distortion. This is in accordance with low energy electron diffraction (LEED) results.

DS 26.3 Thu 15:30 H34

Epitaxially stabilized growth of orthorhombic LuScO_3 thin films — ●TASSILO HEEG¹, MARTIN ROECKERATH¹, JÜRGEN SCHUBERT¹, WILLI ZANDER¹, CHRISTOPH BUCHAL¹, HAN YUAN CHEN², CHUNLIN JIA², YUNFA JIA³, CAROLINA ADAMO³, and DARRELL G. SCHLOM³ — ¹Institute of Bio- and Nanosystems (IBN1-IT), and Centre of Nanoelectronic Systems for Information Technology (cni), Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — ²Ernst-Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C), and Institute of Solid State Research (IFF), Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — ³Department of Materials Science and Engineering, The Pennsylvania State University, University Park, Pennsylvania 16802-5005, USA

Lutetium scandate (LuScO_3) thin films of 10–800 nm in thickness have been prepared by molecular beam epitaxy and pulsed laser deposition on different substrates. Stoichiometry and crystallinity were investigated using Rutherford backscattering spectrometry/channelling, X-ray diffraction and transmission electron microscopy. The results indicate that LuScO_3 , which normally only exists as solid solution of Sc_2O_3 and Lu_2O_3 , could be grown in the orthorhombically distorted perovskite structure. A good crystalline quality (rocking curve FWHM of 0.05°) was gained, and a critical film thickness of around 200 nm for the epitaxial stabilization of the perovskite phase of LuScO_3 on

NdGaO₃(110) substrates was determined.

DS 26.4 Thu 15:45 H34

Tunable Electron Gases in Oxide Heterostructures — ●STEFAN THIEL¹, GERMAN HAMMERL¹, CHRISTOPH RICHTER¹, ANDREAS SCHMEHL², CHRISTOF SCHNEIDER¹, and JOCHEN MANNHART¹ — ¹Experimental Physics VI, Center for Electronic Correlations and Magnetism, University of Augsburg, Universitaetsstrasse 1, D-86159 Augsburg, Germany — ²Department of Materials Science and Engineering, Penn State University, University Park, Pennsylvania 16802-5005, USA

Multilayers of complex oxides can show physical properties that are not found in either of their constituents. For example, a conducting, quasi-two dimensional electron gas is formed at the interface between the two insulating, dielectric perovskites LaAlO₃ and SrTiO₃ [1].

Here we report that the electron gas can be tuned to a very large extent by altering the thickness of the LaAlO₃ layers on the unit cell level. For LaAlO₃ layers that are up to 3 unit cells thick, highly insulating interfaces are obtained. In field effect transistor configurations using such interfaces as drain-source channels a quantum phase transition to the conducting state is readily achieved by gate fields. [2]. Upon change of their carrier densities with applied electric fields, the electron gas reacts with a pronounced memory effect.

[1] A. Ohtomo, H.Y. Hwang, A high-mobility electron gas at the LaAlO₃/SrTiO₃ heterointerface, *Nature* **427**, 423-426 (2004)

[2] S. Thiel, G. Hammerl, A. Schmehl, C.W. Schneider, J. Mannhart, Tunable Quasi-Two-Dimensional Electron Gas in Oxide Heterostructures, *Science* **313**, 1942-1945 (2006)

DS 26.5 Thu 16:00 H34

Unusual Enhancement of Laser Induced Voltages in (LPMO/YBCO)_n Multilayer Thin Films — ●PENGXIANG ZHANG^{1,2}, HUI ZHANG¹, LILAN XIE¹, XINKUN ZHU¹, SONGLIN TAN¹, and HANNS-ULRICH HABERMEIER^{2,1} — ¹Institute Advanced Materials for Photoelectronics, KUST, Kunming, China 650051 — ²FKF, MPI, Stuttgart, Heisenberg Str. 1 D-70569 Germany

Laser induced voltages were observed in (YBa₂Cu₃O₇/La_{1-x}Pb_xMnO₃)_n multilayer thin films grown on vicinal cut LaAlO₃ single crystal substrates by pulsed laser deposition. The induced voltages were proved to be due to an anisotropic thermoelectric property, which was evidenced by the tilting angle dependence of the induced signals in these films. The peak voltages obtained are about one order of magnitude stronger than that obtained from single layer films. The possible mechanisms for the largest signals observed so far in these multilayer thin films are discussed and the enhanced large Seebeck anisotropy by the layered anisotropic structure is most likely the reason. The new finding not only enriches the experimental observations involved in strongly correlated oxides, but also provides great potentials for applications.

DS 26.6 Thu 16:15 H34

Ag-doped LaPbMnO₃ thin films and laser induced thermoelectric voltages — ●PENGXIANG ZHANG^{1,2}, SONGLIN TAN², HUI ZHANG², and HANNS-ULRICH HABERMEIER¹ — ¹Max-Planck Institut for Solid State Research, Stuttgart, D-70569 — ²IAMPE, KUST, Kunming, China 650051

Ag-doped LaPbMnO₃ thin films were grown on vicinal cut substrates by PLD technique. Laser induced voltages were measured for the first time in these thin films. It was proved that the laser induced voltages are due to the anisotropic thermoelectric effect, similar to that observed in YBa₂Cu₃O₇ by Chang et al in 1990 and that in LaCaMnO₃ by H.-U. Habermeier et al in 1998. It was found that with increasing Ag-doping from 0 to 10 wt%, the laser induced thermoelectric voltages (LITV) are firstly increased and then reduced, while the FWHM (to) of the time response of the induced voltages become smaller than that of pure LaPbMnO₃ thin film, and demonstrate a minimum at 6 wt% of Ag-doping. Defining a figure of merit (Fm) for the performance of LITV devices used in pulsed laser detection: $Fm = U_p / t_o$, where U_p is the peak value of LITV, it was found that 6 wt% Ag-doping sample shows a maximum Fm. The short time response of the Ag-doped LaPbMnO₃ thin films in LITV was explained by the increased electric conductivity, hence the higher thermo-conductivity in these thin films.

DS 26.7 Thu 16:30 H34

GaPO₄ epitaxial thin films: Growth and thermal stability — ●JOHANNES PEDARNIG, STEFAN ROITHER, MARTIN PERUZZI, and DIETER BÄUERLE — Institut für Angewandte Physik, Johannes Kepler

Universität Linz, A-4040 Linz

Gallium orthophosphate (GaPO₄) is an outstanding novel piezoelectric material that remains piezoelectric up to a temperature of 970°C. Crystalline GaPO₄ films have not been reported so far due to the complex materials chemistry.

We are reporting on solid phase epitaxial growth of GaPO₄ thin films on alpha - quartz (SiO₂) substrates. Amorphous stoichiometric precursor layers are fabricated by pulsed-laser deposition on (001) SiO₂ substrates and are subsequently transformed to crystalline GaPO₄ by post-annealing in air at elevated temperature. Epitaxial films with thicknesses up to 300 nm exhibit strong in-plane and out-of-plane textures (angular widths < 0.6°). Long-term annealing in air at temperatures above the alpha - to beta - phase transition of the quartz substrate (573°C) does not degrade these films.

This work is supported by the Austrian Federal Ministry of Economics and Labour (Micro@Nanofabrication Austria network) and the European Science Foundation (Thin Films for Novel Oxide Devices project).

DS 26.8 Thu 16:45 H34

The amorphous to crystalline phase transition of chemical solution deposited PbZr_{1-x}Ti_xO₃, studied by soft-x-ray spectroscopy — TIMOTHY LEARMONTH^{1,4}, JINGHUA GUO¹, JONATHAN DENLINGER¹, PER GLANS^{1,4}, ●HERMANN KOHLSTEDT², THEO SCHNELLER³, ADRIAN PETRARU², RAINER WASER^{2,3}, KEVIN SMITH⁴, and RAMAMORTHY RAMESH⁵ — ¹Advanced Light Source, Lawrence Berkeley National Laboratory, USA — ²Inst. für Festkörperforschung, Germany — ³Inst. für Werkstoffe der Elektrot. II, RWTH Aachen, Germany, — ⁴Depart. of Physics, Boston University, Massachusetts 02215, USA — ⁵Depart. of Mat. Sci. and Eng., Berkeley, CA 94720 USA

Chemical solution deposited (CSD) complex oxide thin films attract considerable interest in various emerging research fields. Here we present our results of soft-x-ray spectroscopy between 100 eV and 2 keV on the amorphous to crystalline phase transition of ferroelectric PbZr_{0.3}Ti_{0.7}O₃ thin films. Five samples from the same wafer were annealed to different temperatures between 350°C and 700°C. The soft-x-ray absorption and emission experiments were performed at the undulator beamline 8.0 of the Advanced Light Source of the Lawrence Berkeley National Laboratory. The soft-x-ray spectra were acquired for the Ti L_{2,3}-, O K- and C K-edge thresholds. For two samples, annealed up to 400°C and 700°C, respectively, the resonant inelastic soft-x-ray spectroscopy (RIXS) was applied for various excitation energies near the Ti L-, O K- and C K-edges. Current models of the PZT (111) microscopic texture selection will be discussed.

DS 26.9 Thu 17:00 H34

Structure Formation and Phase Composition of Zirconia Films grown by High Power Pulsed Magnetron Sputtering (HPPMS) — ●CHRISTIAN KLEVER, KOSTAS SARAKINOS, and MATTHIAS WUTTIG — I. Institute of Physics (1A), RWTH Aachen University, 52056 Aachen, Germany

We have employed the novel HPPMS deposition technique for the deposition of ZrO₂ films. ZrO₂ is a polymorphic material, which in thin film form exhibits exceptional mechanical and optical properties and is therefore widely used as a functional coating. In HPPMS unipolar pulses of high-peak power/current and low duty cycle are applied to the target. As a result of the unique properties of the deposition process, several film properties can be improved.

In this study, pulses with pulse off-times t_{off} ranging from 450 to 2450 μs (pulse on-time t_{on} kept constant at 50 μs) are applied to a Zr target (cathode). The films are deposited in a mixed Ar-O₂ ambient on unheated silicon substrates at a constant working pressure (1.5 Pa). Ion saturation current measurements are performed using a flat electrostatic probe. They manifest an increase of the ion flux to the growing film when t_{off} is increased. The changes of the duty cycle settings are accompanied by changes in the film structure. It is shown that monoclinic films are obtained when t_{off} is higher than 950 μs, while films with a mixed monoclinic/cubic phase composition are deposited for lower t_{off} . Also, the effects of the sputtering pressure and substrate temperature on the structure of films grown for t_{off} below 1450 μs are investigated.

DS 26.10 Thu 17:15 H34

Light-induced processes on electrochromic WO₃ layers — ●THOMAS LEICHTWEISS¹, BRUNO K. MEYER¹, ANGELIKA POLITY¹, THOMAS LÖWENSTEIN², DERCK SCHLETTWEIN², JEREMY MATTHEWS³,

and DIRK JÖDICKE³ — ¹Justus-Liebig-Universität Gießen, I. Physikalisches Institut, Heinrich-Buff-Ring 16, 35392 Gießen — ²Justus-Liebig-Universität Gießen, Institut für Angewandte Physik, Heinrich-Buff-Ring 16, 35392 Gießen — ³EControl-Glas GmbH & Co. KG, 93437 Furth im Wald

Electrochromic materials such as tungsten oxide in contact with a suitable electrolyte change their transmission upon the application of a potential. Technical applications include switchable mirrors and smart windows. The latter are made up of thin-film layers containing at least one electrochromic active material and make it possible to control the light- and energy-input of a building.

This work concerns the influence of UV-A and UV-B light on tungsten oxide layers. WO₃ films have been irradiated in an electrochemical cell containing different electrolytes and in atmosphere. Transmission spectra and the open circuit potential have been recorded. All layers show a photochromic behavior, they colour blue upon UV-irradiation due to partial reduction of tungsten atoms without application of an external potential. The films have been bleached electrochemically in order to determine the photogenerated charge and the colouration efficiency of the photochromic process. The reactions taking place in irradiated films and their influence on the electrochromical switching behaviour of smart windows will be discussed.

DS 26.11 Thu 17:30 H34

Characterization of GdScO₃ layers by Spectroscopic Ellipsometry — MARTIN ROECKERATH, •JÜRGEN MOERS, JÜRGEN SCHUBERT, and SIEGFRIED MANTL — Institut für Bio- und Nanosystems, Forschungszentrum Jülich, D-52425 Jülich

For further improvement of MOSFET devices high- κ materials for gate dielectrics are under investigation. Rare earth scandates are drawing increasing attention due to their favorable material properties. The κ -value is above 20, the band offsets to silicon are larger than 2 eV and the layers are stable up to 1000°C. To investigate the properties of those materials, Gadolinium scandate (GdScO₃) was selected exemplarily. Layers with different thickness were deposited on silicon (HF last) and oxidized (2 nm) silicon by electron beam evaporation. Their stoichiometry and morphology were characterized by Rutherford Backscattering (RBS), X-ray reflectometry (XRR) and transmission electron microscopy (TEM).

In order to provide a quick and non-destructive characterization method, the samples were measured at angles of 50°, 60° and 70° by spectroscopic ellipsometry (SE) and the results were compared to the other measurements. The optical data of GdScO₃ were described analytically by a Sellmeier formula with 5 parameters. It was found that the measured thicknesses of SE and XRR are in agreement for film thicknesses above 10 nm. Below 10 nm SE overestimates the thickness by far, indicating the increasing influence of the substrate/GdScO₃ interface.

DS 27: Polymer and Composite Films

Time: Friday 9:30–11:15

Location: H32

DS 27.1 Fri 9:30 H32

Structure and Dynamics of laser deposited poly(alkyl-methacrylate)s — •ANDREAS MESCHEDÉ¹, THORSTEN SCHARF¹, HANS-ULRICH KREBS¹, and KONRAD SAMWER² — ¹Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — ²I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Thin polymer films were grown by pulsed laser deposition (PLD) at 248 nm in ultra high vacuum and by Matrix Assisted Pulsed Laser Evaporation (MAPLE). The observed films show strongly different chemical, structural and mechanical properties depending on the deposition parameters, especially the laser fluence, which will be discussed with respect to the ablation mechanism. In this study, two poly(alkyl methacrylate)s are studied: poly(methyl methacrylate) (PMMA) and poly(ethyl methacrylate) (PEMA). Having the same backbone, these polymers differ by the size of their sidegroups and consequently their dynamics, which easily can be seen by a decrease in glass transition temperature with increasing side group length. Additional to chemical and morphological characterization, results obtained by mechanical spectroscopy using the Double Paddle Oscillator (DPO) and the Plasma Plume eXcited Reed (PPXR) technique will be presented to clarify the relaxation behaviour and the underlying dynamics.

DS 27.2 Fri 9:45 H32

Pulsed laser deposition of PMMA thin films — •BRITTA LÖSEKRUG, THORSTEN SCHARF, and HANS-ULRICH KREBS — Institut für Materialphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Thin films of Poly(methyl methacrylate) (PMMA) are of special interest for instance as photoresist or coating material. Here pulsed laser deposition (PLD) has proven to be an effective and flexible method. The influence of the laser fluence during deposition on the film structure, morphology and roughness was studied by FTIR, REM, AFM and XRR. It is shown that close to the deposition threshold (between 50 and 125 mJ/cm²) completely smooth (roughness at 600 nm thickness: 0.7 nm) and droplet-free films can be prepared. In contrast, at higher laser fluences two components are formed, a smooth cross-linked film and droplets (with a diameter of up to 10 μ m) consisting of polymer with reduced chain length [1]. The origin of the droplet formation and the ablation mechanisms are discussed.

[1] E. Süske, T. Scharf, T. Junkers, M. Buback, H.U. Krebs, J. Appl. Phys. **100** (2006) 014906.

DS 27.3 Fri 10:00 H32

Antimicrobial properties of co-sputtered Ag,Au/PTFE nanocomposite films — •VLADIMIR ZAPOROJTCHEKOV¹, RAINER PODSCHUN², AMIT KULKARNI¹, VENKATA SAI KIRAN CHAKRAVADHANULA¹, and FRANZ FAUPEL¹ — ¹Chair for Multicomponent Materials, Technical Faculty of CAU Kiel, Kaiserstrasse2, 24143 Kiel, Germany — ²Institute of Infection Medicine, CAU Kiel

In this work, we used co-sputtering of noble metals together with polytetrafluorethylene (PTFE) as a method to produce antibacterial polymer/metal nanocomposite coatings, where the precious metals are only incorporated in a thin surface layer. Moreover, they are finely dispersed as nanoparticles, thus saving additional material and providing a very large effective surface for metal ion release. The nanocomposite films with the thickness between 100 and 300 nm were prepared in a large range of metal filling between 10 and 40%. The antimicrobial effect of the nanocomposite coatings was evaluated by means of two different assays. Bactericidal activity due to silver release from the surface was determined by a modification of conventional disc diffusion methods. Inhibition of bacterial growth on the coated surface was investigated by a modified proliferation assay. *Staphylococcus aureus* was used mostly as test bacterium as this species commonly causes infections associated with medical polymer devices. The antibacterial efficiency of the coatings against different bacteria was demonstrated at extremely small noble metal consumption. The maximum ability of antibacterial effect was shown by the polymer/Ag-Au nanocomposite, followed by polymer/Ag nanocomposite.

DS 27.4 Fri 10:15 H32

2-dimensional metal/polymer nanocomposites near the percolation threshold as sensors for organic vapor — •CHRISTIAN HANISCH, AMIT KULKARNI, VLADIMIR ZAPOROJTCHEKOV, and FRANZ FAUPEL — Lehrstuhl für Materialverbunde, Technische Universität Kiel, Kaiserstraße 2, 24143 Kiel Fakultät der Christian Albrechts Universität zu Kiel, Kaiserstraße 2, 24143 Kiel

Low cost reversible sensors for organic vapor detection are of increasing interest for various applications. We have produced quasi two dimensional systems of Au clusters embedded in different polymer films (PMMA, PS). The polymer films were prepared via spin-coating in various thicknesses from 100 to 500 nm on different substrates. The clusters were prepared by the deposition of metal in high vacuum on the ion-beam pretreated polymer surface near the percolation threshold. The threshold was determined by in-situ measurements of the electrical resistance as well as TEM measurements. The shape and size of the clusters were specified by TEM measurements. After embedding of the clusters, vapor concentrations down to a few ppm could be detected

and the signal change was reversible. The time dependent resistance measurements showed that the sensitivity of the sensor depends on the film thickness of the polymer as well as on the type of vapor used. By comparison of the two polymer substrates we could show that each polymer exhibits a different sensitivity to the used gases, which leads to the possibility of creating an electronic nose by combining different polymer substrates in a sensor array.

DS 27.5 Fri 10:30 H32

Hydrophilic finishing of LDPE films using plasma treatment — ●DIETER IHRIG¹, JENS EGGEMANN¹, MICHAEL LICHT¹, ULRICH BRUNERT¹, HUBERT PAULUS², and KARL-HEINZ MÜLLER² — ¹FH Suedwestfalen, Interdis. Zentr. f. Lebenswissenschaften, Frauenstuhlweg 31, 58644 Iserlohn — ²TWS an der FH Suedwestfalen, Lübecker Ring 2, 59494 Soest

Conventional plasma based procedures are able to generate polar groups on the surface of polymers. But they are not stable, because they link to other polymer chains inside the polymer. We have searched for a procedure to inhibit this cross-linking. For this we used an Oxygen or rather Carbon-dioxide Plasma, that are able to generate -COOH, -OH, -C=O groups. To stabilise this groups we coated the films with another layer. By this we are able to generate a lower contact angle on the film than on a film which was only plasmatreated. Also the coated groups are even more long-term stable. This technique is interesting for films which are prepared to be printed with water based lacquer; they can be stored longer before printing. If several areas of the polymer film are covered from the plasma, it is possible to structure the film with hydrophilic and hydrophobic areas. It will be given an introduction in winning water using radiation exchange. First results of field-tests will be presented. The changing contact-angle over the time on plasmatreated and films with stabilisation layer, and the results of XPS measurements will be shown. First results of a structure with hydrophobic and hydrophilic areas present the capability of the used Stenocara surface. The project is funded by the German Federal Ministry of Education and Research (FKZ 02WD0458)

DS 27.6 Fri 10:45 H32

Smoothing of thin film surfaces and interfaces — ●JOHANNA RÖDER, TOBIAS LIESE, BRITTA LÖSEKRUG, and HANS-ULRICH KREBS — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

The control of surface and interface roughness is of great interest in technology especially for all kind of optical applications, e.g. x-ray mir-

rors. To obtain smooth surfaces with only sub-nanometer roughnesses, sputtering with energetic particles, etching, polishing or annealing are usually applied. In this contribution, different methods are discussed to smooth systems with island growth or artificial roughnesses of some nanometers produced before. Here namely Ag islands on PMMA or Si are smoothed by pre-deposition of nucleation sites and/or island zipping. Furthermore, it is shown that such surface roughnesses can significantly be reduced by covering the surface with metal oxide or polymer layers of different thicknesses. This smoothing technique can also be applied for surfaces with statistic roughness or periodic ripple formation created by sputter erosion or nano-structuring. The development of the microstructure and reduction of roughness was investigated via atomic force microscopy (AFM), transmission electron microscopy (TEM) and x-ray reflectivity (XRR). The smoothing mechanisms as well as the limits of smoothing will be discussed with respect to their dependencies on frequency and film thickness.

DS 27.7 Fri 11:00 H32

Deposition of silicon oxide thin films on polymer films using magnetron based PECVD and high frequency PECVD — ●JOHN FAHLTEICH¹, RALPH SCHMITTGENS², MATTHIAS FAHLAND¹, BJÖRN MEYER¹, and WALDEMAR SCHÖNBERGER¹ — ¹Fraunhofer Institut für Elektronenstrahl- und Plasmatechnik, Dresden, Germany — ²Technische Universität Dresden, Institut für Festkörperelektronik, Dresden, Germany

In this study we investigated the deposition of silicon-oxide (SiO_x) thin films on flexible polymer substrates using magnetron-based plasma enhanced chemical vapor deposition (Mag-CVD) and very high frequency (VHF 60 MHz) PECVD. Hexamethyldisiloxane (HMDSO) and oxygen were used as precursor materials. The Mag-CVD process was performed using a dual magnetron sputter system with a 40 MHz mid-frequency power supply.

Both the process-gas excitation and the fragmentation of the monomer were analyzed using optical emission spectroscopy. Additionally similar deposition rates could be achieved for both processes. However, the Mag-CVD process runs at a significantly lower process pressure. Chemical bonds within the different SiO_x layers could be compared by analyzing the FT-IR spectra. The film composition was characterized in dependence on both the monomer and the reactive gas flow using X-Ray photoelectron spectroscopy. The thin film properties could be varied from siloxane plasma polymers to inorganic silicon oxide without changing the gas composition.

DS 28: Silicon Thin Films and Interfaces

Time: Friday 11:30–12:45

Location: H32

DS 28.1 Fri 11:30 H32

Evaluation of Low-Temperature SiO_x as an Insulating Barrier — ●OLIVER SENFTLEBEN, PETER ISKRA, TANJA STIMPEL-LINDNER, IGNAZ EISELE, and HERMANN BAUMGÄRTNER — Universität der Bundeswehr München, Institut für Physik, Werner-Heisenberg-Weg 39, 85577 Neubiberg

Lowering the thermal budget in silicon process technology is one essential demand for the future. Feasibility of abrupt doping profiles or the application of new materials like SiGe, C₆₀ or organic materials highly depends on a low-temperature insulating layer.

Therefore we investigated silicon suboxides which were deposited in a UHV-chamber by sublimation of silicon in oxygen atmosphere. Electrical quality of the oxide layers is the essential figure of merit. The main parameters for optimization are substrate temperature, oxygen partial pressure, silicon sublimation rate and appropriate annealing conditions. Oxygen partial pressure has been varied between 10⁻⁵ to 10⁻² mbar, sample temperatures between 400°C and 600°C and the influence of in-situ annealing in oxygen, hydrogen and UHV at different temperatures has been studied.

Special interest has been taken on double layer systems consisting of thermally grown silicon dioxide layers between 2.3 nm and 10 nm and subsequent deposition of SiO_x layers between 10 nm and 50 nm in thickness. These samples were electrically characterized by IV- and CV/GV-measurements in a MIS-structure. Morphology of the layers was investigated by SEM and AFM and the thickness and stoichiometry by AES and ellipsometry.

DS 28.2 Fri 11:45 H32

Thermische CVD-Abscheidung von Si-C-Schichten — OLIVER DIRSUS, ●DIETER MERGEL und VOLKER BUCK — AG Dünnschicht-Technologie, Fb Physik, Universität Duisburg-Essen, 45117 Essen

Es wurden Si-C-Schichten bei Temperaturen von 880 bis 1050°C auf Si- und Quarz-Substraten abgeschieden und mit Röntgenbeugung, RBS, EDX und REM untersucht. Außerdem wurden Wachstumsraten, Massendichte und Schichtspannung bestimmt.

Das Schichtwachstum ist thermisch aktiviert und auf Si-Substraten schneller als auf Quarz-Substraten. Die Schichten enthalten mehr C als Si. Oberhalb von 930°C entstehen SiC-Körner. Bei den Schichtspannungen lassen sich thermische und intrinsische Anteile unterscheiden.

DS 28.3 Fri 12:00 H32

Nanometer thick antireflection coating for infrared light — ●BRUNO GOMPFF, JÜRGEN BEISTER, TOBBY BRANDT, JENS PFLAUM, and MARTIN DRESSEL — Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, D-70550 Stuttgart

The optical properties of ultrathin Au films on silicon have been studied in the infrared over a wide frequency range from 200 cm⁻¹ to 10.000 cm⁻¹. Thick films show a Drude behavior, i.e. with increasing frequency the transmission gets better; for films below the percolation threshold (at about 5 nm) a negative slope for the frequency dependent transmission is observed. When the thickness is further reduced, between 1 and 3 nm an anomaly occurs: the relative transmission reaches

maximum values above 100 % compared to the bare substrate, indicating an antireflection coating of nm thickness for light with $5\ \mu\text{m}$ wavelength. This anomaly can be explained in the framework of effective medium theories.

DS 28.4 Fri 12:15 H32

Influence of fluorine contamination on semiconductor wafer probing — ●MARKUS REINL¹, TORSTEN SULIMA¹, IGNAZ EISELE¹, OLIVER NAGLER², and FLORIAN KAESEN² — ¹Institut für Physik, Universität der Bundeswehr, Neubiberg — ²Infineon Technologies AG, München

Probing over active area (POAA) is getting more and more important in modern semiconductor production. As a result there is a strong demand on measuring the contact forces and the electrical resistance directly and online to get a better understanding of the failure mechanism. Therefore a new probing tool was developed at our institute. With our tool we can measure all probing relevant parameters like normal and lateral force and the electrical resistance directly on wafer level. In semiconductor production aluminum is still used as material for the probing and bonding pads. It is widely spread that the difficulties during probing are caused by the native aluminum oxide on top of the aluminum pads. We will show measurements for the electrical resistance on aluminum and on gold pads and show that the native oxide is not the only reason for a bad electrical resistance. Also fluorine contaminations, caused by fluorine plasma used to open the passivation for the probing pads, must be considered. To examine the influence of fluorine contaminations of the probing pads we will show measure-

ments of the contact forces and the electrical resistance on aluminum pads exposed to fluorine plasma.

DS 28.5 Fri 12:30 H32

Influence of in-situ phosphorus doping on crystal quality of MBE grown silicon — ●ULRICH ABELEIN, LOTHAR HÖLLT, TORSTEN SULIMA, and IGNAZ EISELE — Universität der Bundeswehr München, Institut für Physik, Werner-Heisenberg-Weg 39, 85577 Neubiberg

Molecular beam epitaxy (MBE) is a method for the epitaxial growth of silicon, which is very suitable for research applications as it allows in-situ doping, variation of layer thickness from a few to several hundred nanometers and changes of process parameters like growth rate and temperature over a wide range to optimise properties of grown layers. But especially the realization of extremely high doped layers, especially n-type with thickness of more than 50 nm, is difficult due to segregation and diffusion.

We investigated the crystal quality of highly phosphorus doped (up to $10^{20}\ \text{cm}^{-3}$) monocrystalline silicon layers with thickness of several 100 nm. Layers with various phosphorus concentrations were grown at temperatures between 200°C and 400°C to find a good trade off between crystal quality and achievable doping level. The analysis was done by secondary ion mass spectroscopy (SIMS) and scanning electron microscopy (SEM) after $\text{HF}:\text{C}_2\text{H}_4\text{O}_3$ etching. The result of this work was a process window for the growth of nearly defect free layers with homogenous phosphorus doping up to $10^{19}\ \text{cm}^{-3}$ and thickness above 300 nm.