THIN FILMS

DÜNNE SCHICHTEN (DS)

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OVERVIEW OF INVITED TALKS AND SESSIONS

(lecture rooms GER 37, GER 38)

Invited Talks

DS 2.1	Mon	11:15	(GER 37)	**Phase change materials for optical and electronic storage**, Ch. Steimer, R. Detemple, H. Dieker, J. Kalb, D. Wamwangi, W. Welnic, M. Wuttig, RWTH Aachen
DS 3.1	Mon	09:30	(GER 38)	**X-ray diffraction analysis of residual stress fields in thin films - basic aspects and applications**, Ch. Genzel, Hahn-Meitner-Institut, Berlin
DS 6.1	Mon	14:00	(GER 38)	**Direct observation of substrate-dependent organic layer growth**, E. Umbach[1], T. Schmidt[1], A. Schöll[1], H. Marchetto[2], H.-J. Freund[2], R. Fink[3], [1]University of Würzburg, [2]Fritz-Haber-Institute Berlin, [3]Max-Planck-Gesellschaft, University of Erlangen
DS 8.1	Tue	09:30	(GER 37)	**Strained silicon-transistor performance increase with new materials**, M. Hecker, L. Zhu, J. Rinderknecht, H. Geisler, E. Zschech, AMD Dresden
DS 11.2	Tue	11:30	(GER 38)	**Fluorescence from ultrathin organic films on crystalline surfaces**, M. Sokolowski, Universität Bonn
DS 15.1	Wed	15:30	(GER 38)	**Nanoparticulate films of high anisotropy magnetic materials: A status quo**, B. Rellinghaus, Leibniz-Institut für Werkstofforschung, Dresden
DS 16.1	Thu	09:30	(GER 37)	**Ion beam shaping of nanometals**, A. Vredenberg, Utrecht University
DS 18.5	Thu	10:30	(GER 38)	**Formation and decay of Si/Ge nanostructures at the atomic level**, B. Voigtländer, Forschungszentrum Jülich
DS 20.1	Thu	14:00	(GER 37)	**Nanostructures by grazing incidence ions: ripple patterns, athermal coarsening and subsurface channeling**, T. Michely, RWTH Aachen
DS 23.1	Thu	15:30	(GER 38)	**Laser-induced diffusion processes on metal particles**, A. Heilmann, Fraunhofer Institute for Mechanics of Materials, Halle (Saale)

Internal Symposium "Functional Thin Films - Future Applications and Challenges"

Organisation: Dr. Zschech, AMD Saxony LLC & Co. KG Dresden, and Prof. Dr. D. Schmeißer, BTU Cottbus

DS 5.1	Mon	14:00	(GER 37)	**Actual trends in optial coatings**, H. Lauth[1], N. Kaiser[2], [1]JENOPTIK Laser, Optik, Systeme GmbH, Jena, [2]Fraunhofer-Institut für Angewandte Optik und Feinmechanik, Jena
DS 5.2	Mon	14:45	(GER 37)	**New materials approaches for advanced nonvolatile memories**, T. Mikolajick, Infineon Technologies Dresden, Dresden
DS 5.3	Mon	15:30	(GER 37)	**EUV optical coatings**, H. Enkisch, S. Müllander, P. Kürz, Carl Zeiss SMT AG, Oberkochen
DS 5.4	Mon	16:30	(GER 37)	**OLEDs: Organic thin film devices for displays and lighting**, R. Paetzold, Siemens AG, Erlangen

DS 5.5 Mon 17:15 (GER 37) **Measurement of nanomechanical properties of low-k dielectric films**, H. Geisler, D. Chumakov, L. Jiang, P. Hofmann, C. Streck, U. Mayer, R.-Q. Su, E. Zschech AMD Saxony LLC & Co. KG Dresden

Internal Symposium "Nanoengineered Thin Films"
Organisation: Prof. Dr. M. Grundmann, Universität Leipzig
This symposium is supported by European Network of Excellence SANDiE

DS 13.1 Wed 14:00 (GER 37) **Adventures in atomic aggregation**, K. Robbie, J. Yang, C. Elliott, C. Buzea, Queen's University Kingston, Canada

DS 13.2 Wed 14:45 (GER 37) **Ion beam assited growth of chiral sculptured thin films**, E. Schubert[1], F. Frost[1], B. Fuhrmann[2], F. Heyroth[2], M. Schubert[3], B. Rauschenbach[1], [1]Leibniz-Institut für Oberflächenmodifizierung, Leipzig, [2]Martin-Luther-Universität Halle-Wittenberg, Halle(Saale), [3]University of Nebraska-Lincoln, Lincoln, USA

DS 13.3 Wed 15:30 (GER 37) **Emerging directions in sculptured-thin-film-research**, A. Lakhtakia, Pennsylvania State University, University Park, USA

DS 13.4 Wed 16:30 (GER 37) **From nanostructured ZnO-based thin films to arrays of free-standing nanowires: self-organized growth by pulsed laser deposition**, M. Lorenz, Universität Leipzig

DS 13.5 Wed 17:15 (GER 37) **Self-assenbled AlInN nano-grass with intrinsically curved crystal structure**, J. Birch[1], T. Seppänen[1], G.Z. Radnoczi[2], B. Pécz[2], L. Hultman[1], [1]Linköping University, Linköping, Sweden, [2]Hungarian Academy of Sciences, Budapest, Hungary

Lecture of the Gaede Prize Laureate

DS 12.1 Tue 14:00 (TRE Phys) **Understanding scanning tunneling microscopy experiments on transition-metal structures**, S. Heinze, Universität Hamburg

Sessions

DS 1	**Optical properties of thin films I**	Mon 09:30–11:00	GER 37	DS 1.1–1.6
DS 2	**Optical properties of thin films II**	Mon 11:15–12:45	GER 37	DS 2.1–2.4
DS 3	**Thin film analysis I**	Mon 09:30–11:00	GER 38	DS 3.1–3.4
DS 4	**Thin film analysis II**	Mon 11:15–12:45	GER 38	DS 4.1–4.6
DS 5	**Internal symposium "Functional thin films - future applications and challenges"**	Mon 14:00–18:00	GER 37	DS 5.1–5.5
DS 6	**Thin film anlysis III**	Mon 14:00–15:45	GER 38	DS 6.1–6.5
DS 7	**Mechanical properties of thin films**	Mon 16:00–18:00	GER 38	DS 7.1–7.8
DS 8	**Functional thin films I**	Tue 09:30–11:00	GER 37	DS 8.1–8.4
DS 9	**Functional thin films II**	Tue 11:15–13:00	GER 37	DS 9.1–9.7
DS 10	**Thin organic films I**	Tue 09:30–11:00	GER 38	DS 10.1–10.6
DS 11	**Thin organic films II**	Tue 11:15–12:15	GER 38	DS 11.1–11.2
DS 12	**Lecture of the Gaede Prize Laureate**	Tue 14:00–14:45	TRE Phys	DS 12.1–12.1
DS 13	**Internal symposium "Nanoengineered thin films"**	Wed 14:00–18:00	GER 37	DS 13.1–13.5
DS 14	**Growth of thin films**	Wed 14:00–15:15	GER 38	DS 14.1–14.5
DS 15	**Thin magnetic films**	Wed 15:30–17:15	GER 38	DS 15.1–15.5
DS 16	**Ion beam solid interaction I**	Thu 09:30–11:00	GER 37	DS 16.1–16.4
DS 17	**Ion beam solid interaction II**	Thu 11:15–12:45	GER 37	DS 17.1–17.6
DS 18	**Thin semiconducting films**	Thu 09:30–11:15	GER 38	DS 18.1–18.5
DS 19	**Thin film deposition and process characterisation I**	Thu 11:30–12:45	GER 38	DS 19.1–19.5
DS 20	**Ion beam induced nanostructures**	Thu 14:00–16:15	GER 37	DS 20.1–20.7
DS 21	**Laser and plasma processes**	Thu 16:30–18:00	GER 37	DS 21.1–21.6
DS 22	**Thin film deposition and process characterisation II**	Thu 14:00–15:15	GER 38	DS 22.1–22.5
DS 23	**Nanowires, nanoparticles and nanostructures**	Thu 15:30–17:30	GER 38	DS 23.1–23.6
DS 24	**Poster presentation**	Tue 15:00–17:30	P2	DS 24.1–24.79

Section Thin Films is participated in different joint symposia:

Symposium SYMS: Magnetic Switching
Monday, March 27, 15:00 - 18:30 h, room: HSZ 04
Organisation : U. Eckern, University Augsburg, and G. Dumpich, University Duisberg

Symposium SYNW: Nano Wires
Wednesday, March 29, 14:30 - 18:00 h, room: HSZ 04
Organisation: P. Echenque, University San Sebastian, Spain

General information:
All oral presentations are expected in electronic form! Details concerning hard- and software requirements will be sent to the speakers until the beginning of March 2006.

Meeting of the Members of the Section Thin Films / Dünne Schichten
Tuesday, March 28, 17:30 h
Room : GER 38

Schedule:

1. Report of the speaker
2. Symposia and invited talks 2007
3. Election
4. Miscellaneous

The meeting of the members of the "Deutschen Vakuumgesellschaft "(DVG) takes place after the meeting of the section Thin Films / Dünne Schichten (DS).

Sessions

– Invited, Contributed Talks and Posters –

DS 1 Optical properties of thin films I

Time: Monday 09:30–11:00 Room: GER 37

DS 1.1 Mon 09:30 GER 37

Spectroscopic ellipsometry of ZnO thin films grown by pulsed reactive magnetron sputtering at elevated temperatures — •M. Vinnichenko[1,2], A. Rogozin[1], N. Shevchenko[1], M. Ozerov[2], A. Kolitsch[1], and W. Möller[1] — [1]Institut für Ionenstrahlphysik und Materialforschung, Forchungszentrum Rossendorf, P.F. 510119, 01314 Dresden, Germany — [2]Division of Optics, Department of Physics, National Kyiv Taras Shevchenko University, 01033 Kyiv, Ukraine

Understanding of the growth process of undoped ZnO thin films is important for optoelectronic applications of the material. In this study, ZnO layers were deposited at single crystalline Al_2O_3 (0001) substrates by pulsed reactive magnetron sputtering. Oxygen partial pressure, base pressure and the substrate temperature (Ts) were varied systematically. The films were characterized by spectroscopic ellipsometry (SE), Seebeck effect measurements and X-ray diffraction (XRD). SE data were analyzed by using graded layer model for the film with Lorentz oscillator parameterization of the ZnO optical constants. The films produced at low temperatures always have negative Seebeck voltage, while at Ts>540 °C it changes to low positive values, which, however, degrade to negative values within several hours. The Lorentz oscillator broadening for the films grown at these temperatures increases with oxygen flow which points to a formation of more disordered structure inside ZnO grains in this case. XRD analysis yields decreasing grain size and increasing rocking curve full width on a half maximum with oxygen flow enhancement at the same Ts.

DS 1.2 Mon 09:45 GER 37

Optical properties of oxide films heavily doped with Ytterbium ions — •Georgiy Malashkevich[1], Oksana Chukova[2], Volodymyr Degoda[2], Sergiy Nedilko[2], and Sergiy Yablochkov[2] — [1]Institute of Molecular and Atomic Physics of BAS, 68, Skarini Ave., Minsk, Belarus — [2]Kyiv National Taras Shevchenko University, 2, block 1, acad. Hlushkov Ave., 03680, Kyiv, Ukraine

The films doped with ytterbium ions can find application in quantum electronics, e.g. as materials for UV- and near IR planar lasers, in scintillation technique as fast detectors of ionising radiations, including detection of neutrinos, etc.

The ytterbium ions are characterized by quasi-absence of cross-relaxation. Efficiency of the Yb^{3+} ions inner emission from 2F5/2 level and charge transfer luminescence are determined by nonradiation and radiation excitation, energy transfer from charge transfer state to the $^2F_{5/2}$ level of the Yb^{3+}, by rate of direct inner excitation and transfer of excitation from electron-hole pairs created under high energy excitation, as well as by cooperative processes and formation of paired centers.

The spectral-luminescent properties and processes of intra-center excitations transfer in $CeO_2H : Yb$ oxide nanoparticles and complicated $[FeO_6] : Yb$ centers in the nano-structured films created by the selection the redox conditions and buffer elements have been investigated. The noble metals (Ag^0, Au^0 and Pt^0) nanoparticles with different sizes and shapes in the films have been formed and their influence on hysteretic behaviour of cooperative luminescence from pairs of the Yb^{3+} ions was investigated. This work is supported by STCU Project 2042.

DS 1.3 Mon 10:00 GER 37

Optical properties of noble metal alloy nanocomposites prepared by vapor phase co-deposition. — •Haile Takele, Venkata Sai Kiran Chakravadhanula, Henry Greve, Vladmir Zaporjtchenko, and Franz Faupel — Lehrstuhl für Materialverbunde, Technische Fakultät der CAU Kiel, Kaiserstr. 2, 24143 Kiel, Germany.

Ag-Au and Ag-Cu nanoparticles have been prepared in a Teflon AF matrixes, by co-deposition of the components from three different evaporators in a high vacuum. The microstructure of the nanocomposites, alloy formation, and there optical properties were investigated by using TEM, XRD, and UV-Visble spectroscopy, respectively. A complete alloy formation of Ag-Au nanoparticles in a Teflon AF matrix provides a single surface plasmon resonance (SPR) that allows tuning over a large range of the visible spectrum. The resonance wavelength of Ag-Au alloy nanocomposites were defined by varying the ratio of the Ag and Au volume fraction at a constant metal volume fraction in the composites. Moreover, multiple resonance wavelengths were observed from immiscible elements of Ag-Cu alloy nanoparticles in a Teflon matrix. The effect of substrate temperature during deposition and post deposition annealing on the alloy formation and nanocomposite morphology were studied as well.

DS 1.4 Mon 10:15 GER 37

Size and Surroundings Dependence of the Optical Interband Excitations in Silver Nanoparticles — •Uwe Kreibig and Almuth Hilger — I. Institute of Physics (IA) RWTH Aachen University D-52056 Aachen, Germany

Ag nanoparticles (2 nm mean diameter) were produced by our thermal evaporation cluster source THECLA. By expansion into UHV a free particle beam was created which could be embedded in different co-evaporated dielectric embedding media. The optical absorption was measured in the VIS-nearUV region, and, by Kramers-Kronig analysis, the average dielectric function of the particle material was determined. The susceptibility of the 4d-5sp interband transition edge could then be separated by subtracting the Drude-Sommerfeld contribution. Two essential results will be discussed: 1) The fine structure of the interband transition edge of the free nanoparticles differs markedly from bulk Ag. 2) The deviations from the bulk Ag spectrum depend clearly on the kind of embedding medium, applied. They are larger for LiF than for SiO_2 but both are smaller than for the free particles.

DS 1.5 Mon 10:30 GER 37

Vapor induced changes in optical and electrical properties of quasi 2-dimensional metal/polymer nanocomposites near the percolation threshold for sensor applications — •Christian Pochstein, Vladimir Zaporojtchenko, Henry Greve, and Franz Faupel — Lehrstuhl für Materialverbunde, Technische Fakultät der CAU Kiel, Kaiserstr. 2, 24143 Kiel, Germany

Easy producible sensors for organic chemical vapor detection are of increasing interest for various applications. We have produced quasi two dimensional systems of noble metal (Au, Ag) clusters embedded in different polymer films (PMMA, PS, Nylon6). The polymer films were prepared via spin-coating in various thicknesses from 100 to 500 nm on different substrates. The clusters with the density near the percolation threshold were synthesized by the deposition of metal in high vacuum on the polymer surface. The threshold was determined by in-situ measurements of the electrical resistance. The size and density of the clusters were specified by TEM measurements. The time dependent resistance measurements showed that responses of the sensor-nanocomposite to different organic vapors depends on the composite conductivity, the polymer thickness and the vapor pressure. In addition the shift of the plasmon resonance due to the absorbance of the solvent vapor was observed by using UV-Visible spectroscopy.

DS 1.6 Mon 10:45 GER 37

Optical properties of ultra-thin metal films at and below the percolation threshold — •Tobby Brandt, Bruno Gompf, Natalia Drichko, and Martin Dressel — 1. Physikalisches Institut der Universität Stuttgart

While the optical properties of thicker metal films are well understood, little has been done at and below the metal-to-insulator transition (percolation threshold), especially in the infrared region.

We present temperature dependent FTIR reflection measurements in the range 500 to 6000 cm^{-1} on ultra-thin gold films grown on vicinal Si (111)(7x7) surfaces. The films with thicknesses between 9 nm and

0.4 nm were characterized in situ under UHV conditions between 300 K and 5 K.

The thicker films show normal Drude behaviour with an increasing reflectivity toward lower frequencies. At about 2 nm the metal-to-insulator transition is observed. Here the films show a nearly frequency and temperature independent optical conductivity. Below 2 nm a dielectric anomaly was observed with an inverted temperature characteristic. The data are analysed within the framework of the model given by D. Bedeaux and V. Vlieger [1], which has the advantage compared to effective medium theories, that it takes explicitly the interaction with the interface into account.

[1] D. Bedeaux and J. Vlieger ; "Optical Properties of Surfaces"; Imperial Collage Press, 2001

DS 2 Optical properties of thin films II

Time: Monday 11:15–12:45 Room: GER 37

Invited Talk DS 2.1 Mon 11:15 GER 37

Phase Change Materials for Optical and Electronic Storage — •Christoph Steimer, Ralf Detemple, Henning Dieker, Johannes Kalb, Daniel Wamwangi, Wojciech Welnic, and Matthias Wuttig — I. Physikalisches Institut 1A RWTH-Aachen, 52056 Aachen, Germany

Phase change materials are commercially used in rewritable optical storage and currently investigated as non-volatile electronic storage to replace conventional FLASH-memory. A short laser or current pulse of high intensity melts a sub-micron spot of crystalline material before quenching to the amorphous state. A second pulse of lower intensity but longer duration leads to a weaker spatial temperature profile and activates recrystallisation. Since reflectivity and conductivity of the amorphous state are lower, a third even weaker laser - or current pulse can be used to read out the state of the bit without changing it. As recrystallisation is the slowest process involved, materials with a small structural difference between the crystalline and amorphous phase promise higher data transfer rates. Such structural similarity however limits the optical and electronic contrast between the phases, i.e. readability, and the stability against spontaneous recrystallisation, i.e. data retention. Despite of their commercial application material development of PC-media still heavily relies on empirical approaches. This contribution summarizes recent progress in understanding how stoichiometry determines the structure of the crystalline and the amorphous phase and the resulting electronic differences.

DS 2.2 Mon 12:00 GER 37

Optical properties of reactively sputtered chromium nitride films — •Kostas Sarakinos and Matthias Wuttig — I. Insitute of Physics (IA) RWTH Aachen University 52056 Aachen, Germany

A study of the optical properties of reactively sputtered Cr_xN_y (1<x< 2, y<1) films is presented. The films have been sputtered in an Ar/N_2 atmosphere at various values of the reactive gas (N_2) flow from 0-50 sccm. Since the phase formation and the stoichiometry of the films upon the variation of the N_2 flow has already been established [1], their effect on the optical properties is investigated. Spectroscopic Ellipsometry has been utilized for the optical characterization of the films. The ellipsometric spectra have been fitted using the combined Drude-Lorentz model. The unscreened Drude plasma energy has been used in order to monitor the evolution of the optical properties of the films. Films deposited at low N_2 flows exhibit high values of and thus metallic conductivity. On the other hand, above 19 sccm of N_2 flow , which is indicative for the absence of free electrons and electronic conductivity. The non metallic behavior above 19 sccm coincides with the predominance of a CrN_{1-x} phase with rocksalt structure. Samples above 19 sccm N_2 flow have been fitted with the Tauc-Lorentz model. Depending on the film stoichiometry within this regime a band gap up to 0.21 eV has been determined. This is in agreement with other experimental reports which state that the cubic CrN phase is a narrow band gap semiconductor.

[1] K. Sarakinos et al, submitted for publication

DS 2.3 Mon 12:15 GER 37

Film Thickness Dependence on The Optical Properties of Ni Thin Films — •Farnaze Maghazeh[1], Hadi Savaloni[1,2], and Michael A Player[3] — [1]Plasma Physics Research Center, Science and Research Campus of I. A. University, P. O. Box 14665-678, Tehran, Iran — [2]Department of Physics, University of Tehran, North-Kargar Street, Tehran, Iran — [3]Department of Engineering, University of Aberdeen, Aberdeen AB24 3UE, U.

Abstract

Ni films of 30 to 130 nm thickness deposited on glass substrates, at 590 K substrate temperature. The optical reflectivity of samples were measured, using spectrophotometery method in the spectral range of 200 to 3000 nm. The optical functions of the films were obtained by Kramers Kronig method. The Effective Medium Approximation (EMA) analysis was used to establish the relationship between the structural changes through film thickness and EMA predictions. The predictions of the Drude free-electron theory are compared with experimental results for dielectric functions of Ni films of different thickness. The variation of both real part and imaginary part of the dielectric constant with film thickness is discussed. Keywords: Effective Medium Approximation (EMA); Optical functions; Substrate temperature; Kramers Kronig; Drude Model.

DS 2.4 Mon 12:30 GER 37

Substrate Temperature Dependence on The Optical Properties of Ti Thin Films — •Haleh Kangarloo[1], Hadi Savaloni[1,2], Fahimeh Farid-Shayegan[1], and Michael Player[3] — [1]Plasma Physics Research Center, Science and Research Campus of I. A. University, P. O. Box 14665-678, Tehran, Iran — [2]Department of Physics, University of Tehran, North-Kargar Street, Tehran, Iran — [3]Department of Engineering, University of Aberdeen, Aberdeen AB24 3UE, U.K

Abstract

Ti films of 68 nm thickness deposited on glass substrates, at different substrate temperatures (Ts). Their optical properties were measured by spectrophotometery in the spectral range of 200 to 3000 nm. Kramers Kronig method was used for the analysis of the reflectivity curves of samples to obtain the optical constants. The influence of Ts on the microstructure of thin metallic films [Structure Zone Model (SZM)] is well established (Movchan and Demchishin (1969); Thornton (1975);Savaloni et al(1995, 2002)). The Effective Medium Approximation (EMA) analysis was used to establish the relationship between the SZM and EMA predictions. The predictions of the Drude free-electron theory are compared with experimental results for dielectric functions of Ti films of different Ts. The real part of the dielectric constant is increased with substrate temperature, while the imaginary part of the dielectric constant, in general, decreased with increasing the temperature over the whole energy range measured, including interaband and interband regions.

DS 3 Thin film analysis I

Time: Monday 09:30–11:00 Room: GER 38

Invited Talk DS 3.1 Mon 09:30 GER 38

X-ray diffraction analysis of residual stress fields in thin films - basic aspects and applications — •Christoph Genzel — Hahn-Meitner-Institut (c/o BESSY), Albert-Einstein-Straße 15, D-12489 Berlin

Thin films grown by physical or chemical vapour deposition have to meet various demands. The fields of application extend from wear protection of cutting tools to rather sophisticated superlattice structures used in microelectronics. At any rate, thin film deposition induces more or less high residual stresses in the growing layer, which influence the material properties to a great extent and therefore, have to be analysed carefully. In this connection X-ray diffraction takes up a key position, because it allows for a nondestructive and phase-selective investigation of the residual stress state. The application of well-established X-ray stress

analysis (XSA) techniques to thin film systems, however, leads to a series of problems which are mainly due to the small layer thickness and the pronounced texture. Different approaches in thin film XSA are discussed with respect to their ability to a depth resolved evaluation of in-plane residual stress gradients within the layer (system). A useful criterion for classifying the individual methods is given by the way used to assign the measured diffraction signal to a certain information depth within the film. It will be shown, that both the so-called Laplace space methods, the depth resolution of which is based on the exponential beam attenuation, and the real space methods using a small volume gauge defined by narrow slits in the primary and the diffracted beam can be applied successfully to special cases in thin film stress gradient analysis.

DS 3.2 Mon 10:15 GER 38

In-situ Study of the Thermal Stability of Fe-Pt Multilayers — •Nikolay Zotov, Jürgen Feydt, Alan Savan, and Alfred Ludwig — Forschungszentrum Caesar, Ludwig-Erhard-Allee 2, D-53175 Bonn

Annealing of Fe-Pt multilayers has attracted attention as a promising reaction pathway for the synthesis of FePt hard-magnetic thin films. Such nanostructures are possible candidates for high-density magnetic recording devices or exchange-spring magnets due to the very large magnetocrystalline anisotropy of the fct FePt phase. Fe-Pt multilayers with modulation periods 2.42 and 3.75 nm were fabricated by magnetron sputtering. Simulations of the high-angle satellites at room temperature revealed the presence of strong (111) texture, some Fe-Pt intermixing during the deposition and vertical grain sizes of about 16-24 nm. The structural evolution of the multilayers with temperature was studied by in-situ X-ray diffraction between 300 and 603 K. Two temperature regimes are established. Below 534 K a slow diffusion with coherent interfaces, no change of the texture and minor decrease of the lateral grain size of the multilayers is observed. Above 534 K, a fast diffusion causes incoherent variations of the modulation periods, increase of the vertical misorientations of the grains and significant changes of the lateral grain sizes, which might suggest the presence of grain boundary diffusion in the multilayers with small modulation period. Both multilayers transform at about 583 K into the fcc FePt phase. The phase transition is of first-order and a power law describes the order parameter with a critical exponent equal to 0.97(2), which is practically independent of the modulation period.

DS 3.3 Mon 10:30 GER 38

Growth and roughness evolution of sputtered aluminum oxide films on organic and inorganic substrates — •S. Sellner[1,2,3], A. Gerlach[3,4], S. Kowarik[3,4], F. Schreiber[3,4], N. Kasper[1,5], H. Dosch[1,2], S. Meyer[6], J. Pflaum[6], and G. Ulbricht[7] — [1]MPI für Metallforschung, Stuttgart — [2]Institut für Theoretische und Angewandte Physik, Universität Stuttgart — [3]Institut für Angewandte Physik, Universität Tübingen — [4]Physical and Theoretical Chemistry Laboratory, Oxford University — [5]ANKA, FZ Karlsruhe — [6]III. Physikalisches Institut, Universität Stuttgart — [7]MPI für Festkörperforschung, Stuttgart

Aluminum oxide is an important material in thin film technology. One critical parameter in thin film growth is the roughness evolution of a growing film with film thickness ($\sigma = L^{\beta}$). We present a comparative study of the growth of sputtered aluminum oxide films on silicon oxide and on organic films of diindenoperylene (DIP). From X-ray diffraction measurements we extract the scaling exponent β of aluminum oxide growth on both substrates. By renormalising the aluminum oxide roughness by the roughness of the underlying organic film we find good agreement with β as obtained from the aluminum oxide on silicon oxide (β=0.37), suggesting a remarkable similarity of the aluminum oxide growth on the two substrates under the conditions employed. We emphasize that aluminum oxide layers deposited on top of organic films have shown the potential to serve as encapsulation material in organic devices and to strongly enhance the thermal stability of the organic films.

[1] Sellner et al., Adv. Mater. 16 (2004)
[2] Sellner et al., J. Mat. Res., in print

DS 3.4 Mon 10:45 GER 38

Residual stress analysis in multilayer systems with synchrotron radiation - complementary investigations using angle and energy dispersive diffraction methods — •Manuela Klaus, Ingwer Denks, and Christoph Genzel — Hahn-Meitner-Institut (c/o BESSY), Albert-Einstein-Straße 15, D-12489 Berlin

Residual stress analysis in multilayer systems consisting of stacks of alternating sublayers poses a special challenge for the measuring as well as the evaluation procedures to be applied. So neighbouring sublayers in the stack may be of similar composition leading to strongly overlapping diffraction lines, or sublayers of identical structure contributing to the same diffraction line are separated by small sublayers of other structure. In both cases problems arise, when the measured diffraction signal should be assigned to some information depth within the multilayer. To overcome these difficulties, different approaches are possible. In any case, they require the use of highly parallel synchrotron radiation being available within a broad energy range that extends from about 5 keV to about 150 keV. It will be shown that both, angle and energy dispersive diffraction yield results which complement one another. So wavelength tuning at absorption edges, for example, allows for the separated analysis of adjoining near surface sublayers being similarly composed, whereas high resolution white beam strain scanning yields depth resolved information even on burried sublayers close to the interface as well on the residual stress distribution in the substrate itself.

DS 4 Thin film analysis II

Time: Monday 11:15–12:45 Room: GER 38

DS 4.1 Mon 11:15 GER 38

Determination of Mn valency using ELNES in the (S)TEM — •Thomas Riedl, Thomas Gemming, and Klaus Wetzig — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

The analysis of electron energy-loss near-edge structures (ELNES) in the (S)TEM provides a tool to probe the symmetry-projected density of unoccupied states near the Fermi level at high spatial resolution. In particular, the Mn-$L_{2,3}$ and O-K edges undergo characteristic changes with Mn valency. With increasing Mn valency the white-line intensity ratio $I(L_3)/I(L_2)$ decreases and the energy separations between (a) Mn-L_3 and O-K_a and (b) O-K_b and O-K_a increase [1]. Our ELNES measurements of $La_{1-x}Sr_xMnO_3$ (x=0.2, 0.4) manganites indicate that the Mn valence sensitivity of both energy separations exceeds that of $I(L_3)/I(L_2)$ by a factor of ≈2. With respect to the impact of oxidation states on the performance of magnetoelectronic devices based on manganite thin films the mentioned Mn valence-sensitive ELNES quantities have been investigated at the $La_{1-x}Sr_xMnO_3$ /$SrTiO_3$ interface. Preliminary results point to a reduction of the Mn valency close to the interface [2].

[1] J. H. Rask et al.: Ultramicr. 21 (1987) 321
[2] We acknowledge the DFG for financial support via FOR 520, project GE 1037/8.

DS 4.2 Mon 11:30 GER 38

Epitaxial anatase (012) and (001) films grown on (110) and (100) $SrTiO_3$ — •Andriy Lotnyk, Stephan Senz, and Dietrich Hesse — Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle, Germany

Rutile, anatase and brookite are well known polymorphs of TiO_2. The rutile structure is the thermodynamically most stable structure of TiO_2 at high temperatures and is the most widely studied. The anatase phase is a low temperature phase. This modification cannot be easily obtained with good crystallinity and its fundamental properties are not well understood. We report on the growth of epitaxial films of TiO_2 on (110) and (100) $SrTiO_3$ (STO). A TiO_2 target was electron beam evaporated in a high vacuum system with $P_{O2}=1\times10^{-2}$ Pa. The substrates were heated at temperatures between 500°C and 1100°C during deposition. The grown films were investigated by XRD, AFM and TEM. The films are predominantly of anatase (A) structure at substrate temper-

atures between 500°C and 600°C. Texture measurements revealed the following orientation relationships: (012)/[100]A ∥ (110)/[001]STO and (001)/[100]A ∥ (100)/[001]STO. The orientation relationship of anatase films on (110) STO is reported first. With increasing temperature the average grain size of the thin films is increasing, as indicated by AFM investigations. (HR)TEM observations revealed grain boundaries in the films.

DS 4.3 Mon 11:45 GER 38

Aberration correction used for interface characterisation with atomic resolution — •Meiken Falke[1], Andrew Bleloch[2], Uwe Falke[2], Gunter Beddies[1], and Steffen Teichert[1] — [1]Institut f. Physik, TU-Chemnitz, 09107 Chemnitz, Germany — [2]superSTEM, Daresbury Laboratory, Daresbury, WA44AD, UK

Recently aberration corrected dedicated scanning transmission electron microscopy with a probe size of 0.1 nm became available . The high angle annular darkfield signal acquired with this spatial resolution allows to distinguish between atomic columns of different composition in a crystal. Thus C_s-corrected dedicated STEM provides a powerful tool for studying metal silicon compounds (silicides) and their interfaces to the silicon substrate. Epitaxial cobalt- and nickel-disilicide silicon (001) junctions of buried thin films were studied by dedicated aberration-corrected STEM. Two different interface structures were unequivocally identified, one of which represents a (2×1) reconstruction found experimentally for the first time. The results are consistent with predictions from total energy calculations. Due to the cubic crystal symmetry of both, the silicide and the Si substrate, the interface consists of a patchwork of different domains. In addition to the usual misfit dislocations at a relaxed commensurate interface, here dislocations are required at the boundaries of those domains. A complex defect structure, was found to solve both crystallographic constraints. The Burgers vector for each type of interface domain junction could be derived from the identified atomic arrangement in the two interface structures and from crystallographic considerations.

DS 4.4 Mon 12:00 GER 38

Texture Characterization of Pyrolytic Carbon Layers: A Quantitative Study by Polarized Light Microscopy and Selected Area Electron Diffraction — •Andreas Pfrang[1], David Bach[2], Dagmar Gerthsen[2], and Thomas Schimmel[1,3] — [1]Institute of Applied Physics, University of Karlsruhe, D-76128 Karlsruhe, Germany — [2]Laboratory for Electron Microscopy, University of Karlsruhe, D-76128 Karlsruhe, Germany — [3]Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

Many properties of pyrolytic carbon strongly depend on the degree of texture which is frequently analyzed by polarized light microscopy (PLM) and selected area electron diffraction (SAED). PLM allows the fast determination of the extinction angle Ae. SAED exhibits a higher spatial resolution and allows the determination of the orientation angle.

A quantitative model for the relationship between extinction angle determined by PLM and orientation angle determined by SAED is presented and applied to our experimental data. The distribution of the orientation of coherent domains is derived from SAED data and the reflection coefficients of pyrolytic carbon are calculated as the sum of the reflection coefficients of the coherent domains. The only fit parameters in our model are the ratio of the reflection coefficients of the coherent domains for extraordinary and ordinary rays, and the relative phase shift. Good agreement between calculation and experiment is achieved.

[1] A. Pfrang, D. Bach, D. Gerthsen, Th. Schimmel. Texture analysis of pyrolytic carbon by polarized light microscopy and selected area electron diffraction. Carbon 2005, Gyeongju, Korea (2005)

DS 4.5 Mon 12:15 GER 38

Local density profiles in thin films and multilayers from diffuse x-ray and neutron scattering — •Markus Rauscher[1,2], Harald Reichert[1], Simon Engemann[1], and Helmut Dosch[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart, Germany — [2]Institut für Theoretische und Angewandte Physik, Universität Stuttgart, Pfaffenwaldring 57, 70469 Stuttgart, Germany

We develop a technique to determine local density profiles in rough thin films and multilayers for which conventional reflectometry does not work. The main idea is to integrate the total scattered intensity for a given vertical momentum transfer over the parallel momentum transfer. Probing Fourier space globally results in a local probe in real space and the integrated intensity is proportional to the local reflectivity of the surface. We also discuss the influence of a finite range of integration as well as sample inhomogeneities. This technique is limited to situations where the kinematic Born approximation is sufficient to describe the scattering process. However, in certain cases the technique can be used in the vicinity of the critical angle of total external reflection as well.

DS 4.6 Mon 12:30 GER 38

Coherence experiments with white synchrotron radiation — •Gudrun Gleber, Tobias Panzner, and Ullrich Pietsch — Universität Siegen, Siegen, Germany

3rd generation storage rings provide partly coherent radiation allowing a new kind of x-ray experiments, so called x-ray photon correlation spectroscopy (XPSC) experiments. XPSC experiments gives access to static or dynamic properties of a sample on a nanometer length scale.

Usually XPCS-experiments are performed by use of monochromatic radiation. To record the whole reciprocal space information by this way, one has to change stepwise the angle of incidence, which also will change the illuminated sample area and subsequently the diffraction pattern. Using a polychromatic beam provided at the energy dispersive reflectometry beamline (EDR-beamline) at the BESSY II and an energy dispersive detector, we are able to measure the same information without changing the incident angle which keeps the illuminated sample area constant. This is a big advantage for the surface reconstruction from the measured diffraction pattern. Due to the fact, that one energy spectrum gives access to different regions of the sample we are using this technique to observe slow processes in polymers.

In this talk we will report on the present status of the static and dynamic measurements in an energy dispersive regime.

DS 5 Internal Symposium "Functional thin films - future applications and challenges"

Time: Monday 14:00–18:00 Room: GER 37

Invited Talk DS 5.1 Mon 14:00 GER 37

Actual trends in optical coatings — •Hans Lauth[1] and Norbert Kaiser[2] — [1]JENOPTIK Laser, Optik, Systeme GmbH — [2]Fraunhofer Institut Angewandte Optik und Feinmechanik

Optical technologies have essential importance as driving forces of innovations in the markets of the 21st century. They are key technologies which create the conditions for a lot of new developments and their applications in the future. Today, optical coating has been regarded as one of the most important segment in optics technology. It can sufficiently improve the performance of the whole optical system, satisfy the function requirements, and therefore is an intensively active research field worldwide.

Optical coatings can be found in nearly every technical application. Meanwhile, it plays a significant role in many fields development. The efficiency of numerous applications and products in innovative and future technology fields is still limited by the quality of optical coatings. All optical coatings rely on control of nanodimensions. Thus, optical coatings are considered as one of the major enabling technologies for further progresses in many innovative applications.

It is a general trend to use shorter and shorter wavelengths. This trend is strongly driven by the lithography market, but other innovative markets too. The demands lead to the physical limits. This needs basic research in the fields of laser radiation - material interaction, material science, physical, chemical and micro - structural properties of thin films and surfaces. A general progress in the deterministic production is reached in Europe in the last years.

Invited Talk DS 5.2 Mon 14:45 GER 37

New Materials Approaches for Advanced Nonvolatile Memories — •Thomas Mikolajick — Infineon Technologies Dresden, Koenigsbrücker Strasse 180, 01099 Dresden

Driven by the rapid development of mobile applications the market for nonvolatile memory devices is rapidly growing. Today, the vast majority of nonvolatile memory devices are based on the floating gate device. The

floating gate transistor, however, is facing serious scaling limitations. One path to extend the scalability is to replace the floating gate by a charge trapping material. Moreover, the combination of charge trapping with a localized channel hot electron injection mechanism allows to store two physically separated bits in one memory cell. Floating gate as well as charge trapping memory concepts both suffer from severe performance limitations with respect to write and erase speed and endurance calling for a significant system overhead. A memory that works like a random access memory and is nonvolatile would simplify system design. This, however, calls for new switching effects that are based on integrating new materials into the memory cell. In this talk first the material innovations currently under investigation to extend the scalability of floating gate devices will be discussed. Then the current status and the prospects of charge trapping devices will be reviewed, demonstrating their superior scalability. Finally an outlook to memory concepts that use, ferroelectric switching, magnetic switching, phase change or other resistive switching effects will be given to illustrate how the integration of new materials may solve the limitations of today's semiconductor memory concepts.

Invited Talk DS 5.3 Mon 15:30 GER 37

EUV Optical Coatings — •Hartmut Enkisch, Stephan Müllender, and Peter Kürz — Carl Zeiss SMT AG; 73446 Oberkochen; Germany

In the semiconductor community, the extreme ultra-violet lithography (EUVL) at 13.5 nm wavelength is considered to be the next-generation technology ensuring both optimum quality and throughput. Presently built lithographic tools make use of deep ultra-violet (DUV, 193 nm) radiation and are based on conventional refractive elements made of glass or transparent single crystals. Since radiation of 13.5 nm wavelength is strongly absorbed by virtually any material this approach is not possible in the EUV range. Therefore, EUVL tools exclusively consist of reflective elements. In order to obtain a sufficiently high reflectance, all mirrors to be operated near normal incidence have to be coated with multilayer coatings. They consist of a periodic stack of spacer and absorber layers possessing different refractive indices at the desired wavelength. These multilayer stacks work analogously to Bragg's Law and thus have a periodic length of about half the wavelength. Therefore, single-layer thicknesses of 3 to 4 nm have to be obtained. The requirements of the optical performance put stringent demands on the quality of the multilayer coatings, such as periodicity, temporal and thermal stability, lateral uniformity, absolute thickness, and film stress.

— 15 min. break —

Invited Talk DS 5.4 Mon 16:30 GER 37

OLEDs: Organic thin film devices for displays and lighting — •Ralph Paetzold, Arvid Hunze, and Joachim Wecker — Siemens AG, Corporate Technology, Erlangen, Germany

Organic materials can be used to fabricate e.g. electronic circuits, solar cells, light sensors, memory cells and light emitting diodes. Because of their huge market potential especially organic LEDs (OLEDs) are very attractive. Only about 10 years after the feasibility of OLEDs had been demonstrated in 1987 the first product entered the market in car radios. Today monochrome and full color OLED-displays can be found in many applications substituting established flat panel display technologies like TFT-LCDs. This is a consequence of their outstanding attributes: They are self-emissive, thin, video-capable and in addition they show a wide temperature operation range and allow a viewing angle of nearly 180° in conjunction with a low power consumption. As performance has steadily increased over the last years, today OLEDs are also under investigation as next generation light sources. In contrast to inorganic LEDs, they can be built as 2-dimensional flat area light sources that are lightweight, color tuneable, and potentially cheap. This will open up new degrees of freedom in design leading also to completely new applications.

In this contribution we will first introduce the basic principle of OLEDs with a focus on the physical processes that lead to light generation in thin organic films. An overview will be given on the main technologies used to build OLEDs and the current status OLED development is illustrated. The last part focuses on the challenges that have to be overcome to enable a sustainable success in the display and lighting markets.

Invited Talk DS 5.5 Mon 17:15 GER 37

Measurement of nanomechanical properties of low-k dielectric films — •H. Geisler, D. Chumakov, L. Jiang, P. Hofmann, C. Streck, U. Mayer, R.-Q. Su, and E. Zschech — AMD Saxony LLC & Co. KG, Wilschdorfer Landstr. 101, D-01109 Dresden, Germany

Interlayer dielectric (ILD) thin films with permittivities of k=3 are currently implemented in advanced integrated circuits to reduce the interconnect signal delay. According to the International Roadmap for Semiconductor Industries, a long-term goal is the fabrication of ILDs with k-values as close as possible to the physical limit k=1. One possible approach to approximate this target is to integrate nano-porous organo-silicate glass materials. As a drawback, low-k and ultra low-k materials possess much lower Young's modulus and hardness values than conventional SiO_2 glasses which have been used so far. This is a critical issue since ILD films must withstand patterning, chemical mechanical polishing, etching, thermal cycling and chip-packaging. Their adhesion inside multilayer interconnect stacks must be as good as possible to prevent reliability issues or delamination. As a consequence, the mechanical properties of (ultra) low-k thin films have to be characterized carefully to improve performance and to maintain reliability. Since ILD film thicknesses and Cu-low-k structure sizes are typically in the range of a few hundred nanometers or below, suitable mechanical characterization techniques need to be operated on the nano scale. It is shown that nanoindentation with in-situ probe scanning, special force-modulation AFM as well as global and local adhesion measurement techniques can fulfill this task.

DS 6 Thin film analysis III

Time: Monday 14:00–15:45 Room: GER 38

Invited Talk DS 6.1 Mon 14:00 GER 38

Direct observation of substrate-dependent organic layer growth — •Eberhard Umbach[1], Thomas Schmidt[1], Achim Schöll[1], Helder Marchetto[2], Hans-Joachim Freund[2], and Rainer Fink[3] — [1]Experimental Physics II, University of Würzburg, D-97074 Würzburg, Germany — [2]Fritz-Haber-Institute, Max-Planck-Gesellschaft, D-14195 Berlin, Germany — [3]Physical Chemistry, University of Erlangen, D-91058 Erlangen, Germany

The growth of highly ordered or even epitaxial organic thin films on inorganic substrates very much depends on the preparation parameters like temperature and deposition rate as well as on the molecular properties, interface bonding, and substrate morphology. Various high resolution surface sensitive techniques are successfully applied to get a deeper understanding of the substrate bonding, intermolecular interaction, and electronic properties of interface and organic thin film. A novel spectro-microscope with aberration correction and energy filtering allows the direct observation of layer growth and the spectroscopic study of nano-objects like organic crystallites. With this instrument called SMART structural, chemical, and electronic properties as well as their dynamic development can be investigated with down to 2 nm spatial, $<$ 100 meV electron energy, and 10 to 50 meV photon energy resolution. The SMART is briefly introduced, and several examples of organic layer growth are discussed. These show the transition from Stranski-Krastanov to Franck-van der Merwe growth, the influence of substrate steps and step bunches, and the dependence of the growth properties on temperature and molecule. (Funded by BMBF, contract 05KS4WWB/4)

DS 6.2 Mon 14:45 GER 38

High Resolution Rutherford Backscattering Spectrometer — •Martin Schnell, Michael Uhrmacher, Carsten Ronning, and Hans Hofsäss — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

A standard Rutherford Backscattering (RBS) set-up is equipped with silicon charged-particle detectors, which posess an energy resolution of 10 to 15 keV. This results in a limited depth resolution of about 5 to 10nm for stoichiometry analysis of thin films.

In this work, we describe a RBS set-up, which has been connected to the 500 keV heavy ion accelerator IONAS at the University of Göttingen. Using up to 1 MeV He^{2+} or 500 keV H^+ as incident ion beams,

the backscattered ions are now analyzed in a cylindrically shaped electrostatic analyzer with 30 cm radius and 6 mm electrode separation. As detector we will use segmented channelplate detectors or silicon strip detectors, providing about 1 mm position resolution, corresponding to an excellent energy resolution of 1 keV. The expected depth resolution is about 1 nm for an analyzing depth up to 100 nm.

We will discuss the feasibility of this method for the "non destructive"investigation of nanoscale multilayer thin films, interface and surface reactions. First experimental results will be presented.

DS 6.3 Mon 15:00 GER 38

Ionenstrahlmikroskopische Untersuchungen an synthetischen Kylindrit-Mikrostrukturen mit hohem Aspektverhältnis und verschiedenen Grundflächen — •Christoph Meinecke[1], Ronny Kaden[2], Jürgen Vogt[1], Klaus Bente[2], and Tilman Butz[1] — [1]Institut für Experimentelle Physik II, Universität Leipzig; Linnéstraße 5; 04103 Leipzig — [2]Institut für Mineralogie Kristallographie und Materialforschung, Universität Leipzig; Scharnhorststr. 20; 04275 Leipzig

Das Mineral Kylindrit gehört zu den Sulfosalzen und besitzt in der natürlichen Form die Stöchiometrie $FeSn_4Bb_3Sb_2S_{14}$. Neben einer komplexen Chemie sind auch die physikalische Eigenschaften des Kylindrites, wie para- bzw. ferromagnetisches Verhalten und die Bandlücke von ca. 0.7 eV "narrow band gap" interessant. Ziel dieser Arbeit war es an synthetisch, mittels CVT, erzeugtem Kylindrit die Stöchiometrie zu bestimmen. Dafür wurden Kylindrit-Mikrostäbe mit runder und rechteckiger Grundfläche, ionenstrahlanalytisch an der Ionenstrahl-Nanosonde LIPSION (Universität Leipzig) untersucht. Vorteil dieser Analysemethode ist, dass die Mikrostrukturen im Ganzen analysiert wurden und danach für weitere physikalische Untersuchungen, wie z.B. Messung der elektrische Leitfähigkeit und des Halleffektes, zur Verfügung standen. Dazu musste bei der Auswertung der PIXE und RBS Spektren die Morphologie der Mikrostruktur berücksichtigt werden. Diesbezüglich wird hier vorgestellt, wie diese Techniken, die sonst zur Dünnschichtanalyse benutzt werden, zur Analyse von Mikrostrukturen modifiziert werden können und welche Auswirkungen die Morphologie der Probe auf die Spektrenform hat.

DS 6.4 Mon 15:15 GER 38

Characterization of nanostructures by conducting AFM — •Andrei Andreev, Yue Hou, and Christian Teichert — Institute of Physics, University of Leoben, Franz-Josef-Str. 18, A-8700 Leoben, Austria

The Conducting Atomic-Force Microscope (C-AFM) is a conventional AFM working in contact mode, where the usual AFM tip is replaced by a conductive tip. Between the tip and the sample a voltage is applied and the resulting current is measured using a special amplification circuit. The C-AFM is well known as a valuable tool for nanometer scale characterization of electric and topographic properties of very thin oxide layers [1,2].

In this work, we focus on the capabilities of C-AFM technique for spatially resolved investigations of various nanostructures like hybrid organic-inorganic structures, metallic nanowires or light emitting organic nanofibers. Here, the applicability of C-AFM, in particular of two-dimensional current mapping, for the characterization of such nanostructures is presented.

[1] S. Kremmer, et al., Mat. Sci. Eng. B102 (2003), 88
[2] S. Kremmer, et al., J. Appl. Phys. 97 (2005), 074315

DS 6.5 Mon 15:30 GER 38

Inhomogeneities in film properties deposited in large area magnetron sputter devices — •Ronny Kleinhempel, Benjamin Graffel, Gunar Kaune, Hartmut Kupfer, Walter Hoyer, and Frank Richter — Chemnitz University of Technology, Institute of Physics, D-09107 Chemnitz

An industrial application of thin films requires optimized functional film properties as well as a lateral homogeneity of these parameters. Especially by using large area deposition devices like rectangular magnetron sources it is necessary to keep the process parameters constant at each substrate point. We deposited indium tin oxide (ITO) films using a dual magnetron powered by a sine-wave generator at a frequency of 70 kHz and constant power of 4 kW. The films were deposited by reactive sputtering from rectangular (130x400 mm^2) alloy targets (In-90/Sn-10) in an Ar/O_2 gas mixture. The substrates were either moved (dynamic deposition) or kept at a fixed position in front of the targets. For a high deposition rate and a low electrical resistivity it is preferable to work in the transition mode at set-points close the metallic target mode. This includes the risk that a small decrease of oxygen partial pressure causes a lower film transparency. This fact does not appear in a homogeneous way, but it appears always at the same substrate position. These lateral inhomogeneities are reflected in film properties like electrical resistivity, average grain size and residual stress as well. Discussing the film properties and the results of plasma measurements reveals that low transparency is connected to a smaller charge carrier density in the plasma. The reduced charge carrier density results in a lower residual stress.

DS 7 Mechanical properties of thin films

Time: Monday 16:00–18:00 Room: GER 38

DS 7.1 Mon 16:00 GER 38

Characterization, mechanistic study and mechanical properties of diamond/ß-SiC nano-composite thin films — •Venkata Satya Siva Srikanth Vadali, Thorsten Staedler, and Xin Jiang — Institute of Materials Engineering, University of Siegen, Paul-Bonatz-Str. 9-11, 57076 Siegen, Germany

Diamond thin films often feature poor adhesion on many substrates due to high mechanical stresses induced by a difference in the thermal expansion coefficient between the diamond film and the substrate. One option to overcome this difficulty is to prepare composite films consisting of diamond and a second phase. In this work the synthesis of smooth nanocrystalline diamond/ß-SiC composite films, which are prepared by a microwave plasma assisted chemical vapor deposition process usually used to deposit pure diamond films in combination with the introduction of tetramethylsilane (TMS), will be reported. The composition of the films is controlled by adjusting the TMS concentration in the reaction gas. Changing the TMS flow during a deposition process even allows for gradient composite layers. The morphology and the crystallographic structure of these composite films were characterized by SEM, XRD and Raman spectroscopy. The surface roughness of the films was analysed by AFM. Both, hardness and friction co-efficient values of films prepared with various TMS flow rates were obtained using nanoindentation techniques and will be discussed.

DS 7.2 Mon 16:15 GER 38

Phase stability in ultra thin multilayer systems containing Zr, Ta, Nb, Mo and Fe or Fe(Zr) alloy layers — •Andreas Grob, Mohammad Mujeebuddin, and Ulrich Herr — Universität Ulm, Abteilung Werkstoffe der Elektrotechnik, Albert-Einstein-Allee 47, 89081 Ulm

The properties of binary ultra thin multilayer systems undergo significant changes with respect to the bilayer period. Depending on the selected material combination for the constituent single layers structural, elastic and magnetic properties are affected. Various investigation techniques such as x-ray reflectometry, x-ray diffraction, magnetometry and surface acoustic wave measurements have been carried out on multilayer systems prepared by DC magnetron sputtering under high vacuum conditions. The systems studied consisted of Zr, Ta, Nb and Mo as one layer material and Fe or an iron-rich Fe-Zr alloy as the other layer respectively. The results indicate the stabilization of amorphous phases due to the large interface to volume ratio. With increasing layer thickness a transition from amorphous to crystalline phase is observed in many cases. For some material combinations the phase transitions are accompanied by large changes in elastic properties compared to continuum elasticity theory calculations of the average elastic properties expected for the corresponding multilayers. Additionally a thermodynamic model is used to predict the phase stability for different single layer thickness.

DS 7.3 Mon 16:30 GER 38

Evaluation of Adhesion of Diamond/Tungsten carbide Composite Films Prepared by Microwave Plasma Assisted CVD. — •Hisham Abu Samra, Ruijiang Hong, Thorsten Staedler, and Xin Jiang — Institute of Materials Engineering, University of Siegen, Siegen, Germany

Diamond coatings are in demand in a wide range of applications. Unfortunately, the adhesion issues of this film system in the context of many technical substrates are still to be solved. One proposed solution is to increase the adhesion strength by depositing a functional gradient diamond/carbide composite film. In this study, we investigate the adhesion strength of the following coating systems: (i) diamond (ii) diamond/tungsten carbide and (iii) diamond with diamond/tungsten carbide composite as an interlayer on tungsten and WC-Co substrates. The films were prepared in a single microwave plasma assisted chemical vapour deposition (MWCVD) process. The adhesion strength was assessed by employing indentation tests using a Brinell indenter with loads up to 1225 N. In addition, Finite-Element-Method (FEM) simulations were carried out to calculate the stress state and the stress distribution of these systems. The simulation results are correlated with the experimental findings.

DS 7.4 Mon 16:45 GER 38

Yield strength of soft and brittle porous materials by nanoindentation — •Matthias Herrmann[1], Norbert Schwarzer[2], and Frank Richter[1] — [1]Solid State Physics, Institute of Physics, TU Chemnitz, Germany — [2]Saxonian Institute of Advanced Surface Mechanics, Eilenburg, Germany

Yield stress and Young's modulus of the above mentioned materials have been investigated in order to understand the material behaviour under typical loading conditions for instance during the chemical-mechanical polishing process.

For the characterization of such soft and brittle layers, no adequate method exists. Two usable methods for the determination of yield stress of porous materials will be demonstrated which are based on Pharr's concept of the effectively shaped indenter. It assumes the plastically/elastically deformed zone beneath the indenter as an equivalent indenter and enables one to evaluate the complete elastic stress field during nanoindentation. One of us (N.S.) has proposed an extension of Pharr's concept which allows the evaluation of the yield stress for the case of higher amounts of inelastic deformation even at low applied loads.

Our investigations were done on mesoporous SiO_2 xerogel as well as MSQ-based films on silicon with porosities of 30 up to 57 volume percent. The film thickness was in the range of 600 nm. The yield strength was in the range of 75 - 150 MPa and the Young's modulus between 1 and 4 GPa, depending on material (xerogel or MSQ) and porosity.

DS 7.5 Mon 17:00 GER 38

Stress in TiO_2 thin films — •Janika Boltz, Dieter Mergel, Nicolas Wöhrl, and Buck Volker — Thin film working group, Physics Department, University Duisburg-Essen, 45117 Essen

Thin films of TiO_2 have been prepared on silicon substrates by rf diode sputtering. Substrate temperature, sputter pressure and oxygen content in the sputter gas have been varied to obtain a variety of microstructures.

For every sample, mass density, film stress and crystallinity have been determined. The mass density ranges between 3.2 and 4.2 g/cm^3. The films exhibit amorphous, anatase, rutile and mixed structures depending on the preparation conditions.

The film stress is in the range +0.2 GPa (tensile) to -2 GPa (compressive). It is mainly determined by the sputter pressure during deposition and the mass density of the films. By measuring the temperature dependence of the film stress, intrinsic and thermal stress can be distinguished.

DS 7.6 Mon 17:15 GER 38

Cubic boron nitride coatings (c-BN) on cemented carbide cutting tools — •Ulrike Springborn[1], Sung-Tae Park[1], Eric Wiemann[2], Kai Weigel[1], Martin Keunecke[1], and Klaus Bewilogua[1] — [1]Fraunhofer Institute for Surface Engineering and Thin Films, Bienroder Weg 54 E, D-38108 Braunschweig — [2]Institute for Machine Tools and Factory Management, TU Berlin, Pascalstraße 8 - 9, D-10587 Berlin

Cubic boron nitride is the 2nd hardest of all known materials. In combination with other promising properties, like very high wear resistance, c-BN is a very attractive tool coating material. With a modified PVD sputter technique from a boron carbide target c-BN coatings with thicknesses over 1 μm could be deposited on pre-coated cemented carbide cutting inserts. After a first adhesion layer of a hard material, like TiN or TiAlN, a boron carbide layer is deposited. In the following B-C-N gradient layer deposition the c-BN nucleation takes place. The total coating thickness is in the range of 3 - 4 μm with a 1 to 2 μm thick c-BN top layer. The coating process and results from different mechanical and tribological characterisation methods will be presented in detail. The mechanical properties of the super hard, nano-crystalline c-BN coating systems with hardness above 60 GPa and Young's modulus about 550 - 800 GPa are comparable with c-BN bulk material. The feasibility of c-BN coating systems as a super hard tool coating will be verified by results of cutting tests with coated cemented carbide cutting inserts.

DS 7.7 Mon 17:30 GER 38

Residual Stress Control in Nanocrystalline Diamond Films — •Nicolas Wöhrl and Volker Buck — Thin Film Technology Group, Dept. of Physics, University of Duisburg-Essen, Universitätsstr. 3-5, 45141 Essen, Germany

Nanocrystalline diamond films were deposited with a microwave CVD plasma source. The nanocrystalline films shown here were deposited in a pressure range between 200 and 300 mbar from an $Ar/H_2/CH_4$ plasma. The films were characterized by two wavelength scanning micro Raman spectroscopy, FTIR and SEM measurements.

Residual stress is a critical parameter in thin film deposition and crucial for technical applications of nanocrystalline diamond films because the adhesion of the films on the substrate is affected by the intrinsic stress. High residual stress can lead to cracking or even to delamination of the film from the substrate. An ex-situ optical device (SSIOD 'Surface Stress Induced Optical Deflection') was used to measure the curvature of silicon substrates coated with nanocrystalline diamond films. With respect to Stoney's equation one can calculate the residual stress from the curvature of the substrate. Taking the different thermal expansion coefficients of the diamond and the silicon substrate into account the intrinsic stress was determined from the stress measurements. It is shown that the intrinsic stress in the substrate can be varied in a wide range just by controlling the deposition parameters. A possible explanation for the origin of the intrinsic stress is given based on the data taken from Raman Spectroscopy and FTIR Spectroscopy.

DS 7.8 Mon 17:45 GER 38

Thermomechanical Properties of Thin α-Iron Films Above Room Temperature — •Thomas Wübben, Andreas Schneider, Gunther Richter, and Eduard Arzt — Max-Planck-Institut für Metallforschung, Stuttgart

The mechanical properties of thin metal films as compared to their bulk counterparts have been in the focus of materials science in the recent years. Owing to their technological importance, almost only metals with a face centered cubic structure like copper and aluminum have attracted scientific interest. Thin films made of bcc metals, on the other hand, have been largely neglected. However, from a scientific point of view, the mechanical properties of bcc metals are of special interest. As an example, the yield stress of bcc metals is strongly temperature dependent for low temperatures, while it shows a behavior similar to fcc metals for higher temperatures. The mechanisms for this so-called brittle to ductile transition (BDT) are still not understood in full detail. A major problem is the understanding of dislocation dynamics in bcc systems. As a model system we chose iron with a BDT temperature slightly above room temperature. A first step is to verify in thin films that for temperatures above the BDT the thermomechanical behavior of bcc metals resembles that of fcc metals. To test this, we applied the substrate curvature method under vacuum to thin iron films for temperatures from 40°C to 540°C. We will present results of these measurements obtained with iron films with thicknesses down to 100 nm and compare these to the thermomechanical behavior observed for metals with fcc crystal structure.

DS 8 Functional thin films I

Time: Tuesday 09:30–11:00 Room: GER 37

Invited Talk DS 8.1 Tue 09:30 GER 37

Strained silicon - transistor performance increase with new materials — •Michael Hecker, Liang Zhu, Jochen Rinderknecht, Holm Geisler, and Ehrenfried Zschech — AMD Saxony LLC & Co. KG Dresden, Wilschdorfer Landstrasse 101, D-01109 Dresden

In semiconductor industry, there is an ongoing tendency of downscaling device dimensions, accompanied by a continuous improvement of transistor performance. However, there are physical limits of downscaling within the present CMOS technology. One possibility to improve the device performance nevertheless is to introduce dedicated strain into the channel region of the field-effect transistors. Whereas global strain on the whole wafer level has been extensively investigated in the previous years, there is a rapidly increasing interest in generating local strain on the scale of single transistor channels. The talk compares several methods to create strain in the active regions for N- and PMOS transistors. To achieve the desired performance gains, huge strains and related stresses ranging into the GPa region are necessary in silicon. Detection and measurement of such stresses in unpatterned films can be achieved by several methods, whereas actually stress or strain determination with high spatial resolution in local device regions is crucial. As a promising technique to measure the local strain state, a Raman spectroscopy approach is discussed.

DS 8.2 Tue 10:15 GER 37

ELS to determine the band gap of thin dielectric layers — •Matthias Bergholz, Rakesh Sohal, and Dieter Schmeisser — Brandenburgische Technische Universität Cottbus, Angewandte Physik-Sensorik, Konrad-Wachsmann-Allee 17, 03046 Cottbus

In ultra thin layers of high-K materials the value of the band gap can be derived not explicitly although it is a key quantity in the electric behavior. We use ELS with a monochromatized (50 meV - 150 meV) electron gun and primary energies between 20 eV and 30 eV. Starting with the native SiO_2/Si(001) layers we find that loss function of the substrate dominates for using primary energies beyond 50 eV. In contrast at energies below 50 eV the loss intensity can be used to derived the band gap with an accuracy of ±200 meV. We compare thin (<3 nm) films of HfO_x, Pr_2O_3, Al_2O_3 and Si-Oxynitrides and discuss the band gap values as well as the scattered intensity observed within the gap.

DS 8.3 Tue 10:30 GER 37

Phase stability and epitaxial growth of NiMn-based magnetic shape memory thin films using MBE technique — •R. Hassdorf[1], J. Feydt[2], and M. Moske[1] — [1]Thin adaptive films, Research center caesar, 53175 Bonn, Germany — [2]Electron microscopy, Research center caesar

In a theoretical approach using *ab initio* calculations, we established that in the system Ni-Mn-Al the magnetic ground state close to the Heusler stoichiometry is ferromagnetic ordered [1]. Moreover, as for the lattice dynamics of the system, the cubic $L2_1$ Heusler structure is shown to be unstable against shear displacement along the [110] direction which confirms the tendency to form modulated martensitic structures in this regime. Indeed, such structures, namely 2M and 14M, are found experimentally in coexistence within thin film samples grown by MBE technique, with a composition around $Ni_{50}Mn_{30}Al_{20}$.

The structural transition from the disordered B2 to the fully ordered $L2_1$ phase is subject of current investigations. Hereto, NiMn(Ga,Al) alloy thin films were realized by co-deposition of Ni, Mn, and Al on top of single-crystal GaAs at elevated temperatures. As demonstrated from XPS and Auger depth profiling, Ga is incorporated into the film structure almost homogeneously due to its high diffusion mobility. An epitaxial relationship between film and substrate has been confirmed by RHEED. The compositional and microstructural aspects will be discussed.

[1] T. Büsgen, J. Feydt, R. Hassdorf, S. Thienhaus, M. Boese, A. Zayak, P. Entel, and M. Moske, Phys. Rev. B 70, 014111 (2004).

DS 8.4 Tue 10:45 GER 37

Ultra thin dielectric film on silicon — •Ali Bahari P. — Physics Department, Mazandran University, Iran

In the current CMOS CPU generation the silicon gate oxide is 1.2 nm thick. A shrinking of this thickness with one atomic layer for the next generation will lead to a couple of orders of magnitude increase in tunneling current. Another critical issue for future generations is gate oxide degradation due to boron penetration into the oxide from the polysilicon gate electrode. We have recently demonstrated a number of new processes to grow ultra thin silicon nitride and aluminium oxides, based on the self limiting nature of the direct interaction between atomic nitrogen produced in a microwave discharge and heated silicon surfaces. The procedure to grow ultra thin films of aluminium oxide (and nitride) employ a two step process including evaporation of aluminium to less than monolayer coverage followed by gas exposure at room temperature. The pure ultrathin silicon nitride and aluminium oxide (and nitride) films have been grown and studied on silicon in ultrahigh vacuum and studied by XPS and synchrotron in SDU and Aarhus facilities in Denmark. The obtained results indicate that it might be possible to substitute silicon oxide with silicon nitride or aluminium oxide films.

DS 9 Functional thin films II

Time: Tuesday 11:15–13:00 Room: GER 37

DS 9.1 Tue 11:15 GER 37

Characterization of Chemical Bonding in Low-K Dielectric Materials for Interconnect Isolation: XAS and EELS Study — •P. Hoffmann[1], D. Schmeisser[1], F. Himpsel[2], H.-J. Engelmann[3], E. Zschech[3], H. Stegmann[4], and J.D. Denlinger[5] — [1]LS Angewandte Physik, BTU Cottbus, Conrad-Wachsmann-Allee 17, 03046 Cottbus — [2]University of Wisconsin / Madison (USA) — [3]AMD Saxony LLC & Co KG, Dresden (Germany) — [4]Carl Zeiss NTS GmbH, Oberkochen (Germany) — [5]ALS Berkley / California (USA)

The use of low dielectric constant materials in the on-chip interconnect process reduces interconnect delay, power dissipation and crosstalk noise. In CVD deposited organo-silicate glass (OSG) the substitution of oxygen in SiO_2 by methyl groups (-CH_3) reduces the permittivity significantly (from 4.0 in SiO_2 to 2.6-3.3 in the OSG). However, plasma processing removes C and H containing molecular groups. Therefore, compositional analysis and chemical bonding characterization of structured films with nanometer resolution is necessary. OSG thin films as-deposited and after plasma treatment are studied using XAS and EELS. In both techniques, the fine structure near the C1s edge allows to identify C-H, C-C, and C-O bonds. XAS spectra have been recorded for non-patterned films and EELS spectra for patterned structures. The chemical bonding is compared for as-deposited and plasma-treated low-k materials. The fluorescence and the electron yield recorded while XAS measurement are compared. Examination of the C 1s near-edge structures reveal a modified bonding of the remaining C atoms in the plasma-treated sample regions.

DS 9.2 Tue 11:30 GER 37

High-k Metal-Insulator-Metal Capacitors for Radio Frequency Mixed-Signal Application — •Christian Wenger, Anil U. Mane, Roland Sorge, Guenter Weidner, Thomas Schroeder, Jarek Dabrowski, Gunther Lippert, Peter Zaumseil, and Hans-Joachim Muessig — IHP microelectronics

RF (radio frequency) SiGe technologies make it possible to integrate the RF section of wireless devices with baseband processors. The RF circuits convert the input radio signals into signals that can be converted into digital data for the baseband processor. The ADC/DAC conversion is integrated into the SiGe technology, furthermore MIM capacitors occupy a large area of the signal conversion part. Thus the introduction of high-k materials into MIM capacitors to reduce the area attracts much

attention. Due to the restrict capacitance voltage linearity requirements, the electrical performance of MIM capacitors with a single layer high-k dielectric miss these requirements. However, the voltage linearity can be engineered by using a stacked structure of high-k and Silicondioxide dielectrics. Stacked MIM capacitors with high capacitance density and engineered voltage linearity will be presented.

DS 9.3 Tue 11:45 GER 37

Growth and stress evolution of reactively sputtered ZrN films — •Patrick Karimi and Matthias Wuttig — I. Institute of Physics (1A), Aachen University, 52056 Aachen, Germany

In this study we present the growth, in-situ stress evolution as well as optical properties of DC sputtered ZrN thin films grown on Si substrates. The variation of N_2 flow during the Zr deposition processes results in ZrN with different properties. Film characterization has been done by Rutherford backscattering spectroscopy (RBS), x-ray diffraction (XRD), x-ray reflectometry (XRR), in-situ stress measurements and spectroscopic ellipsometry. From the deposition characteristics it has been shown that ZrN exhibits a weak hysteresis. The deposition rate initially increases and then characteristically drops with increasing N_2 flow. RBS and GXRD studies show structure evolution from hexagonal Zr, to cubic understoichiometric ZrN and stoichiometric ZrN films. We have shown that the drop in the sputter rate by 41.5 % after the transition point is accompanied by significant drop of the (111) texture coefficient while (200) texture coefficient starts to rise sharply. Film thickness, density, surface and interface roughness were deduced from XRR experiments. The stress evolution has been explained in-terms of the bombardment and subplantation mechanism, which induces the observed increase in cell volume. Optical constants of ZrN films have been investigated by spectroscopic ellipsometry and the results are correlated with RBS and XRR experiments.

DS 9.4 Tue 12:00 GER 37

Stöchiometrische Eigenschaften von, in Atmosphärendruckplasma abgeschiedenen, SiOx-Schichten — •Marcel Hähnel, Volker Brüser, and Holger Kersten — INP Greifswald, F.-L.-Jahn Straße 19, 17489 Greifswald

Schichten, die aus siliziumorganischen Monomeren abgeschieden wurden, können zum Beispiel als UV- und Kratzschutz, als Antireflexschichten, als hydrophobe Schichten sowie für physikalisch und chemisch stabile dielektrische Schichten dienen. Ebenso zahlreich wie die Anwendungen sind auch die Untersuchungen der Eigenschaften in Abhängigkeit von den verschiedensten Prozessparametern. Die bei den PECVD-Verfahren ablaufende Plasmachemie ist, in Abhängigkeit vom eingesetzten Monomer, kaum oder gar nicht verstanden.

Das Anliegen dieser Arbeit ist die Untersuchung solcher Schichten, die aus HMDSO als Monomer in verschiedenen Argon-Sauerstoff Gemischen abgeschieden wurden sowie der Vergleich mit den in der Literatur beschriebenen Schichteigenschaften. Die Depositionen erfolgten unter Atmosphärendruck in einer dielektrisch behinderten Oberflächenentladung. Neben der starken Abhängigkeit der Kohlenstoffkonzentration in den Schichten von der Sauerstoffkonzentration des Prozessgases, werden auch Zusammenhänge der auf Silizium normierten Kohlenstoff- und Sauerstoffkonzentrationen in den Schichten vorgestellt. Aus dem Vergleich mit der Literatur wird deutlich, dass die Schichteigenschaften (z.B. SiOx-Stöchiometrie) bei den verschieden PECVD-Verfahren gleiches Verhalten in den Kohlenstoff -zu Sauerstoffkonzentrationen zeigen.

DS 9.5 Tue 12:15 GER 37

Titanium at the interface between Si and high-k silicates — •Jarek Dabrowski, Grzegorz Lupina, Gunther Lippert, Anil Mane, and Hans-Joachim Müssig — IHP, Im Technologiepark 25, 15236 Frankfurt(Oder), Germany

When a high-k film containing a high concentration of fast interface states is covered with a Ti overlayer and subsequently annealed, most of the fast states disappear. By analysing the behavior of Ti at SiO_2/Si(001) interfaces as revealed by ab initio calculations, we discuss the mechanism of this effect. Passivation by substitution is excluded because a Ti atom substituting a Si atom with a dangling bond has similar electrically active states in the gap as a Si dangling bond. Moreover, the Ti atom would not stop at the interface to substitute the Si atom, but would advance into the substrate to form a seed of a metallic Ti silicide inclusion. We may also exclude that Ti dissolved in the film induces a recombination of interfacial dangling bonds indirectly, through strain field. This is because the recombination would require a long-range reconstruction of the oxidized Si, but the passivation occurs already at 200°C. We argue that the electrically active interfacial defects passivated by Ti are valence-alternation defects associated with high compressive stress. Such defects are expected to appear in SiO_x at the very interface because the oxidation of Si occurs in a constrained manner under the high-k film. Titanium atoms dissolved in the interfacial silicate layer expell Si atoms, while the metallic Ti overlayer drains oxygen from the defected interfacial sites. This results in Si regrowth in previously strained areas

DS 9.6 Tue 12:30 GER 37

Quantenkinetic description of the electron-phonon-interaction in intersubband systems — •Stefan Butscher and Andreas Knorr — Institut für theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin Hardenbergstr. 36, 10623 Berlin, Germany

The effect of quantum kinetic (non-Markovian) electron-phonon for semiconductor intersubband transitions is investigated. At low temperatures and even in weakly coupled systems we find that electron phonon interaction leads to a suppression of Coulomb binding effects. Furthermore, for the case of strong electron-phonon interaction a quantum kinetic description is important even at room temperatures.

DS 9.7 Tue 12:45 GER 37

Preparation and characterization of rare earth scandate thin films for high-κ applications — •M. Wagner[1], T. Heeg[1], J. Schubert[1], C. Zhao[2], M. Caymax[2], St. Lenk[1], and S. Mantl[1] — [1]Institute of Thin Films and Interfaces and CNI, Research Centre Jülich, D-52425 Jülich, Germany — [2]IMEC, Kapeldreef 75, B-3001 Leuven, Belgium

Rare earth scandate thin films ($GdScO_3$ and $DyScO_3$) were deposited on a native SiO_2 or HF last surface of (100) silicon substrates using either pulsed laser deposition or electron beam evaporation. The films were investigated by means of Rutherford backscattering spectrometry, high temperature X-ray diffractometry, X-ray reflectometry, transmission electron microscopy and atomic force microscopy. Capacitor stacks with metal contacts have been electrically characterized. With both deposition techniques stoichiometric amorphous films with smooth surfaces (roughness RMS < 1 Å) were achieved. The amorphous phase of the films proved to be stable up to 1000°C. The films grown by pulsed laser deposition revealed featureless C-V-curves with nearly no hysteresis and a κ-value around 20 extracted from a CET plot. An interfacial SiO_2 grown during deposition could be observed. Films grown by electron beam evaporation show nearly no interfacial layer. A dielectric constant of 23 was determined. Consequently, a CET value of 1.5 nm along with a low leakage current density of 2.5×10^{-4} A/cm^2 could be achieved. The main advantage of the evaporation technique is that particulate free films can be homogeneously deposited over a wide area. A deviation of $< 5\%$ in film thickness over a 2"-wafer was obtained.

DS 10 Thin organic films I

Time: Tuesday 09:30–11:00 Room: GER 38

DS 10.1 Tue 09:30 GER 38

Application of infrared spectroscopic ellipsometry in studies of electrochemically grafted thin organic monolayers — •K. Roodenko[1], J. Rappich[2], R. Hunger[3], M. Gensch[1], A.G. Güell[4], Th. Dittrich[5], A. Merson[6], Y. Shapira[6], N. Esser[1], and K. Hinrichs[1] — [1]ISAS-Institute for Analytical Sciences, Dept. Berlin, Albert-Einstein-Str. 9, 12489, Berlin, Germany — [2]Hahn-Meitner Institute Berlin GmbH, Abt. SE1, Kekulestr. 5, 12489 Berlin — [3]Institute of Material Science, TU Darmstadt, Petersenstr. 63, 64287 Darmstadt, Germany — [4]Dept. Quimica Fisica, Universitat de Barcelona, c/ Marti i Franques, 108028 — [5]Hahn-Meitner Institute Berlin GmbH, Abt. SE2, Glienicker Str. 100, 14109 Berlin — [6]Dept. of Physical-Electronics, Faculty of engineering, Tel-Aviv University, 69978, Tel-Aviv, Israel

Infrared spectroscopic ellipsometry (IR-SE) is a non-destructive method, which is based on measuring of changes in the polarization state of radiation upon reflection from a sample. When performed in the infrared spectral range, information on molecular composition and structure can be gained through the absorption bands of molecular vibrations. Due to its high sensitivity, this method was applied to study electrochemically grafted organic thin films, such as methoxybenzene and nitrobenzene, on silicon substrates. Formation of the organic layer was confirmed by this method [1], as well as the formation of silicon oxide under certain grafting conditions. A model for competing processes during electrochemical grafting was developed by cross-referencing the IRSE results with synchrotron XPS results.

[1]. M. Gensch et al, J. Vac. Sci. Technol. B 23, 1838 (2005)

DS 10.2 Tue 09:45 GER 38

Systematic trends in the surface roughness of organic films — •Phenwisa Niyamakom, Maryam Beigmohamadi, Azadeh Farahzadi, Stephan Kremers, Thomas Michely, and Matthias Wuttig — I. Insitute of Physics (IA) RWTH Aachen University 52056 Aachen, Germany

Depending on the specific application, different surface morphologies are required for organic thin films. For example, in optoelectronic applications, the absence of long-range order in amorphous films can result in smooth surfaces and efficient radiative recombination, which allows for the realization of high performance organic optoelectronic devices. In order to tailor surface morphologies and hence film properties, an understanding of thin film growth is very important. For the organic film investigated in this study, the film morphology and surface roughness was measured by X-ray reflectometry (XRR) and Atomic Force Microscopy (AFM). The surface morphologies were studied for films of N,N'-diphenyl-N,N'-bis(1-naphthyl)-1-1'biphenyl-4,4"diamine (α-NPD), 4,4'-bis(2,2' diphenylvinyl)-1,1'-biphenyl (DPVBI) and 2,2',7,7'-tetrakis(2,2-diphenylvinyl)spiro-9,9'-bifluorene (Spiro-DPVBI). A clear difference in roughness of the different materials is observed and explained by a model. The influence of the deposition rate has been investigated in addition for films of N,N'-diphenyl-N,N'-bis(1-naphthyl)-1-1' biphenyl-4,4"diamine (α-NPD) and tris-(8-hydroxyquinoline)aluminum (Alq3).

Financial support by the BMBF is gratefully acknowledged.

DS 10.3 Tue 10:00 GER 38

XANES and resonant Auger measurements of benzo-annelated Copper Porphyrazine molecules — •D. R. Batchelor[1], D. Pop[2], A. Schöll [1], S. Kera [3], B. Winter [2], W. Freyer [2], and E. Umbach[1] — [1]Exp.Physik II, Univ. Würzburg — [2]MBI für Nichtlineare Optik und Kurzzeitspektroskopie, Berlin — [3]Faculty of Engineering, Chiba University, Japan

High resolution x-ray absorption spectra from a family of linear benzo-annelated copper porphyrazine molecules have been measured at the nitrogen K and copper $L_{2,3}$ edges in an effort to understand the charge transfer between the central copper atom and the conjugated ring of nitrogen atoms. The spectra are very distinctive showing a clear trend in energy structure and an energy shift of the main π^* resonances. Calculations using the STOBE code for both edges are able to reproduce the structure and shift well. Auger resonance experiments for copper phthalocyanine exhibit a large spectator shift and show that the main π^* resonance contains appreciable, if not dominating, orbital excitations besides those simply involving the LUMO. This is contrary to the normal interpretation of XANES data and demonstrates the complex nature of the excitation and at the same time the wealth of information obtainable in such experiments.

Funded by BMBF under contract no. 05KS4WWC/2

DS 10.4 Tue 10:15 GER 38

Molecular Orientation of ZnPc grown on Silicon(111) Substrates and its Influence on the Optical Constants. — •Sindu John Louis[1], Daniel Lehmann[1], Katy Roodenko[2], Karsten Hinrichs[2], Norbert Esser[2], Marion Friedrich[1], and Dietrich R. T. Zahn[1] — [1]Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany — [2]ISAS - Institute for Analytical Sciences, Department Berlin, Albert-Einstein-Straße 9, 12489 Berlin, Germany.

To improve the electronic properties of opto-electronic devices, the molecular stacking and the optical constants of the organic compounds are of great interest. Thin films of ZnPc were prepared by Organic Molecular Beam Deposition (OMBD) on silicon substrates. Variable Angle Spectroscopic Ellipsometry (VASE) measurements in the infrared, visible and ultraviolet regions and infrared (IR) reflection measurements were used to study the samples.

From the ellipsometry data evaluation the film thickness, surface roughness and the ZnPc optical constants were determined. These optical constants depend strongly on the method of preparation. Together with the evaluation of infrared reflection spectra and of transmission spectra of KBr pellets with ZnPc powder these results show that the films are optically anisotropic. The results are used to extract the average molecular tilt angle and to generate optical constants and spectra for isotropic films and for films of molecules which are oriented perpendicular and parallel to the substrate surface.

DS 10.5 Tue 10:30 GER 38

Ellipsometric Study of an Organic Template Effect — •Ovidiu D. Gordan[1], Takeaki Sakurai[2], Katsuhiro Akimoto[2], Marion Friedrich[1], and Dietrich R. T. Zahn[1] — [1]Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany — [2]Institute of Applied Physics, University of Tsukuba, Japan

The research of the last decade proved that organic materials can be used as a low cost alternative to inorganic semiconductors. However, optimizing the performance of the organic devices remains a challenging task, as the electronic and optical properties of the organic layers strongly depend on the preparation conditions and molecular orientation. It was already shown [1] that the molecular orientation can be controlled using an organic template layer.

In this work we demonstrate the template effect of 3,4,9,10-perylenetetracarboxylic dianhydride (PTCDA) on metal-free phthalocyanine H_2Pc molecules studied by spectroscopic ellipsometry. From the differences [2] between in-plane and out-of-plane components of the dielectric function, the molecular orientation was deduced. It was found that the strong interaction of the PTCDA π orbitals with the H_2Pc π orbitals modifies the growth mode of H_2Pc molecules on PTCDA with respect to the growth on glass and oxidised silicon substrates.

[1] T. Sakurai, S. Kawai, J. Shibata, R. Fukasawa and K. Akimoto, Jpn. J. Appl. Phys. 44 (2005) 1982
[2] O. Gordan, M. Friedrich, D. R. T. Zahn, Organic Electronics 5 (2004) 291

DS 10.6 Tue 10:45 GER 38

Real-time observation of organic semiconductor growth: Evolution of structure and surface morphology — •S. Kowarik[1,2], A. Gerlach[1,2], S. Sellner[1], F. Schreiber[1], J. Pflaum[3], L. Cavalcanti[4], and O. Konovalov[4] — [1]Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen — [2]Physical and Theoretical Chemistry Laboratories, Oxford University, South Parks Road Oxford OX1 3QZ — [3]Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, D-70550 Stuttgart — [4]ESRF, 6, rue Jules Horowitz-B.P.220, 38043, Grenoble, Cedex 9, France

We use in-situ real-time X-ray scattering during growth of the organic semiconductors rubrene and diindenoperylene (DIP) to study the evolution of the film structure with time. We manage to produce "movies"of the changes in reflectivity and grazing incidence diffraction (GID) during organic molecular beam deposition. These measurements yield structural and morphological information for a range of film thicknesses, and also contain information about the dynamics of growth. For DIP we identify

structural transitions during growth and follow the evolution of the surface morphology. For rubrene we find a relatively low surface roughness (sigma below 15 Å for thicknesses up to at least 600 Å) and a significant delay in the onset of roughening with thickness. This anomalous behavior may be related to conformational changes in the early stages of the growth.

DS 11 Thin organic films II

Time: Tuesday 11:15–12:15 Room: GER 38

DS 11.1 Tue 11:15 GER 38

Molecular Ordering of Thin DNA Base Films on Vicinal Silicon Surfaces — •Simona Silaghi[1], Dietrich Zahn[2], and Norbert Esser[1] — [1]ISAS - Institute for Analytical Sciences, Department Berlin, D-12489, Germany — [2]Institute of Physics, TU Chemnitz, D-09107, Germany

The adsorption of DNA bases particularly on semiconductor surfaces is motivated by biosensing and nanotechnology applications [1]. An important issue for future applications is the capability to fabricate well-ordered structures with characteristic dimensions in the nanometer range. In this sense vicinal surfaces may serves as suitable templates for molecular ordering. Here, reflectance anisotropy spectroscopy (RAS) is employed for monitoring the molecular ordering of DNA bases on vicinal H:Si(111). It is observed that DNA bases behave differently on the vicinal surfaces. The first transition dipole moments of adenine and thymine molecules align mainly perpendicular to the step edge direction while for guanine and cytosine they align parallel to this direction [2]. Additionally, time-resolved RAS measurements demonstrate the sensitivity to the biomolecular/inorganic interface formation.

[1] K. Meeker and A.B. Ellis, J. Phys. Chem. B 104 (2000) 2500

[2] D.R.T. Zahn, S.D. Silaghi, C. Cobet, M. Friedrich, and N. Esser, Phys.stat.sol. (b) 242 (13) (2005) 2671

Invited Talk DS 11.2 Tue 11:30 GER 38

Fluorescence from ultrathin organic films on crystalline surfaces — •Moritz Sokolowski — Institut für Physikalische und Theoretische Chemie, Universität Bonn, Germany

Ultrathin ordered films of fluorescent organic molecules grown by vapour deposition on crystalline and atomically well-defined surfaces are presently of interest under both applied and fundamental aspects. In particular, they offer a possibility to study basic processes of excitons in molecular materials, e.g., in relation to the film structure, morphology, and thickness. This approach also makes use of the possibility that thin organic films can often be grown in different polymorphic, partly metastable, structures on surfaces, as a consequence of the chemical bonding of the molecules to the substrate surface, and can thus lead to new optical properties. We discuss fluorescence spectra of several examples of films of aromatic molecules, e.g., films of tetracene, grown on metallic and dielectric substrates. This work was supported by the DFG.

DS 12 Lecture of the Gaede Prize Laureate

Time: Tuesday 14:00–14:45 Room: TRE Phys

Prize Talk DS 12.1 Tue 14:00 TRE Phys

Understanding Scanning Tunneling Microscopy Experiments on Transition-Metal Structures — •Stefan Heinze — Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Scanning tunneling microscopy (STM) is one of the most important techniques to characterize nanostructures on surfaces with a resolution down to the atomic scale. However, the interpretation of such measurements is not trivial, especially on the atomic scale, due to contributions to the tunneling current from various sources such as structural, electronic, chemical, and magnetic properties. Successful interpretation approaches, e.g. the Tersoff-Hamann model, rely on an accurate description of the electronic structure of the sample. Hence, the combination with modern density functional theory (DFT) calculations has proven a powerful tool for the understanding of STM experiments.

Here, the theory of STM is applied to structures on transition-metal surfaces and a transparent method is introduced to correlate bandstructure features with STM measurements. With this approach surprising effects such as bias-dependent corrugation reversal, imaging of buried nanostructures, and even the detection of small spectroscopic signals due to spin-orbit coupling can be explained based on the electronic structure. Further, the theory of spin-polarized STM (SP-STM) is presented and the potential of SP-STM to unravel complex, e.g. non-collinear, magnetic structures on the atomic scale is demonstrated. A particular striking example is the verification of a two-dimensional antiferromagnetic structure in a monolayer of Fe, the prototypical ferromagnet, on W(001).

DS 13 Internal Symposium "Nanoengineered thin films"

Time: Wednesday 14:00–18:00 Room: GER 37

Invited Talk DS 13.1 Wed 14:00 GER 37

Adventures in Atomic Aggregation — •Kevin Robbie, Kate Kaminska, Jian Yang, Chelsea Elliott, and Cristina Buzea — Department of Physics, Queen's University, Kingston, ON, Canada, K7L 3N6

The conceptually simple experiment of sequentially depositing atoms onto a flat surface can yield surprisingly complex results. The resulting thin film coatings are seen to depend strongly, in structure and physical behaviour, on the arrival geometry of condensing atoms, in addition to the manifest dependence on chemistry, temperature, etc. Dynamic control of geometry during the growth of thin films, particularly under conditions of glancing vapour incidence, allows atomic-scale engineering of uniquely structured matter, exhibiting anomalous birefringence, chiral optical activity, magnetic anisotropy; and likely bioactivity, novel superconductivity and more.

This talk examines the origin of structure in atomically aggregated materials, and questions their usefulness as a nano-technology. Specific examples discussed will include: molecular ordering and light switching in a hybrid liquid crystal device, interference filters with continuously varying refractive index, highly anisotropic magnets, nanostructured silicon with an absolute birefringence of 0.4, and noble-metal 'pyramids' that arise through an as-yet unexplained mechanism. Atomic granularity is seen to play a central role in the emergence of complex form in these structures, suggesting that fundamental questions of predictability and chaos might be probed with this experiment.

Invited Talk DS 13.2 Wed 14:45 GER 37

Ion beam assisted growth of chiral sculptured thin films — •Eva Schubert[1], Frank Frost[1], Bodo Fuhrmann[2], Frank Heyroth[2], Mathias Schubert[3], and Bernd Rauschenbach[1] — [1]Leibniz-Institut für Oberflächenmodifizierung e.V., 04318 Leipzig, Permoserstr. 15 — [2]Martin-Luther-Universität Halle-Wittenberg, Interdisziplinäres Zentrum für Materialwissenschaften, Hoher Weg 8, D-06120 Halle(Saale) — [3]University of Nebraska-Lincoln, Department of Electrical Engineering, 209 WSEN, Lincoln, NE 68588-0511

The controlled preparation of materials with sizes smaller than 100 nm in at least one dimension is an up to date challenge in modern material science. Their functionality may exceed beyond knowledge and understanding gathered until today. Nanomaterials continue to spark research in science and engineering and are expected to emerge into wide-spread applications. Porous sculptured thin films (STF) consist of three-dimensional nanostructure components and are one example for

nanoengineered materials. The films originate from self organization processes during a highly directional growth mode under an extremely oblique particle flux angle of incidence combined with an appropriate substrate rotation. The growth regime allows for the customized fabrication of anisotropic thin films with different chiral morphologies. Novel material properties caused by the nanostructure morphology are discussed and predicted for new materials design.

Invited Talk DS 13.3 Wed 15:30 GER 37

Emerging Directions in Sculptured-Thin-Film-Research — •Akhlesh Lakhtakia — Department of Engineering Science and Mechanics, Pennsylvania State University, University Park, PA 16802-6812, USA

Sculptured thin films are assemblies of shaped, parallel, identical nanowires generally grown by vapor deposition techniques on substrates [1]. Their optical applications have advanced significantly during the last five years, but other applications have not progressed beyond the embryonic stage. In this lecture, several new directions in STF research shall be presented. These include: (a) STFs with transverse architectures; (b) deposition of polymeric STFs by replamineform, multibeam lithographic, and mixed vapor deposition techniques; (c) growth of bioscaffolds on STFs; (d) STF light emitters; (e) energetic STFs; and (f) electrically controlled STFs and punctuated STFs.

[1] A. Lakhtakia and R. Messier, Sculptured Thin Films: Nanoengineered Morphology and Optics (SPIE Press, 2005)

— 15 min. break —

Invited Talk DS 13.4 Wed 16:30 GER 37

From Nanostructured ZnO-Based Thin Films to Arrays of Free-Standing Nanowires: Self-Organized Growth by Pulsed Laser Deposition — •Michael Lorenz — Universität Leipzig, Institut für Experimentelle Physik II

Currently, the wide-bandgap material zinc oxide attracts considerable research interest in view of envisaged applications as fast scintillators, light emitting diodes, and UV lasers by taking advantage of efficient excitonic effects even at room temperature. Pulsed laser deposition (PLD) has proved to be a flexible and fast exploratory tool for the self-organized growth of ZnO-based, nanostructured thin films [1-2] and nanowire arrays [3-5]. The formation of nanosized grain structures in ZnO thin films that promote the outcoupling of luminescence light and determine electrical properties can be controlled via the background gas pressure in PLD. With further increasing gas pressure, arrays of free-standing ZnO-based nanowires can be grown reproducibly by PLD. This unique, high-pressure PLD process allows for a wide-range control of morphology, diameter, and composition of the nanowires and works successfully on various growth templates and in a wide temperature range. The PLD grown nanostructured thin films and nanowires show superior luminescence properties and are serving therefore as materials base for selected device demonstrations.

[1] E. M. Kaidashev, M. Lorenz et al., Appl. Phys. Lett. 82 (2003) 3901.
[2] M. Lorenz et al., Thin Solid Films 486 (2005) 205.
[3] M. Lorenz et al., Ann. Phys. (Leipzig) 13 (2004) 39.
[4] Th. Nobis et al., Phys. Rev. Lett. 93 (2004) 103903.
[5] M. Lorenz et al., Appl. Phys. Lett. 86 (2005) 143113.

Invited Talk DS 13.5 Wed 17:15 GER 37

Self-assembled $Al_{0.53}In_{0.47}N$ nano-grass with intrinsically curved crystal structure — •Jens Birch[1], Timo Seppänen[1], György Z. Radnoczi[2], Bela Pécz[2], and Lars Hultman[1] — [1]IFM, Linköping University, SE-58216 Linköping, Sweden — [2]Res. Inst. for Tech. Phys. and Mat. Sci. of the Hungarian Academy of Sciences, H-1525 Budapest, P. O. Box 59, Hungary

$Al_{1-x}In_xN$ is a very attractive semiconductor as the direct bandgap, ranging from 0.9 eV for InN to 6.2 eV for AlN, opens possibilities to engineer opto-electronic devices operating from near infra-red to deep ultra-violet. However, a miscibility gap in $Al_{1-x}In_xN$ between $0.1 < x < 0.9$ implies a necessity of low-temperature growth under kinetically limited adatom conditions. In this work epilayers of semiconducting $Al_{1-x}In_xN$ were grown by reactive magnetron sputter epitaxy (MSE) with directional fluxes of Al and In onto static (111)-oriented single crystal ZrN seed layers under ultra-high-vacuum conditions at a temperature of 300 °C. High resolution electron microscopy of $Al_{0.53}In_{0.47}N$ reveals densely packed ≈10 nm wide single crystal whiskers growing with curvature of approximately 0.09°/nm, giving about 26.5° for the entire length (300 nm) of the column, as confirmed by X-ray diffraction. It is shown that a generically new materials structure is formed which is characterized by extreme crystal lattice curvature caused by a lateral 2-dimensional lattice parameter gradient due to a gradual intra-domain lateral compositional variation. We present a model for this unique, self-assembled, nanograss-like curved crystal structure and its implications are discussed.

DS 14 Growth of thin films

Time: Wednesday 14:00–15:15 Room: GER 38

DS 14.1 Wed 14:00 GER 38

Sputtering of Cr-Mn-O thin films — •Philip Dellinger and Dieter Mergel — Thin film working group, Physics Department, University Duisburg-Essen, 45117 Essen

Thin films have been prepared by rf-diode sputtering of a Cr_2MnO_4 target. Substrate temperature and oxygen content in the sputter gas have been varied.

The packing density of the films increases with increasing substrate temperature. The refractive index at 1000 nm, as obtained from transmittance measurements by dielectric modelling, varies between 2.2 and 2.7.

The x-ray diffractograms do not allow a unique interpretation. Some samples exhibit only peaks that are unambiguously due to Cr_2O_3. Other samples are 'mixed' in that they exhibit peaks that could be attributed to Cr_2O_3 as well as to Cr_2MnO_4. EDX-analysis gives a nearly stoichiometric ratio of [Cr]/[Mn] of 2/1 for all samples. The Raman spectra of the two groups of samples do not show significant differences.

DS 14.2 Wed 14:15 GER 38

Effect of substrate temperature and thickness on nano-structure of UHV deposited Titanium thin films — •Mehran Gholipour[1], Hadi Savaloni[1], and Michael Antony Player[2] — [1]Department of Physics, University of Tehran, North-Kargar Avenue, Tehran ,Iran — [2]Department of Engineering, University of Aberdeen, Aberdeen AB24 3UE, U.K

The effect of substrate temperature and film thickness on microstructure of Titanium thin films is investigated. Titanium thin films were deposited on glass substrate at different substrate temperatures in the range of 313 to 600 K with different thickness in the rang of 20-240 by electron beam evaporation using a Balzers UMS 500U UHV. Deposition rate was 0.29 Ås-1 and monitored by a quadruple mass spectrometer and controlled by feedback to the evaporation source. Crystallite sizes (size of coherently diffracting domains) and micro-strain are evaluated using Scherrer and Stocks-Wilson relations, Double-Voigt (DV) and Warren-Averbach (WA) methods. Results show that Ti samples are oriented in (002) direction at low thickness and substrate temperature and preferred orientation changed to (101) at highest thickness and substrate temperature. Crystallites size of Ti samples increased with temperature, thickness but micro-strain and lattice constants decrease with thickness. Crystallite sizes distribution function was obtained from the size broadened part of DV function, and results show a shift in the maximum to larger sizes with increasing the temperature and thickness. Keywords: size-strain analysis; XRD; Warren-Averbach; Double-Voigt

DS 14.3 Wed 14:30 GER 38

Deposition rate and thickness dependence of nano-structure of UHV deposited silver thin films — •Mehran Gholipour Shahraki[1,2], Hadi Savaloni[1,2], and Michael Antony Player[3] — [1]Plasma Physics Research Center, Science and Research Campus of I. A. University, P. O. Box 14665-678, Tehran, Iran — [2]Department of Physics, University of Tehran, North-Kargar Avenue, Tehran ,Iran. — [3]Department of Engineering, University of Aberdeen, Aberdeen AB24 3UE, U.K.

Silver thin films of different thickness were deposited on float glass substrate at different deposition rates ranging from 0.4 to 22.5 $Å s^{-1}$ by electron beam evaporation using a Balzers UMS 500U UHV at substrate temperature of 313 K. Preferred orientation, crystallite sizes (size of coherently diffracting domains) and micro-strain, stacking and twin faults probability are evaluated using Scherrer-Williamson-Hall plot, Single Voigt and Double-Voigt methods. XRD analysis of Ag samples showed that Ag samples are oriented in (111) direction normal to the substrate surface. Results show that the Crystallite sizes increase with deposition rate while micro-strain and lattice constants decrease with thickness. Crystallite sizes distribution function was obtained from the size broadened part of DV function, and results show a shift in the maximum to larger sizes with increasing the thickness and deposition rates. Keywords: size-strain analysis; Silver thin films; XRD

DS 14.4 Wed 14:45 GER 38

Control of pattern formation in ultrathin polyethyleneoxide films — •Hans-Georg Braun and Evelyn Meyer — Leibniz Institute of Polymer Research / Max Bergmann Center of Biomaterials, D-01069 Dresden, Hohe Strasse 6

Ultrathin polymerfilms (thickness < 5 nm) of crystallisable polymers as for example polyethyleneoxide (PEO) can crystallize in highly branched lamellae patterns which result from a diffusion controlled growth process. We demonstrate the control of the nucleation process for dendritic growth by surface defects such as surface steps, edges or rims resulting from thin film dewetting and demonstrate the connection between dewetting structures and crystallization behaviour (1). By surface heterogenization we were able to control the initial dewetting process of thin PEO films and to generate micropatterned amorphous films. The amorphous regions could be nucleated to start dendritic growth by AFM contact. Dendritic growth within confined geometries strongly influences the growth pattern through change of the diffusion conditions inside the lateral confined layers. The dendritic PEO films can act as substrates for electron beam lithography because the material crosslinkes during irradiation and becomes permanently anchored to the surface. 1) E. Meyer, H.-G. Braun J.Phys:Condens. Matter 17 (2005) S623-635

DS 14.5 Wed 15:00 GER 38

Electrical transport mechanisms in growing Pd thin films - modified by hydrogen loading — •Stefan Wagner, Olof Dankert, and Astrid Pundt — Institut für Materialphysik, Georg- August- Universität Göttingen, Friedrich- Hund- Platz 1, 37077 Göttingen

During thin film growth the electrical resistivity of the film changes within orders of magnitude. Different conduction mechanisms can be identified, dominating the conductivity in the different stages of growth. These stages depend on the substrate that, on the one hand, modifies the shape of the islands and, conversely, contributes differently to the condution mechanisms.

Resistance measurements during thin film growth are presented and divided into regimes where charge tunnelling, island percolation and thin film properties are dominating.

The influence of hydrogen loading on the conduction behaviour of a discontinuous film is shown and appears strongly substrate dependent. It will be discussed in terms of magnitude, reversibility and switching time.

DS 15 Thin magnetic films

Time: Wednesday 15:30–17:15 Room: GER 38

Invited Talk DS 15.1 Wed 15:30 GER 38

Nanoparticulate films of high anisotropy magnetic materials: A status quo — •Bernd Rellinghaus — IFW Dresden, P.O. Box 270116, D-01171 Dresden

In recent years, attempts to push the areal storage density of materials for single-grain-per-bit hard disk media towards their physical (superparamagnetic) limits have gained significant attention. However, a breakthrough in preparing films of high anisotropy $L1_0$-FePt nanoparticles for this purpose is yet to be awaited. The talk reviews the advantages and shortcomings of both, colloidal and gas phase preparation routes – the two most wide-spread approaches in the field. Whereas wet-chemical preparation allows for precise size control and periodic particle arrangement on a substrate, the simultaneous provision of high magnetic anisotropy and texture seems problematic. Advantageous to the gas phase preparation is the possibility to thermally anneal such particles prior to their deposition on a substrate. This in principle allows to disentangle inter- and intra-particle sintering processes from the $L1_0$-ordering. The dependence of the degree of $L1_0$ order in FePt nanoparticles on the local environment, particle size, time, and temperature will be reported. Potential measures to overcome the present obstacles by interdisciplinarily combining different methods will be given as an outlook.

DS 15.2 Wed 16:15 GER 38

Order by smoothness - crystallization at amorphous interfaces — •Andreas Liebig[1], Hans Lidbaum[2], Panagiotis Korelis[1], Gabriella Andersson[1], Klaus Leifer[2], and Björgvin Hjörvarsson[1] — [1]Department of Physics, Uppsala University, Box-530, SE-75121 Uppsala, Sweden — [2]Department of Engineering Sciences, Uppsala University, Box 534, SE-751 21 Uppsala, Sweden

The structural and magnetic properties of amorphous $Fe_{90}Zr_{10}$ thin films and multilayers have been investigated by x-ray diffraction and TEM. Crystallites of limited size are observed at the interface between the iron-zirconium layers and the underlying amorphous oxide. The interface related seeding of crystallites suggests the presence of a purely symmetry-induced ordering.

The magnetic properties are strongly affected by the interface density. The ordering temperature for thin films is around 200 K, which is comparable to the ordering temperature for bulk samples. For samples with high interface density, the Curie temperature can be increased up to 360 K. The origin of the shift in the ordering temperature, as well as the interface induced crystallization will be discussed.

DS 15.3 Wed 16:30 GER 38

Substrate dependent Mn Valence Instability on $La_{2/3}Ca_{1/3}MnO_3$ Thin Films — •Sergio Valencia[1], Andreas Gaupp[1], Alexei Erko[1], Wolfgang Gudat[1], Llibertad Abad[2], Lluís Balcells[2], and Benjamin Martínez[2] — [1]BESSY, Albert-Einstein-Str. 15, D-12489, Berlin, Germany — [2]Institut de Ciéncia de Materials de Barcelona, Campus de la UAB, E-08193, Bellaterra, Spain

The Mn valence state of $La_{2/3}Ca_{1/3}MnO_3$ (LCMO) thin films grown on $SrTiO_3$ (STO), $LaAlO_3$ (LAO) and $NdGaO_3$ (NGO) substrates has been studied by X-ray absorption spectroscopy: The spectra at the Mn K and L edges and at the O K edge show the presence of a divalent Mn component, besides the expected $Mn_3^+ : Mn_4^+ = 2/3 : 1/3$ mixed valence state, for as-grown films related to the air exposure of the samples. For films grown on STO the Mn_2^+ presence is constant in time, while an increase of it is observed for films on LAO and NGO substrates. The origin of the Mn valence instability giving rise to the Mn_2^+ formation and the substrate dependent differences are discussed and tentatively related to the surface homogeneity of the substrate prior to the deposition of the material.

DS 15.4 Wed 16:45 GER 38

Rare-Earth Scandate Multi-Layer Thin Films prepared by Pulsed Laser Deposition — •T. Heeg[1], J. Schubert[1], Ch. Buchal[1], M. Boese[2], and M. Luysberg[2] — [1]Institut für Schichten und Grenzflächen ISG1-IT/CNI, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany — [2]Institut für Festkörperforschung IFF, ER-C and CNI, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

The rare-earth scandates have gained considerable attention as candidate materials for the replacement of SiO_2 in silicon MOSFETs in either amorphous or epitaxial form. In this work, amorphous as well as epitaxial multi-layer systems consisting of scandate and titanate layers were grown in situ on different substrates using PLD. $BaTiO_3$ was used in combination with $GdScO_3$, and $SrTiO_3$ was combined with $DyScO_3$. The thickness ratio and the total number of layers were varied. RBS and RBS/channeling were used to investigate the stoichiometry and crystal quality of the films. XRD measurements were performed to analyze the crystal structure. HRTEM was used to get detailed information on the orientation relationship between scandate and titanate layers as well as on the strain present in the layers.

To determine the electrical properties of the amorphous multi-layer

films on silicon substrates, the results of several samples with a thickness from 26 nm to 100 nm have been evaluated using an EOT plot. To investigate the dielectric properties of the epitaxial films, $SrRuO_3$ covered $SrTiO_3$(100)-substrates were used for the electrical characterization. The amorphous films have a dielectric constant of 35, whereas the epitaxial films show a higher value of 60.

DS 15.5 Wed 17:00 GER 38

Isolated cadmium atoms in different environments on nickel surfaces — •Wolf-Dietrich Zeitz — Hahn-Meitner-Institut, Glienicker Strasse 100, 14109 Berlin

The electronic configurations of isolated Cd atoms on Ni surfaces were measured by the PAC tracer method. The Cd impurities could be positioned at steps, kinks, in and at the surface layers of ferromagnetic nickel single crystals. The outstanding result of the experiments is a dependence of the magnetic hyperfine field on the coordination number.

The presentation at this conference shall give a review on the experimetal findings and the interpretation which includes band structure calculations.

According to the calcutations, the measured electric gradients are interpreted by the distribution of electrons among different p-sublevels, while the magnetic hyperfine fields are explained from the polarisation in the local density of s-states in the conduction band.

In addition, the calculations give predictions for other sp-elements on surfaces of ferromagnets and thus present a generalised view of this topic.

DS 16 Ion beam solid interaction I

Time: Thursday 09:30–11:00 Room: GER 37

Invited Talk DS 16.1 Thu 09:30 GER 37

Ion beam shaping of nanometals — •Arjen Vredenberg — Debye Institute, Utrecht University

Metal nanorods and nanowires have great potential in a wide range of fields, because of their tunable (by shape and size) optical and magnetic properties. We present a new and unique way of producing nanorods and -wires, embedded in a solid, that are aligned in the same direction. Starting from spherical Au nanocolloids in a silica film we will show that the colloids are shaped controllably into rods and -at later stages- wires by irradiation with an MeV heavy ion beam. The ion-beam induced anisotropy (from a spherical colloid to a rod) is caused by the highly anisotropic ion track: a long, few nm diameter cylinder of highly excited material. The colloids elongate and form rods with their long axis in the direction of the ion beam. The mechanism of this deformation is still under investigation, but we will discuss possible origins, involving anisotropy in mechanical or mass balance gradients.

DS 16.2 Thu 10:15 GER 37

Swift heavy ion irradiation of InP: Thermal spike analysis of ion track formation — •Andrey Kamarou, Werner Wesch, and Elke Wendler — Institut für Festkörperphysik, Universität Jena, Max-Wien-Platz 1, 07743 Jena

Irradiation of single-crystalline InP with swift heavy ions (SHI) in above-threshold electronic stopping regime causes formation of ion tracks for certain irradiation temperatures [1]. With increasing SHI fluence, more and more ion tracks are formed, until at high ion fluences a continuous amorphous layer is produced finally due to the multiple overlapping of the tracks.

Single-crystalline InP samples were irradiated either at liquid nitrogen temperature (LNT) or at room temperature (RT) with Kr, Xe, or Au ions with specific energies ranging within ca. 0.3 to 3.0 MeV/u. Afterwards the samples were investigated by means of the Rutherford backscattering spectrometry (RBS) and the transmission electron microscopy (TEM) in plan-view and cross-section geometries.

The obtained experimental data can be qualitatively and quantitatively explained using the thermal spike model. The results of the thermal spike calculations offer a self-consistent way to explain the influence of various irradiation conditions on the ion track formation and damage accumulation in InP and, therefore, can make a contribution to a better understanding of the underlying mechanisms.

[1] O. Herre, W. Wesch, E. Wendler, P.I. Gaiduk, F.F. Komarov, S. Klaumünzer, and P. Meier, Phys. Rev. B 58, 4832 (1998).

DS 16.3 Thu 10:30 GER 37

Swift Heavy Ion induced Modifications in Thin Halogenide Coatings — •Hartmut Paulus, Thunu Bolse, and Wolfgang Bolse — Institut für Strahlenphysik, Universität Stuttgart

Thin layers of several Halogenides have been deposited onto Silicon and Silicon Oxide substrates by thermal evaporation at different substrate temperatures. The samples were irradiated with swift heavy ions (SHI) of various energies and fluences at a temperature of about 80K. The irradiated as well as the remaining unirradiated parts of the samples were characterized by Rutherford backscattering spectrometry. In selected cases also scanning electron and atomic force microscopy as well as surface profilometry and X-ray diffraction were performed.

Low temperature (300K) deposition results in rough layers, which upon SHI irradiation significantly smoothen. The latter can be attributed to grain size reduction and compaction of the material. Substrate temperatures around 900K on the other hand result in already smooth layers. Higher fluences lead to significant intermixing of the coating with the Silicon Oxide substrate, while the interfaces (and surfaces) of the films deposited onto Si remain smooth. At very high fluences a reduction of the film thickness can be observed due to sputtering and in some cases circular holes of sub-micrometer dimensions form, which point at SHI induced dewetting phenomena similar to those recently reported for thin oxide films.

DS 16.4 Thu 10:45 GER 37

Ion-beam induced effects at 15 K in α-Al_2O_3 of different orientation — •W. Wesch[1], C.S. Schnohr[1], E. Wendler[1], K. Gaertner[1], and K. Ellmer[2] — [1]FSU Jena, Institut für Festkörperphysik — [2]HMI Berlin

In order to study the primary effects of ion-beam induced damage formation in sapphire, both implantation and subsequent damage analysis by Rutherford backscattering spectrometry (RBS) were performed at 15 K. We used Ar^+, K^+ or Na^+ ions to investigate the amorphisation of α-Al_2O_3 with either the c-axis (0001), the a-axis $(11\bar{2}0)$ or the r-axis $(01\bar{1}2)$ being perpendicular to the surface. Defect annealing was observed during the RBS measurements with 1.4 MeV He^+ ions. It can be understood in terms of the electronic energy loss of the He ions which may cause changes in the charge state of the defects thus enhancing their mobility. This results in actual damage recovery or the alignment of the defect structures. The He beam induced defect annealing is taken into account to obtain the undisturbed curves of damage accumulation. The analysis of these curves yields three stages of defect formation. In the first stage isolated point defects are formed. Recombination of point defects is observed when the collision cascades start to overlap. Above a critical concentration these point defects are altered into a second type of defects called clusters. With further increasing ion fluence these clusters exhibit a stimulated growth. A third stage occurs by a saturation of the clusters and their gradual transformation into amorphous material. For the various orientations investigated differences were found, which seem to be caused by a different visibility of the created defects.

DS 17 Ion beam solid interaction II

Time: Thursday 11:15–12:45 Room: GER 37

DS 17.1 Thu 11:15 GER 37

Nanobeam — •Thomas Vogel[1], J. Meijer[1], B. Burchard[1], I. Rangelow[2], L. Bischoff[3], J. Wrachtrup[4], F. Schmidt-Kaler[5], and H. Wiggers[6] — [1]Ruhr-Universität Bochum, RUBION — [2]Uni Kassel, Technische Physik — [3]Forschungszentrum Rossendorf, Ionenstrahl Physik — [4]Universität Stuttgart, 3. phys. Institut — [5]Universität Ulm, Quanten-Informationsverarbeitung — [6]Uni Duisburg-Essen, Institut für Verbrennung und Gasdynamik

A new setup for the formation of a particle beam with nanometer resolution will be presented. The main idea is to use an Atomic-Force-Microscope with a modified tip which acts as an aperture for the particle beam. Therefore a small hole with a diameter of some ten nanometer has to be drilled into the AFM-tip by focussed ion beam. The AFM can be used for orientation on the sample surface. Simultaneously particles can then be deposited on defined sites. The next step is to manufacture an electrostatic micro-lens placed on the AFM-tip to actively focus the particle beam. With this setup a spatial resolution for the particle deposition of some nanometer is achievable. Different sources can be used for the formation of the particle beam: A cluster-source that produces particles with a size of some nm, an ion gun to produce a beam of single ions or an ion trap, to reach the highest spatial resolution of below 1 nm. The presented technique can for example be used to create luminescence centres in diamond by single ion implantation. Such single photon sources can be quantum mechanically coupled if placed in near vicinity and be used for quantum computational operations.

DS 17.2 Thu 11:30 GER 37

Relaxation of slow highly charged ions penetrating a solid surface - energy deposition and reemission — •Daniel Kost and Stefan Facsko — Forschungszentrum Rossendorf, Dresden

Highly charged ions carry a large amount of potential energy, which is defined as the sum of the binding energies of all removed electrons. In the case of low velocities of the ions this energy can exceed their kinetic energy. Approaching the solid surface the ions are neutralized, relaxe to the ground state, and their potential energy is released. Thereby different mechanisms, such as surface sputtering, secondary ion emission, secondary electron emisson and X-ray emission take place [1]. The secondary particles leaving the surface carry only up to 10% of the potential energy. Using a calorimetric setup [2] we measured the amount of the potential energy which remains in the solid to 85% ± 10%. To study the detailed mechanism of the energy retention materials with different electronic structures were investigated: Cu, n-Si, p-Si, SiO_2. We can conclude, that the difference in energy depositon between these materials is below 10%. The calorimetric results are rounded off with results from energy reemission measurements using electron spectroscopy. The value of the reemitted energy increases with increasing charge state up to 10%.
[1] A. Arnau et.al.: Surf. Sci. Rep. **27**, 113 (1997).
[2] U. Kentsch et.al.: Phys. Rev. Lett. **87**, 10 (2001).

DS 17.3 Thu 11:45 GER 37

SHI Induced Phase Formation At NiO/Si-Interfaces — •Wolfgang Bolse[1], Christian Dais[1], Thunu Bolse[1], Siegfried Klaumünzer[2], Peter Schubert-Bischoff[2], and Jörg K.N. Lindner[3] — [1]Institut für Strahlenphysik, Universität Stuttgart — [2]Hahn-Meitner-Institut, Berlin — [3]Institut für Physik, Universität Augsburg

In the course of a systematic investigation of the modification of thin oxide films on Si by swift heavy ion irradiation we found that distinct phase formation and phase separation occurs at the NiO/Si-interface. The NiO was deposited onto untreated Si-wafers by means of reactive magnetron sputtering.. The irradiation was performed at 80 K with 140 - 600 MeV Kr-, Xe- and Au-ions at fluences up to $10^{16}/cm^2$. The interfaces were characterized utilizing Rutherford Backscattering Spectrometry (RBS), High Resolution Transmission Electron Microscopy, Energy Filtered Transmission Electron Microscopy (EFTEM) and Energy Dispersive X-ray spectroscopy (EDX). On top of the subtrate an undulated layer forms, which according to EDX and EFTEM contains only Si and Ni and is thus attributed to the $NiSi_2$-phase also found with RBS. This layer is sharply separated from a region containing Ni, O and Si, which according to RBS refers to $NiSiO_3$. The Silicate is followed by NiO. The undulation and the formation of the high-temperature, high-pressure phase $NiSiO_3$ clearly reflect the extreme non-equilibrium conditions in the excited ion track, which obviously govern the phase formation at the NiO/Si interface.

DS 17.4 Thu 12:00 GER 37

Ion beam enhanced etching of $LiNbO_3$ — •Thomas Gischkat[1], Frank Schrempel[1], Holger Hartung[2], Ernst-Bernhard Kley[2], and Werner Wesch[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany — [2]Institut für Angewandte Physik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany

Single crystals of z-cut and x-cut $LiNbO_3$ were irradiated at room temperature and 15 K using 350 keV Ar^+-ions with ion fluences between 5×10^{12} and 1×10^{15} cm^{-2}. The damage formation investigated with RBS channeling analysis depends on the crystal cut as well as the irradiation temperature. Irradiation of z-cut material at 300 K provokes complete amorphisation at 0.4 dpa (displacements per target atom). In contrast 0.27 dpa are sufficient to amorphise the x-cut $LiNbO_3$. Irradiation at 15 K reduces the number of displacements per atom necessary for amorphisation to 0.18 dpa. To study the etching behavior 400 nm thick amorphous layers were generated via multiple irradiation with Ar^+-ions of different energies and fluences. Etching was performed in a 3.6% HF-solution at 40 °C. Whereas the etching rate of the perfect crystal is negligible, that of amorphised regions amounts to 80 nm min^{-1}. The influence of the ion fluence, the irradiation temperature and subsequent thermal treatment on damage and etching of $LiNbO_3$ is discussed.

In conlusion, negligible etching of the perfect crystal, high etching rates and high contrast of Ion Beam Enhanced Etching (IBEE) allow the realisation of high aspect ratio microstructures in $LiNbO_3$.

DS 17.5 Thu 12:15 GER 37

Dewetting of thin metal-oxide films on silicon under swift heavy ion bombardment — •Thunu Bolse[1], Klara Lyutovich[2], Hartmut Paulus[1], Bouchaib Bouhachi[1], Siegfried Klaumünzer[3], and Wolfgang Bolse[1] — [1]Institut für Strahlenphysik, Universität Stuttgart — [2]Institut für Halbleitertechnik, Universität Stuttgart — [3]Hahn-Meitner Institut Berlin

Dewetting, occuring when a thin film on a non-wettable substrate is transferred to its molten state, has gained strong interest during the last decade, since it results in nano-scale, large-area-covering patterns. Recently we found that swift heavy ion irradiation of thin NiO-, Fe_2O_3- and TiO_2-films on Si at 80 K results in amazingly similar dewetting pattern, although in this case the coating has never reached its melting point. SEM analysis clearly reveals that similar dewetting mechanisms as for liquid films were active. AFM shows that the circular holes formed in the early stages of the dewetting process exhibit the same rim-structure as in the case of thermally driven dewetting. RBS was used to measure the open surface of the film as a function of the fluence. The substrate coverage decreases with increasing fluence and reaches a saturation value after the holes coalesce. The different dewetting stages exhibit different kinetics, from which conclusions concerning the involved processes can be drawn. The observed dewetting pattern and kinetics will be discussed in close comparison with the models developed for dewetting of liquid films with special attention to the fact, that here mass transport can occur only step-by-step in a highly localised nano-scale region during the excited stage of the ion track.

DS 17.6 Thu 12:30 GER 37

Ion-beam induced nano-sized metal clusters in glass — •Heinz-Eberhard Mahnke[1], Beate Schattat[1], Ivo Zizak[1], Peter Schubert-Bischoff[2], Nikola Novakovic[1,3], and Vasil Koteski[3] — [1]Ionenstrahllabor ISL, HMI Berlin — [2]HMI Berlin — [3]VINČA Institute, Belgrade

We have studied the formation of Ag-metal clusters in soda lime glass with x-ray absorption spectroscopy (XAS), with transmission electron microscopy (TEM), and with small angle x-ray scattering (SAXS). Silver was introduced by ion exchange into 0.1-mm thick glass platelets. While annealing under a reducing atmosphere of Ar with a few % H_2 already leads to the formation of metal clusters, such clusters are not very uniform in size and are randomly distributed over the Ag-containing glass volume. Irradiating these Ag-containing glass platelets with 600-MeV

Au ions with fluences around 10^{12} ions/cm^2 at ISL followed by annealing, the distribution of the size of the metal clusters becomes more uniform and the clusters are arranged in chains parallel to the direction of the ion beam. While the metallic form of Ag in the glass is proven by determining the local structure (co-ordination and inter-atomic distances) with EXAFS, measured at HASYLAB, the arrangement of the clusters in chains and their size is made visible by TEM. In a first SAXS experiment on the newly commissioned 7T-MPW beamline at BESSY an arrangement of the clusters approaching a columnar shape with a diameter around 7 nm could be proven. An extension to Cu-metal clusters is under way.

DS 18 Thin semiconducting films

Time: Thursday 09:30–11:15 Room: GER 38

DS 18.1 Thu 09:30 GER 38

Characterisation of Si and SiGe layers with different strain by spectroscopic ellipsometry — •Jürgen Moers, Dan Mihai Buca, and Siegfried Mantl — Institute for Thin Films and Interfaces; Research Center Jülich; D-52425 Jülich; Germany

For further improvement of MOSFET devices high mobility materials as strained silicon are under investigation. Strained silicon is produced by growing thin silicon layers on relaxed SiGe-buffers, where the Ge-content determines the in-plane lattice constant and the incorporated strain. For process characterization it is mandatory to measure the thickness of the epitaxially grown layers and the homogeneity of the Ge-content. In order to provide a non-destructive characterization method, spectroscopic ellipsometry was investigated for thickness and composition measurement, as well as for wafer mapping.

Measurements were performed with a SENTECH SE800 spectroscopic ellipsometer and the appendant SpectraRay software was used for data analysis and simulation. The accuracy of the method is strongly dependent on the provided optical indexes. For SiGe as well as for the strained silicon an extended 4-oscilator-Leng-Model was used to describe analytically the refractive indexes and the absorption coefficient of the materials. SiGe-buffers with different Ge-content and strain were used to investigate the dependence of the model-parameters. Similar measurements were done with strained silicon layers directly on insulator. With the acquired optical data simulations where done to estimate the limits of spectroscopic ellipsometry as characterization method for strained silicon and SiGe layers.

DS 18.2 Thu 09:45 GER 38

On the epitaxy of twin-free cubic (111) praseodymium sesquioxide films on Si(111) — •Thomas Schroeder, Christian Wenger, and Hans-Joachim Müssig — IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt - Oder

The preparation of truly single crystalline oxide films on Si substrates is a challenge in modern oxide physics. Twin-free epitaxial cubic (111) praseodymium sesquioxide films were prepared on Si(111) by hexagonal to cubic phase transition. Synchrotron radiation grazing incidence X-ray diffraction and Transmission electron microscopy were applied to characterize the phase transition and the film structure. As-deposited films grow single crystalline in the (0001) oriented hexagonal high-temperature phase of praseodymium sesquioxide. In-situ X-ray diffraction studies deduce an activation energy of 2.2 eV for the hexagonal to cubic phase transition. Transmission electron microscopy shows that the phase transition is accompanied by an interface reaction at the oxide / Si(111) boundary. The resulting cubic(111) low-temperature praseodymium sesquioxide film is single crystalline and exclusively shows B-type stacking. The 180° rotation of the cubic oxide lattice with respect to the Si substrate results from a stacking fault at the substrate / oxide boundary.

DS 18.3 Thu 10:00 GER 38

Contribution by M. Wagner was moved to the end of session DS 9. — • —

DS 18.4 Thu 10:15 GER 38

Atomic vapour deposition of high-k HfO_2: Growth kinetics and electrical properties — •Anil Mane[1], Christian Wenger[1], Jarek Dabrowski [1], Grzegorz Lupina[1], Thomas Schroeder[1], Gunther Lippert[1], Roland Sorge[1], Peter Zaumseil[1], Günter Weidner[1], Ioan Costina [1], Hans-Joachim Müssig[1], Sergej Pasko [2], Ulrich Weber[2], Vincent Méric [2], and Marcus Schumacher[2] — [1]IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt (O), Germany — [2]AIXTRON AG, 52072 Aachen, Germany

Atomically smooth thin layers of HfO_2 were grown by atomic vapour deposition (AVD) from tetrakis(ethylmethlyamido)Hf {$Hf(NEtMe)_4$} precursor and O_2. All the depositions are carried at substrate temperature 400 °C on thermally grown SiO_2 (≈2 nm) on 200 mm p-Si(100) wafers under various deposition conditions. These layers were amorphous as deposited, as shown by x-ray diffraction and transmission electron microscopy. The atomic force microscopy and ellipsometry scans confirm the HfO_2 layers were deposited uniformly over the substrate in the thickness of 4 to 50 nm. Chemical compositions of these layers were studied by time-of-flight secondary ion mass spectrometry (TOFSIMS) and x-ray photoelectron spectroscopy (XPS). Deposited layers demonstrated well behaved capacitance as function of gate voltage (C-V) curve and leakage current density as low as 10^{-8} A/cm^2 at 1 V. The effective permittivity of theses layers ranges from 9 to 20 depending on growth conditions. Post deposition annealing in oxygen ambient improve the dielectric properties in great extent, which could explain the role of oxygen partial pressure and temperature for HfO_2 growth.

Invited Talk DS 18.5 Thu 10:30 GER 38

Formation and Decay of Si/Ge Nanostructures at the Atomic Level — •Bert Voigtländer — Institut für Schichten und Grenzflächen ISG 3 and cni - Center of Nanoelectronic Systems for Information Technology, Forschungszentrum Jülich, 52425 Jülich, Germany

The step-flow growth mode is used to fabricate two-dimensional Si and Ge nanowires with a width of 3.5 nm and a thickness of one atomic layer (0.3 nm) by self-assembly on a Si(111) surface. Alternating deposition of Ge and Si results in the formation of a nanowire superlattice covering the whole surface. One atomic layer of Bi terminating the surface is used to distinguish between the elements Si and Ge. A difference in apparent height is measured in scanning tunneling microscopy (STM) images for Si and Ge, respectively. The reason for the height difference observed in STM will be discussed. Also different kinds of two-dimensional Si/Ge nanostructures like alternating Si and Ge nanorings having a width of 5-10 nm were grown. The method to distinguish between Si and Ge allows to study intermixing on the nanoscale and to identify the fundamental diffusion processes giving rise to the intermixing.

DS 19 Thin film deposition and process characterization I

Time: Thursday 11:30–12:45 Room: GER 38

DS 19.1 Thu 11:30 GER 38

In-situ **mechanical spectroscopy on pulsed laser deposited polymer films** — •Thorsten Scharf, Erik Süske, and Hans-Ulrich Krebs — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

Pulsed laser deposition (PLD) is a promising technique for the preparation of thin films, including non-equilibrium composites of polymers with metals or ceramics. Laser deposited polymers are chemically modified due to the depositon process and therefore show different mechanical properties. To determine these properties in dependency of the deposition parameters and to learn about the microscopic processes leading to these properties an *in-situ* mechanical spectroscopy apperatus was de-

veloped, where the excitation of an vibrating reed is done by the plasma plume of the PLD. This new technique will be shown in detail with results for the temperature dependent spectroscopy on PMMA which was laser deposited under different deposition parameters.

DS 19.2 Thu 11:45 GER 38

Ba substituted $Pb(Zr_xTi_{1-x})O_3$ Thin Films grown by MOCVD — •Jochen Puchalla, Susanne Hoffmann-Eifert, and Rainer Waser — IFF/IEM and CNI, FZ Jülich, Jülich, Germany

The most prominent ferroelectric material for integrated non-volatile memories is $Pb(Zr,Ti)O_3$. In this study we report on the modification of PZT thin films by substitution of Pb against Ba in order to study the effects accompanied with incorporation of a bigger A-site cation in the PZT system. The polycrystalline $(Pb,Ba)(Ti,Zr)O_3$ films are grown on $Ir(111)/TiO_2/SiO_2/Si$ as well as on $Pt(111)/TiO_2/SiO_2/Si$ substrates at temperatures between 580°C and 650°C applying a liquid-delivery MOCVD technique. A PZT (30/70) film of 150 nm thickness shows good ferroelectric properties with $P_r = 35\ \mu C/cm^2$ and $E_c = 90$ kV/cm. In first randomly oriented films the Ba substitution was unfortunately not effective in lowering the coercive field. The $(Pb,Ba)(Ti,Zr)O_3$ films show improved phase stability and a more homogeneous morphology compared to the pure PZT films. In addition the dielectric losses in the PBZT films are as small as 0.025. The presentation will in addition deal with the Ba substitution effect in films with a preferred orientation of the grains, namely (111). Further studies address the formation of IrO_2 or $PbPt_x$ interfacial layers, and the analysis of the ferroelectric and dielectric properties and the leakage currents in the Ba-doped PZT thin films.

DS 19.3 Thu 12:00 GER 38

In situ doping profiling of MOVPE-grown GaAs — •Ch. Kaspari[1], M. Pristovsek[1], and W. Richter[2] — [1]Technische Universität Berlin, Institut für Festkörperphysik, Sekr. PN 6-1, Hardenbergstraße 36, D-10623 Berlin — [2]Università di Roma "Tor Vergata", Dipartimento di Fisica, Via della Ricerca Scientifica 1, I-00133 Roma, Italy

It is well known that doping of III-V-semiconductors can be measured with reflectance anisotropy spectroscopy (RAS) [1]. The interface electric field induced by the dopant atoms changes the RAS spectrum. This change, observed near the E_1 and higher critical points, can be described by the linear electro-optic effect (LEO).

We have found that during growth of GaAs layers with different doping concentrations, oscillations appear in the RAS signal at photon energies near the fundamental band gap E_0. From the period of these oscillations the thickness can be obtained during growth. The amplitude of the oscillations is related to the doping contrast. With this information, a profile of the doping concentration can be measured *in situ*. To refine the accuracy of our measurements, we employ a multichannel RAS setup [2] that is designed to measure transients at multiple photon energies simultaneously in the spectral range between 1.5 and 5 eV.

[1] Tanaka et al., Appl. Phys. Lett. **59**, 3443 (1991)
[2] Kaspari et al., phys. stat. sol. (b) **242**, 2561 (2005)

DS 19.4 Thu 12:15 GER 38

Role of positive ions in reactive sputtering of Al-doped ZnO thin films — •F. Ruske[1], V. Sittinger[1], W. Werner[1], B. Szyszka[1], R. Wiese[2], M. Hannemann[2], and H. Kersten[2] — [1]Fraunhofer IST, Bienroder Weg 54 E, D-38108 Braunschweig — [2]INP Greifswald, F.-L.-Jahn-Str. 19, D-17489 Greifswald

Highly conductive, transparent films (ITO, SnO_2, ZnO) are of significant interest i.e. in the field of thin film photovoltaics, flat panel display or automotive glazings. Especially ZnO-based films have attracted much interest due to low material cost at accaptable film properties in respect to ITO. Reactive magnetron sputtering of metallic Zn/Al-targets has shown to be a suitable way to produce high quality Al-doped ZnO thin films.

In order to characterize the deposition process films have been deposited onto stationary substrates and characterized in respect to chemical composition, texture, etching behaviour as well as optical and electrical properties. In these measurements significant differences in respect to films deposited onto moving substrates can be found.

The key to understanding properties distributions are particle and energy fluxes onto the substrate. We present measurements with a retarding field analyzer (RFA) yielding energy-resolved distributions of positive ions. The measurements show that no highly energetic ions with positive charge are obtained with the present setup and most ions originate from the Debye sheath. Measurements of total energy flow show that energy introduction by positive ions plays only a minor role in the examined process.

DS 19.5 Thu 12:30 GER 38

Thin film combined systems for detection of ionizing radiation — •Sergiy Nedilko[1], Volodymyr Degoda[1], Borys Okhrimenko[1], Igor Zakharchenko[1], Yuriy Zorenko[2], and Georgiy Malashkevich[3] — [1]Kyiv National Taras Shevchenko University, 2, block 1, acad. Hlushkov Ave., 03680, Kyiv, Ukraine — [2]Ivan Franko National University of Lviv, 8, Kyryla & Mefodiya Str., Lviv, Ukraine — [3]Institute of Molecular and Atomic Physics of BAS, 68, F. Skarini Ave., Minsk, Belarus

Two oxide systems doped with cerium ions are developed for registration of partial components of mixed ionizing flows. The first are detectors based on the grown by liquid phase epitaxy YAG and LuAG films co-doped with Ce and Sc, Tb and Eu ions. Mentioned oxides and their structural types have to allow a possibility of wide modification of both the single-crystalline films and substrates compositions for optimization of detectors parameters. Some oxide sol-gel thin films co-doped with Ce and Ag are the seconds systems. In this case increasing intensity of Ce luminescence resulted by interaction between Ce ions and silver nanoparticles. We assume the data are explained by the overlapping of the Ce ions spectral bands with absorption bands of surface plasmons in silver nanoparticles. The luminescence intensity depends on the preparation procedure, redox conditions of heat-treatment as well as on the dopants concentrations. Experiments with of synchrotron radiation use were done at SUPERLUMI, HASYLAB, Germany. This work is supported by STCU Project No 2042.

DS 20 Ion beam induced nanostructures

Time: Thursday 14:00–16:15 Room: GER 37

Invited Talk DS 20.1 Thu 14:00 GER 37

Nanostructures by grazing incidence ions: ripple patterns, athermal coarsening and subsurface channeling — •Thomas Michely — I. Physikalisches Institut, RWTH Aachen, 52056 Aachen

The recent years showed significant progress in our ability to use ion beams for the controlled patterning of surfaces. New applications of such patterned substrates as functional surfaces or templates for subsequent growth of thin films emerge. Nevertheless, our present understanding of the atomic scale mechanisms governing pattern formation is still poor.

With the help of scanning tunneling microscopy investigations and molecular dynamics simulations a few steps towards a better understanding of metal surface patterning in the grazing incidence ion beam geometry could be made. Most surprising, pattern formation depends crucially on the angle of incidence of the ions. As soon as this angle allows subsurface channeling of the ions, pattern regularity and alignment with respect to the ion beam greatly improves. These effects rare traced back to the positionally aligned formation of vacancy islands through the damage created by the ions at dechanneling locations. The long term pattern evolution is characterized by a temperature independent increase of the ripple pattern wavelength. This coarsening is shown to be due to pattern defects, which travel in the ion beam direction and perform defect reactions.

The contributions of Henri Hansen, Alex Redinger, Sebastian Meßlinger, Yudi Rosandi and Herbert Urbassek to this work are acknowl-

edged.

DS 20.2 Thu 14:45 GER 37

Self-organized pattern formation on Si and Ge surfaces during low-energy ion beam erosion — •Frank Frost, Bashkim Ziberi, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstrasse 15, D-04318 Leipzig

Self-organization during low-energy ion bombardment or erosion of solid surfaces is a promising approach for the generation of large-area nanostructured surfaces. In addition to superficial materials removal upon sputtering, caused by energy and momentum transfer from the incoming ions to target atoms, the interplay between sputter-induced roughening and various surface relaxation mechanisms can lead to a wide range of surface topographies and patterns. In this contribution recent findings on topography evolution on Si and Ge surfaces caused by low energy noble gas ion beam erosion (Ar^+, Kr^+, Xe^+; $E_{ion} \leq 2000$ eV)at normal and oblique ion incidence at room temperature are summarized. In particular, it is demonstrated that various surface topographies do arise during erosion of surfaces depending on ion species, ion energy and ion incidence angle. Examples for highly ordered dot as well as ripple pattern are shown where the size of the individual structure elements (ripples or dots) is well below 50 nm.

DS 20.3 Thu 15:00 GER 37

Formation of nanopatterns induced by low-energy ion sputtering of Si surfaces — •Frank Rotter[1], Kun Zhang[1], Carsten Ronning[1], Hans Hofsäss[1], Michael Uhrmacher[1], and Johann Krauser[2] — [1]II. Physikalisches Institut and SFB 602, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Fachbereich Automatisierung und Informatik, Hochschule Harz, Friedrichstraße 57-59, D-38855 Wernigerode

Sputter erosion of Si generates nanoscale ripple patterns which are stable at ambient conditions and which may serve as experimental test of ripple formation theories. This ion-beam induced surface morphology evolution is the result of a balance between ion beam erosion roughening and soothing surface diffusion processes. The evolution of Si surfaces has been investigated using atomic force microscopy after low-energy ($\leq$ 50 keV) Xe^+ ion irradiation at room temperature with ion-fluences up to $1 \cdot 10^{17}$ ions/cm^2. Different effects have been observed as a function of the incidence angle of the ion beam: mount-like roughening occurs near normal direction ($\theta \leq 45°$); whereas, ripple formation takes place for $\theta \geq 60°$ with the wave-vector parallel or perpendicular to ion-beam direction, depending on the incidence angle and the ion-fluences. Furthermore it is found that the orientation of the induced ripple pattern switches from perpendicular to parallel with increasing the ion-fluence at glance incidence angle ($\theta \geq 80°$).

DS 20.4 Thu 15:15 GER 37

In-situ X-Ray Diffraction of GaSb Nanopatterned by Normal Incidence Sputter Erosion — •Adrian Keller[1], Stefan Facsko[1], Olivier Plantevin[2,3], Dina Carbone[2], Hartmut Metzger[2], and Raul Gago[4] — [1]IIM, Forschungszentrum Rossendorf, Dresden, Germany — [2]ID01, ESRF, Grenoble, France — [3]CSNSM, Orsay, France — [4]CMAM, Universidad Autónoma de Madrid, Spain

Low energy ion erosion of surfaces can lead to the formation of self-organized structures in the range from 10 to 100 nm [1]. Periodic ripple patterns and hexagonally ordered dot arrays can be achieved for oblique and normal incidence, respectively. The evolution of ripple structures on different materials has been studied extensively during the last decades whereas the formation of dots has been discovered only recently [2] and is not fully understood yet. In the presented work, the evolution of GaSb(001) surface morphology under normal incidence sputtering has been studied *in-situ* by Grazing Incidence Small Angle X-ray Scattering (GISAXS) and Grazing Incidence Diffraction (GID) measurements which have been performed at the beam line ID01 at the ESRF. These techniques were used to study the evolution of the dots for ion energies from 100 to 1000 eV. With GISAXS the morphology and the correlation of the dots is analysed, while in GID information about the crystalline structure (i.e. strain) is added. This way, three regimes are observed and identified as smoothing, pattern formation and increase of lateral order.
[1] M. Navez, D. Chaperot and C. Sella, C. R. Acad. Sci. 254 (1962), 240
[2] S. Facsko et al., Science 285 (1999), 1551

DS 20.5 Thu 15:30 GER 37

Ripple to dot transition on Si and Ge surfaces by ion beam erosion — •Bashkim Ziberi[1], Frank Frost[1], Dina Carbone[2], Hartmut Metzger[2], and Bernd Rauschenbach[1] — [1]Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstr. 15, D-04318 Leipzig, Germany — [2]ID01, ESRF, Grenoble, France

In the last years, pattern formation during low-energy ion beam erosion becomes a promising tool for large-area and cost-efficient nanostructuring of surfaces. Due to self-organization processes caused by low-energy ion beam erosion, well arranged nanostructures can evolve on different materials. In this contribution results for noble gas ion beam erosion (ion energy $\leq$ 2000 eV) of silicon and germanium semiconductor surfaces under oblique ion incidence without sample rotation are presented. It will be shown that in both materials there is a continuous transition from ripple to dot patterns by varying the ion incidence angle from 5 deg up to 35 deg. The evolving dots, with a mean size of $\approx$ 45 nm, show a large area ordering given by the previous existence of ripples. For Si square arrays of almost perfectly ordered dots evolve on the surface, while for Ge the dots show a hexagonal ordering. The formation of the dot nanostructures is influenced by different parameters of the ion beam. Additionally, a appropriate adjustment of the ion optical parameters of the broad beam ion source offers the possibility to influence the large-area ordering of dots. The surface topography and structure ordering are analyzed using high resolution scanning force microscopy (AFM) and grazing incidence small angle x-ray scattering and diffraction (GISAXS/GID).

DS 20.6 Thu 15:45 GER 37

Ion sputtering induced surface nanostructuring of ferromagnetic thin films — •Kun Zhang[1], Frank Rotter[1], Carsten Ronning[1], Hans Hofsäss[1], Michael Uhrmacher[1], and Johann Krauser[2] — [1]II. Physikalisches Institut and SFB 602, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Fachbereich Automatisierung und Informatik, Hochschule Harz, Friedrichstraße 57-59, 38855 Wernigerode, Germany

We have investigated the possibility of nanoscale ripple formation on polycrystalline iron and nickel thin films (typically of 100 nm in thickness) and the correlation between surface morphology and magnetic textures of these films. Sputter erosions were performed by using Xe ions at room temperatures with energies between 4 keV and 10 keV, ion fluences up to 1×10^{17} ions/cm^2, and incidence angle up to 85° respective to the surface normal. Atomic force microscopy, magneto optical Kerr effect, and Rutherford backscattering have been used to characterize the evolution of surface morphology, magnetic properties and sputter yield, respectively. The as-deposited films have a rms roughness of 1 nm and magnetically isotropic properties. The sputter erosion increased the surface roughness and decreased the coercive field of the films. Ripple formation was observed at incidence angles of $\theta \geq 80°$ for an ion-energy of 5 keV and an ion-fluence of 1×10^{16} ions/cm^2. A small uniaxial magnetic anisotropy was detected being parallel to the ripple orientation and the direction of the incident ion beam.

DS 20.7 Thu 16:00 GER 37

Self-organized nanoscale multilayer growth during the deposition of hyperthermal species — •Hayo Zutz[1], Inga Hannstein[1], Carsten Ronning[1], Michael Seibt[1], Hans Hofsäss[1], Wan-Yu Wu[2], and Jyh-Ming Ting[2] — [1]2. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Department of Materials Science and Engineering, National Cheng Kung University, Tainan, Taiwan, ROC

The quasi-simultaneous deposition of low energy mass selected C^+ and either Au^+ or Fe^+ ions resulted in the formation of alternately metal-rich and metal-deficient layers with periods in the nm range. Transmission electron microscopy reveals that the metal-rich layers consist of rather densely distributed crystalline particles while the metal deficient layers are amorphous or contain only smaller numbers of crystalline clusters. The concentration variation is confirmed by Rutherford backscattering spectroscopy and Auger electron spectroscopy depth profiling. A similar structure was found in films grown by dc-magnetron sputtering of Cu, Pt, and Ni targets in an Ar/CH_4 plasma. The processes during mass selected ion beam deposition and magnetron sputtering deposition are far from thermodynamical equilibrium. Therefore, the formation of such periodic concetration variations cannot be attributed to mechanisms like Liesegang pattern formation. The multilayer formation can be decribed by an interplay of sputtering, surface segregation, ion induced diffusion, and the stability of small clusters against ion bombardment.

DS 21 Laser and plasma processes

Time: Thursday 16:30–18:00 Room: GER 37

DS 21.1 Thu 16:30 GER 37

Laser-induced formation and characterization of periodic nanostructures in polymer thin films with embedded metal particles — •Katrin Löschner[1], Marcel Dyrba[2], Andreas Kiesow[1], Gerhard Seifert[2], and Andreas Heilmann[1] — [1]Fraunhofer Institute for Mechanics of Materials, Heideallee 19, 06120 Halle — [2]Martin Luther University Halle-Wittenberg, Department of Physics, Hoher Weg 8, 06120 Halle

The nanostructural properties of metal particle containing plasma polymer films can be modified by the irradiation with linearly polarized, femtosecond laser pulses. The interaction of the metal nanoparticles with the oriented, intense electric field leads to the formation of line-like, periodically arranged nanoparticle structures in the laser-treated area. These structural modifications are characterized by longish regions with obvious changes in particle size and shape distribution which alternate with regions without apparent particle changes. The optical properties of such nanocomposite materials are mainly determined by the size, shape, and spatial arrangement of the particles. Therefore, the generation of anisotropic structure changes results in dichroitic properties of the irradiated area. The periodical structural changes were generated by systematic variation of laser irradiation parameters (also at varying the film properties, i.e., thickness, matrix material). As result a phenomenological model of the occurring physical processes is suggested. For the characterization of the structural changes transmission and scanning electron microscopy were applied. Optical modelling is used as a helpful tool for explanation of the resulting optical properties.

DS 21.2 Thu 16:45 GER 37

Ultrakurzpuls-Laserdeposition von Cr-Sc-Multilagenschichten — •Frank Ulmer and Thomas Höche — Leibniz-Institut für Oberflächenmodifizierung e.V.,

Multilagenspiegel sind für die Herstellung effizienter Röntgenspiegel von großem industriellen Interesse. Je nach Anwendung reichen die Periodenlängen von einigen Nanometern (etwa im Bereich der EUV-Lithographie mit 13,4 nm Wellenlänge) bis hin zu wenigen Nanometern (im Bereich des sogenannten Wasserfensters, in dem die Absorption des Wassers sehr gering ist, mit Röntgenwellenlängen von ca. 2 - 4 nm). Für die Abscheidung qualitativ hochwertiger, ultradünner Schichten mit alternierenden Chrom- und Scandiumlagen kommt, neben etablierten Verfahren, die Laserdeposition mit ultrakurzen Pulsen in Betracht. In einer dedizierten Ultrahochvakuumanlage wurde ein Femtosekundenlaser (Pulslänge: 130 fs) für die Ablation genutzt und es wurden drei Verfahren zu Reduktion von Partikulaten, welche im Ablationsplasma durch Kondensation entstehen, untersucht. Es konnte gezeigt werden, dass sowohl der Einsatz elektrischer und magnetischer Felder als auch die Streuung an einem Hintergrundgas (Argon) genutzt werden können, um weitgehend partikulatfreie Schichten zu erzeugen. Die abgeschiedenen Schichten wurden mittels Rasterelektronenmikroskopie, Sekundärionenmassenspektrometrie sowie Transmissionselektronenmikroskopie an Querschnittspräparaten eingehend charakterisiert.

DS 21.3 Thu 17:00 GER 37

Influence of energetic ions on the $L1_0$ ordering of FePt films fabricated by magnetron sputtering — •V. Cantelli, J. von Borany, J. Fassbender, and N. Schell — Institute of Ion Beam Physics and Materials Reserarch, Forschungszentrum Rossendorf, P.O.Box 51 01 19, 01314 Dresden

Due to the high uniaxial anisotropy $L1_0$-ordered FePt is currently the most favoured candidate for future high density storage applications. With respect to a feasible fabrication technology, it is necessary (i) to produce such films on amorphous substrates, and (ii) to enable a low processing temperature ($T \leq 400°C$). FePt films deposited at RT only exhibit the face-centered cubic A1-phase. Thus, either deposition or a post-deposition heat treatment at temperatures above typically 500°C is required in order to achieve the $L1_0$-phase. We report on the $L1_0$-ordering of stoichiometric FePt thin films fabricated on SiO_2/Si substrates by magnetron sputtering at various temperatures (RT- 400°C). Using a low deposition rate of approx. 0.6 Å/s and an Ar pressure of 0.3 Pa the ion/atom-ratio during deposition is $\gg 1$ where the ions exhibit energies of about 20 eV. In addition, FePt films have been irradiated subsequently with He ions of 50 keV and fluences between $1x10^{15}$ and $3x10^{16}$ cm^{-2} for comparison. The kinetics of $A1 \rightarrow L1_0$ transition and ordering have been investigated with *in − situ* X-ray diffraction at the Synchrotron-beamline ROBL at ESRF. $L1_0$ ordered FePt films with an ordering parameter $S \geq 0.8$ have been achieved already for an overall process temperature below 350°C. The results are discussed in terms of ion-assisted activation and segregation which supports the atomic relocation during $L1_0$ ordering.

DS 21.4 Thu 17:15 GER 37

Design and application of a UHV-compatible RF plasma source to remove the ligand-sphere from self-assembled layers of $CoPt_3$-nanoparticles — •B. Gehl[1], V. Aleksandrovic[2], A. Kornowski[2], J.-I. Flege[3], J. Falta[3], H. Weller[2], and M. Bäumer[1] — [1]Institut für Angewandte und Physikalische Chemie, Universität Bremen, Leobener Str. NW II, 28359 Bremen — [2]Institut für Physikalische Chemie, Universität Hamburg, Grindelallee 117, 20146 Hamburg — [3]Institut für Festkörperphysik, Universität Bremen, Postfach 330440, 28334 Bremen

Self-assembly from colloidal solution onto a substrate is an efficient way to create well-ordered arrays of cobalt-platinum nanoparticles on a range of substrates. To access and analyze the particles' chemical properties, it is necessary to remove the surrounding ligand sphere. A capacitively coupled rf-plasma-source was designed to strip the particles of their ligands and to let the treated samples be transferred into a UHV-environment without exposure to the atmosphere to avoid contamination. Compatibility to the standard omicron-type sample transfer system was maintained. In SE microscopy it was shown that the particles kept their identity and monodisperse size distribution after treatment in plasmas of oxygen or a mixture of argon and hydrogen. In SEM and GISAXS-measurements the two dimensional ordering of the particle layers was confirmed to be largely maintained. The plasma parameters were varied and the resulting effects on the chemical properties of treated layers such as carbon content, oxide formation and contamination with electrode material were analyzed with XP spectroscopy.

DS 21.5 Thu 17:30 GER 37

Determination of plasma parameters during deposition of ZnO-films with ceramic and metallic targets and correlation with film parameters — •Ruben Wiese[1], Holger Kersten[1], Florian Ruske[2], Volker Sittinger[2], Richard Menner[3], and Mario Hannemann[1] — [1]INP Greifswald — [2]IST Braunschweig — [3]ZSW Stuttgart

At ZnO-film sputter deposition, the plasma parameters essentially determine the physical properties of the deposited films. In the present case, the energy flux to the substrate was measured with special thermal probes. A thermally isolated substrate dummy was placed in the magnetron plasma at the position of the substrate. By the temporal behavior of the probe one can obtain the energy flux to the surface. Furthermore, it is possible to apply a substrate bias, whereby the energy flux of the charge carriers can be estimated. To determine further plasma parameters, Langmuir-probes were placed in the substrate region. The probes could be moved across the target axis, and thus, the profile of the parameters in the substrate plane across the target could be determined. For comparable sputter conditions, so called static prints were prepared to measure the film property profile across the target axis. By comparison of spatially measured plasma parameter profile across the target axis in the substrate level with the profile of the film properties, correlations could be obtained. Particularly, being aware of the thickness profile, the energy influx per deposited particle was estimated and a correlation with the film properties is discussed. The measurements have been carried out with ceramic targets as well as in reactive processes with metallic targets.

DS 21.6 Thu 17:45 GER 37

The effect of target aging on the structure formation of Zinc oxide during reactive sputtering — •Dominik Koehl, Daniel Severin, Oliver Kappertz, Andreas Pflug, and Matthias Wuttig — I. Institute of Physics (1A), Aachen University, 52056 Aachen, Germany

We present a comparative study of reactively sputtered Zinc oxide films deposited using (a) a new metallic Zn target and (b) an old one with a pronounced erosion trace. Depending on the shape of the target surface

there are remarkable differences in the film structure at different substrate positions. Our findings can be attributed to the influence of the inhomogeneous bombardment of the substrate surface by fast negatively charged oxygen ions. These ions are created at the poisoned/oxidized fraction of the target and accelerated towards the substrate. We show that the trajectory of these ions strongly depends on the shape of the target surface, as the electric field above the target is altered by the erosion trace. Hence, the spatial distribution of the ion bombardment depends on the geometry of the erosion trace and therefore on the age of the target.

DS 22 Thin film deposition and process characterization II

Time: Thursday 14:00–15:15 Room: GER 38

DS 22.1 Thu 14:00 GER 38

Functionalising of Tips for Scanning Probe Microscopy — •Danny Kowerko, Falk Müller, Andi Käppel, Steffen Schulze, and Michael Hietschold — TU Chemnitz, Institut für Physik

Throughout the last 15 years different material deposition techniques have become powerful tools for creating nanodots, nanowires, nanotips and nanolayers. In this work the application potential of EBID-(Electron Beam Induced Deposition)-nanotips as probes for SPM (scanning probe microscopes) will be discussed. A precursor material is sublimated and aligned by dint of a needle close to a silicon substrate or an AFM-Cantilever. A fine focused electron beam dissociates the adsorbed molecules and a tip will be generated. The influence of secondary electron-distribution, surface diffusion and dissociation energies of the precursor materials like tungstenhexacarbonyl ($W(CO)_6$) hint at the chances and limits of forming SPM tips on different surface geometries such as AFM-Cantilevers. As a possibility to overcome the current density limitation at usual SEMs, field emission induced deposition (FEID) is mentioned for fabrication of sub-10-nm-deposits consisting of highly conducting or magnetic material. Therefore FEID-whisker growth at the apex of STM-tips can be exhibited.

DS 22.2 Thu 14:15 GER 38

Thin Zn-Phthalocyanine films in ITO sputter processes — •Martina Mohr, Klaus Ellmer, and Konstantinos Fostiropoulos — Hahn-Meitner-Institut Berlin, Glienicker Str. 100, D-14109 Berlin

Indium-tin-oxide (ITO) films are widely used as conductive transparent electrodes for optoelectronic devices. However for stability reasons they are usually not sputter grown directly on photoactive organic materials. Here we present a bi-layer system consisting of sputter deposited ITO on vacuum evaporated Zn-Phthalocyanine films. The influence of the sputter process on the organic material and the quality of the ITO layer has been studied by means of optical spectroscopy, XRD and SEM. New ITO structures and morphologies have been discovered. The absorption spectra of the Zn-Phthalocyanine film as well as the conductivity of ITO in these bi-layers are promising for photovoltaic applications.

DS 22.3 Thu 14:30 GER 38

At wavelength inspection of extreme ultraviolet lithography mask blank defects by photoemission electron microscopy — •Jingquan Lin[1], Andreas Oelsner[2], Nils Weber[3], Ulrich Neuhäusler[1], Jawad Slieh[1], Armin Brechling[1], Dimitrii Valdaitsev[2], Michael Merkel[3], Gerhard Schönhense[2], Ulf Kleineberg[1], and Ulrich Heinzmann[1] — [1]Faculty of Physics, University Bielefeld, D-33615 Bielefeld — [2]Institute of Physics, University of Mainz, D-55128 Mianz — [3]Focus GmbH, D-65510 Hünstwetten-Gorsröth

Extreme ultraviolet lithography (EUVL) is one the leading next-generation lithography candidates for fabricating integrated circuits with a feature size of 45 nm and below. According to International Semiconductor Road map, density of defects on EUV mask blank must be reduced to the level of 0.005 defects per cm^2. Here we report a new actinic EUVL mask defect inspection approach, in which EUV photoemission electron microscopy (PEEM) technique was used. The actinic inspection experiment was performed with a standing wave field illumination PEEM at BESSY II. Experimental results show that buried defects with lateral sizes down to 50 nm in a mask blank sample are detectable. Our EUV PEEM also demonstrates the ability to detect phase defects with height as low as 6 nm in a programmed line-space sample. Moreover, we found that the contrast of a multilayer phase defect in the PEEM image is strongly dependent on the inspecting wavelength, eg. showing a contrast reversal when changing the illumination wavelength from 12.5 nm to 13.8 nm.

DS 22.4 Thu 14:45 GER 38

Hydrogen assisted growth of Fe/V superlattices — •Gregor Nowak[1], Arndt Remhof[1], Andreas Liebig[2], Björgvin Hjörvarsson[2], and Hartmut Zabel[1] — [1]Fakultät für Physik und Astronomie, Festkörperphysik, Ruhr-Universität Bochum — [2]Department of Physics, University of Uppsala, Sweden

We have studied the influence of hydrogen on the growth of sputter deposited Fe/V superlattices. We show that the high structral quality achieved previously [1] can be further improved by using a hydrogen enriched process gas. The multilayers have been grown epitaxially on MgO(001) substrates at elevated temperatures by DC-magnetron sputtering. In an argon-atmosphere (p_{Ar} = 7 mbar) containing a hydrogen partial pressures of up to 2×10^{-6}mbar we deposited [Fe(2ML)/V(16ML)]×30 superlattices. At each chosen hydrogen pressure we prepared a series of samples at substrate temperatures between 270°C and 320°C. The structural characterization was carried out by x-ray diffraction at the wiggler beamline W1.1 of the Hamburg synchrotron laboratory (HASYLAB). Two trends are clearly observed. The mosaicity decreases with increasing H-pressure. Simultaneously, the interface quality increases, shown by x-ray reflectivities studies. We attribute this effects to an increased surface mobility of the metal atoms in the presence of hydrogen [2].This project was founded by the DFG under contract-Nr. RE 2203/1-1.

[1]P. Isberg et al., Vacuum 48, 483 (1997).
[2]Horch et al., Nature 398, 132 (1999).

DS 22.5 Thu 15:00 GER 38

Influence of salt ions on the structure of polyelectrolyte multilayers — •Christof Ecker[1], John E. Wong[2], Pantea Nazaran[3], and Regine v. Klitzing[1] — [1]Christian-Albrechts-Universität Kiel, Institut für Physikalische Chemie, Ludewig-Meyn-Str. 8, 24118 Kiel — [2]RWTH Aachen, Institut für Physikalische Chemie, Landoltweg 2, 52056 Aachen — [3]Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Wissenschaftspark Golm, 14424 Potsdam

A polyelectrolyte multilayer is grown by dipping the substrate alternately into solutions of polycations and polyanions. At each step a polyelectrolyte layer adsorbs from solution onto the surface.

We investigated how the addition of monovalent salt to the solutions of polyanions (PSS) and polycations (PAH or PDADMAC) influences the structure of such layers. We found that the layer thickness always increases with salt concentration. We explain this by the more compact conformation in solution. Further, we found a strong dependence on the type of salt. Films built-up with NaBr are about five times thicker compared to those prepared with NaF. The mobility of the polymers chains within the multilayer film was measured using FRAP (Fluorescence Recovery After Photo bleaching). We found the mobility for films prepared under NaBr conditions to be large compared to films prepared with NaCl and similar to films prepared from a less charged copolymer. This indicates that Br- ions are embedded within the film reducing the charge of the polycations extrinsically and whereas Cl- ions are not. We further performed calorimetric experiments to quantify the interaction between polyelectrolyte and salt ions.

DS 23 Nanowires, nanoparticles and nanostructures

Time: Thursday 15:30–17:30 Room: GER 38

Invited Talk DS 23.1 Thu 15:30 GER 38

Laser-induced diffusion processes on metal nanoparticles — •Andreas Heilmann — Fraunhofer Institute for Mechanics of Materials Halle (Saale)

Although metal nanoparticles embedded in an insulating matrix show sufficient long-term stability, diffusion processes of metal atoms occur at temperatures far below the melting point of the metals. The material transport is driven by the free surface energy of the nanoparticles and associated with lattice defects and grain boundaries. These diffusion processes result in changes of the size and shape distribution of the embedded particles. Therefore, the optical and electrical properties of the nanoparticles change dramatically.

The simplest way to accelerate and to study such diffusion processes is thermal treatment, but also Laser irradiation or electron beam irradiation can cause nanostructural changes inside the beam spot without material ablation. By irradiating nanoparticle assemblies with linearly polarized, ultrashort laser pulses in far field arrangement, parallel arranged line structures of embedded gold or silver nanoparticles were achieved inside the laser spot. These structures are result of diffusion processes induced by the irradiation energy and directed by linear polarization of the laser pulses. The anisotropic structure modification results in anisotropic optical and electrical properties of the nanoparticle assemblies.

DS 23.2 Thu 16:15 GER 38

Electromigration in single- and polycrystalline silver nanowires — •M. Hartmann and G. Dumpich — Experimentalphysik, Universität Duisburg-Essen (Standort Duisburg), Lotharstr. 1, 47048 Duisburg

Electromigration measurements are conducted for polycrystalline silver nanowires prepared by electron beam lithography (EBL) as well as for singlecrystalline nanowires grown by self organization of Ag onto vicinal Si substrates. The observed resistance changes as a function of time can be directly correlated to structural changes in the nanowire, such as void and hillock formation, by *in situ* observation in a scanning electron microscope (SEM). A direct comparison between single- and polycrystalline wires in a parallel connection shows that the ratio between the two governing forces, the windforce and the direct force, differs greatly for these wire types.
While polycrystalline wires exhibit the electrical breakdown at the cathode, the atomic mass flux in singlecrystalline wires is just the other way around. This indicates a higher absolute value of the direct force in singlecrystalline nanowires - as compared to the wind force - which is found in nearly no other system. However, by increasing the current density in these singlecrystalline wires the direction of the diffusion is found to change its sign at a certain critical value of j_c. This effect is discussed in terms of current induced defect formation. This work is supported within SFB 616.

DS 23.3 Thu 16:30 GER 38

Reversible electromigration behavior of gold nanowires — •Burkhard Stahlmecke and Günter Dumpich — Experimental Physics, Department of Physics, University Duisburg-Essen (Duisburg Campus), Lotharstraße 1, 47057 Duisburg, Germany

We perform *in-situ* scanning electron microscopy (SEM) observations of electromigration in gold nanowires. The wires are prepared by means of electron beam lithography and have typical dimension of length l = 10 μm, width w = 200 $nm - 1$ μm and thickness t = 40 nm. Electrical currents with a current density of approximately $1 * 10^8 A/cm^2$ are applied to the wires using either a constant voltage or a constant current mode. During the measurements the polarity of the current is reversed, which leads to a partly reversed electromigration behavior in the nanowires. Additionally we investigate the influence of contaminations due to the *in-situ* SEM observations on the electromigration behavior of the nanowires.

This work was supported by the DFG within the special research area (SFB) 616: Energy dissipation at surfaces.

DS 23.4 Thu 16:45 GER 38

Electronic properties of nanometer-sized ion tracks embedded in tetrahedral amorphous carbon — •Anne-Katrin Nix[1], Daniel Schwen[1], Hans Krauser[2], Christina Trautmann[3], and Hans Hofsäss[1] — [1]II. Physikalisches Institut, Universität Göttingen, Germany — [2]Hochschule Harz, Wernigerode, Germany — [3]Gesellschaft für Schwerionenforschung, Darmstadt, Germany

We investigated the formation of quasi one-dimensional conducting filaments in diamondlike carbon (DLC) films by swift heavy ion irradiation. Various DLC films with thicknesses of several 100 nm were grown using mass separated ion beam deposition on highly conducting Si and Fe substrates. After deposition the films were irradiated with 1 GeV ^{238}U ions with fluences between 10^9 and 10^{11} ions/cm^2. Due to their high electronic energy loss of about 30 keV/nm the swift heavy ions graphitize the predominantly (80%) sp^3-bound carbon film along their trajectories yielding conductig 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 23.5 Thu 17:00 GER 38

Electrical investigations of tungsten oxide nano-particles using Impedance Spectroscopy — •Tim Patrick Hülser[1,2], Hartmut Wiggers[2], and Axel Lorke[1] — [1]Institute of physics, University Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg — [2]Institute of combustion and gas dynamics, University Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg

We report on the electrical properties of tungsten oxide nanoparticles, which are analyzed using Impedance Spectroscopy. The particles are synthesized in a low pressure premixed flame reactor using WF_6 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 capacitors as well as small discs of this material are investigated by AC-methods.

Impedance Spectroscopy on the as-prepared WO_X thin films have been carried out under air in the range from 313 K to 503 K. Two contributions to the overall impedance are detected and analyzed by fitting the data using equivalent circuits. Two contributions can be identified, one from the grain-boundary contacts (GB), the other from the electrode-particle (EC) contacts. The resistance of both decreases with increasing temperatures as expected for semi-conducting materials. Activation energies of -1.93 eV for the GB and -201 meV for the EC contacts have been found.

The conductivity of compacted, understoichiometric WO_X is higher than that of stoichiometric WO_3. Furthermore, compacted material also shows GB and EC contributions in agreement with the results from the interdigitated capacitors.

DS 23.6 Thu 17:15 GER 38

Large-scale fabrication of Au nanostructures in the process of amalgam formation followed by Au-Hg alloy thermal decomposition — •Tomasz Kobiela — University of Bonn, Institute of Physical and Theoretical Chemistry, Wegelerstrasse 12, D-53115 Bonn, Germany — Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

Formation of gold nanostructures onto surfaces is fundamental process for fabricating various micro/nano devices and systems. These nanostructures exhibit not only the novel physical properties, but are commercially used in the electronic devices, catalysts and efficient biomolecular sensors. In this work, Au films deposited under ultra-high vacuum conditions on air-cleaved mica substrates were exposed "in situ" to Hg vapor (residual gas pressure 1x10^{-7} Pa, with Hg vapor pressure 0.24 Pa). This led to transformation of continuous gold film into isolated amalgam islands of nanometer scale. The changes of Au thin film surface topography caused by amalgamation carried out within 40 h was studied by the atomic force microscopy method, while the phase transition in the bulk of Hg-dosed Au films was monitored by means of X-ray diffraction. The islands' morphology varies from irregular, ramified structures on terraces to compact shapes along the steps on the mica substrate. After thermal decomposition of the amalgam, thin gold films consisting of isolated Au nanostructures on mica can be obtained. The experimental data are compared with theoretical calculations of the kinetic processes occurring at the thin Au film surface.

DS 24 Poster presentation

Time: Tuesday 15:00–17:30 Room: P2

DS 24.1 Tue 15:00 P2

Argon: bulk, sheets and nanotubes — •Karin Schmalzl[1,2], Maikel Rheinstaedter[2], and Dieter Strauch[3] — [1]Forschungszentrum Juelich, 52425 Juelich, Germany — [2]Institut Laue-Langevin, BP 156 - 38042 Grenoble, France — [3]Institut fuer Theoretische Physik, Universitaet Regensburg, Germany

Condensed matter in geometrical confinement like nanoporous matrices allows to study the change of dynamics due to spatial restrictions. We investigated ^{36}Argon adsorbed in nanoporous Gelsil Glass by inelastic neutron scattering. At low filling fractions the atoms form an amorphous adsorbate film on the pore walls. At higher fillings, a capillary condensate forms in the pore center. The preparation of single or of several monolayers were possible what permitted the study of, e.g., the dynamical interaction between the third and second layer.

We compare the measured density of states of different fillings with the ones calculated with ab initio calculations . The calculations were done with LDA and GGA pseudopotentials. We studied rods and hollow cylinders with different number of atoms to appraoch the different fillings of the pores.

We also investigated the dynamics of a 2D system like a monolayer, double layer and several layers of atoms and followed in this way the transition to the bulk state.

DS 24.2 Tue 15:00 P2

Self-Organized Surface Patterning — •Michael Hirtz[1,2], Xiaodong Chen[1,2], Harald Fuchs[1,2], and Lifeng Chi[1,2] — [1]Physikalisches Institut WWU Münster, Wilhelm-Klemm-Straße 10, 48149 Münster — [2]CeNTech, Gievenbecker Weg 11, 48149 Münster

Surface patterning is of great importance in modern science and technology. Patterning is usually achieved by top-down strategies, such as optical and e-beam lithography, soft-lithography, scanning probe lithography, and nanoimprint lithography. In contrast, the concepts of self-assembly and self-organization provide another interesting route toward the formation of patterned structures via a bottom-up approach. Here, we present the formation of regular striped patterns in a self-organized manner by means of Langmuir-Blodgett (LB) technique, and their applications.

DS 24.3 Tue 15:00 P2

Reorganisation of ultrathin PEO films by water exposure — •Evelyn Meyer and Hans-Georg Braun — Leibniz Institute of Polymer Research, Max-Bergmann Center of Biomaterials, D-01069 Dresden, Hohe Strasse 6

Ultrathin PEO films (thickness < 5 nm) which are prepared by dip-coating can crystallize in highly branched lamella structures which are caused by a diffusion controlled growth process within the thin polymer layer. The water soluble polymer can rearrange on the surface by water exposure. We used a inkjet based microdroplet generator to deposit small ($\approx$ 80 micrometer) sized water droplets on the ultrathin film. Dissolution of the PEO film within the water droplet impact zone results in micropatterned PEO films. The morphological features resulting from the water droplet impact give information about the size of the impact zone on the surface and about the dissolution and reorganisation processes of the PEO molecules. Within the impact zone dewetting layers were observed and dendritic PEO lamellae growing from the rim inside the impact zone are identified and discussed. An experimental setup in which a thin water layer entrapped in a slit between a truncated pyramidal made and an ultrathin PEO layer can be moved with defined velocities across the PEO film will be used to demonstrate the reorganisation processes of (partly) dissolved PEO films both on homogeneous and heterogeneous surfaces.

DS 24.4 Tue 15:00 P2

Domain shape dynamics and local viscosity in stratifying foam films — •Peter Heinig — MPI für Dynamik und Selbstorganisation, Bunsenstr. 10, 37073 Göttingen

For the development of microfluidic devices (the lab on a chip) the effect of an interface on bulk parameters, as viscosity, is an issue of great importance. Nevertheless experimental results on local viscosity are rare and partially contradictory. We studied the domain shape dynamics in a foam film composed of oppositely charged surfactant and polyelectrolyte. These films thin in stepwise fashion: circular domains of lower film thickness are formed, expand and coalesce until they cover the whole film surface. On the one hand we analyzed the shape relaxation of coalescing domains and retreating stripes, on the other hand the dynamics of domain growth. Both kinds of dynamic events represent independent ways for measuring local film viscosity. We found consistent results and an increase of film viscosity of almost two orders of magnitude compared to bulk. The effect can be explained by strong interactions between surfactant and polyelectrolyte.

DS 24.5 Tue 15:00 P2

Calculation of the Evolution of Surface Area and Free Volume During the Infiltration of Fiber Felts — •Andreas Pfrang[1], Katja Schladitz[2], Andreas Wiegmann[2], and Thomas Schimmel[1,3] — [1]Institute of Applied Physics, University of Karlsruhe, D-76128 Karlsruhe, Germany — [2]Fraunhofer Institut für Techno- und Wirtschaftsmathematik, D-67653 Kaiserslautern, Germany — [3]Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

Carbon-carbon composites offer a unique combination of excellent mechanical properties, high thermal stability and low mass density. For the chemical vapor infiltration of pyrolytic carbon the ratio of surface area to free volume A/V plays a crucial role in understanding and modeling the deposition process. Here, the evolution of surface area and free volume during the infiltration of fiber felts was calculated quantitatively, using both an analytical approach and numerical calculations.

A/V was obtained analytically with a Boolean model using the approximation of overlapping fibers. For this model, we find that A/V increases linearly with the radius of the fibers. The model also allows to estimate surface area and free volume for felts with non-overlapping fibers for low initial filling factors.

In addition, numerical calculations of the evolution of A/V were performed. Models of felts with randomly distributed, non-overlapping fibers with different degrees of orientation anisotropy, including parallel fibers and isotropic orientation of the fibers, were generated. It is shown that A/V increases nearly linearly.

DS 24.6 Tue 15:00 P2

Growth of axially textured Bismuth layers on amorphous substrates — •Christian Patzig[1], Ingo Uschmann[2], Frank Schmidl[1], Ortrud Wehrhan[2], Matthias Grube[1], and Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Helmholtzweg 5, 07743 Jena, Germany — [2]Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

The growth of thin bismuth layers on floatglas was investigated. Thermal evaporation and Pulsed Laser Deposition (PLD) were used as deposition techniques, and X-ray diffraction by means of the Bragg-Brentano-geometry was used to investigate the crystalline structure of the layers. It could be observed that the evaporated layers show an out-of-plane - texture, in contrast to the layers grown on glas by using PLD, which in general are of polycristalline nature. The layers deposited by thermal evaporation show the c-axis as preferred direction of growth. By deposition of a thin evaporated seed layer followed by PLD, homoepitaxy could be induced, leading to a reduction of the FWHM of the rocking curves of the (003) - and respectively (006) - peak, depending on layer thickness and substrate temperature. It was possible to grow layers with an FWHM (003) < 1° on amorphous floatglas. Possible applications of those layers are discussed.

DS 24.7 Tue 15:00 P2

Method of Crystallization Mechanism Control During Epitaxy from Solution-Melt — •Yewgen Baganov, Stanislav Shutov, Vladislav Kurak, and Olena Andronova — Kherson National Technical University, 24, Berislavske shose, Kherson, 73008, Ukraine

Liquid phase heteroepitaxy difficulties appeared due to chemical potentials of solution-melt and substrate are differ and lattice constants of epitaxial layer and substrate are usually mismatched lead to violation of crystallization interface. As a result, it leads to deviation of epitaxial layer thickness and composition from needed ones for realization of planar device structure based on heterojunctions.

Mechanical stress that appears at heteroepitaxy and produce both increasing of solid phase chemical potential and crystallization interface perturbation, demands a short period additional supercooling on crystallization interface and high crystallization rate during initial stages of growth. To provide high structural perfection after initial growth the long period of equilibrium crystallization must follow.

Foregoing facts lead to main requirement to heat flow through substrate: it must be easy controlled, low inertial and time unlimited.

In present work we consider a possibility of substrate cooling by external reactor gas feeding for producing of crystallization conditions that consecutively combine properties both pulse and with quasiequilibrium conditions growth methods.

Model of heat-mass transfer for a priori determination of cooling gas consumption was examined experimentally.

DS 24.8 Tue 15:00 P2

Decorated twin boundaries in homoepitaxy on Ir(111) — •Sebastian Bleikamp[1], Arne Thoma[1], Gerhard Pirug[2], and Thomas Michely[1] — [1]I. Physikalisches Institut, RWTH Aachen University, 52056 Aachen, Germany — [2]Institut für Schichten und Grenzflächen, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

Scanning tunneling microscopy and low energy electron diffraction were used to investigate the growth of thin Ir films on Ir(111).

A transition from the expected layer-by-layer to a defect dominated growth mode with a fixed lateral length scale and increasing roughness is observed. During growth the majority of the film area is stably transformed to twinned stacking. This transition is driven by the energetic avoidance for the formation of intrinsic stacking faults compared to two independent twin faults, and the existance of preferential nucleation sites at incoherent twin boundaries. These boundaries are decorated by rows of atoms (decoration rows) which replicate themselves in subsequently grown layers and determine the kinetics of growth and stacking.

DS 24.9 Tue 15:00 P2

Reactive Deposition of TiO_x-Layers in a DC-Magnetron Discharge — •Stefan Wrehde[1], Marion Quaas[2], Hartmut Steffen[1], Oleg Zhigalov[1], Harm Wulff[2], and Rainer Hippler[1] — [1]Institute of Physics, Ernst-Moritz-Arndt-University Greifswald, Domstraße 10a, D-17489 Greifswald, Germany — [2]Institute of Chemistry and Biochemistry, Ernst-Moritz-Arndt-University Greifswald, Soldmannstraße 16, D-17489 Greifswald, Germany

The properties of thin solid films produced by plasma activated deposition are strongly influenced by the ions hitting the substrate. To get information about type, energy and density of these incoming ions a DC magnetron plasma for reactive deposition of TiO_x-layers was characterized under different discharge conditions by means of energy resolved mass spectrometry. Absolute values of the ion current densities of the different species could be obtained by using the ion saturation current. It was found that discharge power, chamber pressure, reactive gas flow and operation mode of the magnetron influence the shapes of the IVDF as well as the ion current densities.

In the second step TiO_x-layers were deposited under the examined conditions and investigated using different X-ray-methods as X-ray photoelectron spectroscopy and X-ray reflectometry and diffractometry at grazing incidence. These measurements showed that the deposition rates are higher and the incorporation of oxygen into the layers is lower in unbalanced mode.

DS 24.10 Tue 15:00 P2

Oxide - noble metals - nanocomposites for gas sensing applications — •Sajid U. Khan[1], Giray Kartopu[1], Andre Piorra[1], Klaus Rätzke[2], Claus-Henning Solterbeck[1], and Mohammed Es-Souni[1] — [1]Institute for Materials and Surface Technology, Kiel University of Applied Sciences, Kiel, Germany — [2]Technical Faculty, Chair of Multicomponent Materials, Christian-Albrechts-University, Kiel, Germany

We report on the processing of TiO_2 and SnO_2-noble metal thin film nanocomposites using a one step sol-gel method. The films were spin coated on oxidized silicon substrates and subsequently annealed at temperatures as low as 400°C. The noble metals essentially Pt and Au were added to the oxide precursor solutions either in form of colloidal solutions or as an acid compound. Microstructural characterization included Raman spectroscopy, XRD, X-ray porosimetry and electrical force microscopy (EFM). The gas sensing properties in reducing gases such as hydrogen and carbon monoxide were investigated using a custom set-up at different temperatures. It is shown that mesoporous nanocrystalline thin films of both oxides with embedded nanoparticles of Pt or gold can be obtained. The EFM investigations show homogeneously distributed noble metal nanoparticles. Preliminary results on gas sensing properties indicate high sensitivities at temperatures as low as 250°C.

DS 24.11 Tue 15:00 P2

Structural and optical characterization of $CuAlO_2$ thin films prepared by RF reactive sputtering — •Yinmei Lu, Bin Yang, Angelika Polity, Christian Neumann, Dietmar Hasselkamp, Niklas Volbers, and Bruno K. Meyer — I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen, Germany

Transparent $CuAlO_2$ thin films have been deposited on various kinds of substrates such as float glass, quartz and single-crystal sapphire by RF reactive sputtering using a stoichiometric $CuAlO_2$ ceramic target. The ceramic target with a diameter of 7.8 cm and 7 mm in thickness was self-made via a traditional ceramic fabrication process. X-ray diffraction (XRD) identified a single delafossite $CuAlO_2$ phase of the ceramic target. The thin films were typically deposited with a fixed sputter power of 300 W at room temperature, and then annealed in air at temperatures between 900 and 1100 °C. X-ray diffraction revealed that the as-sputtered films are amorphous, which crystallize during annealing evolving a mixture phase of $CuAlO_2$, $CuAl_2O_4$, and elemental Al. The surface morphology of the films was characterized by scanning electron microscopy (SEM). The composition and homogeneity of the films were examined using Rutherford backscattering spectroscopy (RBS) and secondary ion mass spectroscopy (SIMS), respectively. Typically the films are slightly Al-rich and have good depth homogeneity. The absorption coefficients and optical bandgaps of the films were estimated by optical transmission measurements at room temperature, which revealed a bandgap of 3.3-3.8 eV of the sputtered and annealed $CuAlO_2$ films.

DS 24.12 Tue 15:00 P2

Thickness Dependence of Optical Properties of Amorphous Indium Oxide Thin Films Deposited by Reactive Evaporation — •Kemal Ulutas and Deniz Deger — Istanbul Univ., Sci. Fac., Physics Dep.,Vezneciler,Istanbul,Turkey

Conductivity and absorption coefficient of amorphous indium oxide (IO) thin films, thermally evaporated on glass substrates at room temperature, were evaluated. We attribute the variation of absorption coefficient with thickness to the variation of band gap energy rather than optical interference.

*K.Ulutas Corresponding author : hku@istanbul.edu.tr Fax: +212 519 08 34 Keywords: Thin films, indium oxide

DS 24.13 Tue 15:00 P2

Influence of optical concentration on the properties of Indium oxide thin films — •Nevin Kalkan — Istanbul Univ., Science Faculty, Physics Dept. Vezneciler/ Istanbul - TURKEY

Current - voltage characteristics of Indium-embedded Indium oxide thin films (550-850 Å) with Ag electrodes approximately 1000 Å in thickness, prepared by reactive evaporation of pure indium in partial air pressure were studied. The electrical and optical properties of these films have been investigated as a function of optical concentration. It is seen that the I-V characteristics of all the samples are non-ohmic independent of optical concentration. The conductivity of the films was also seen to increase with the optical concentration. Furthermore, for possible conduction mechanism were proposed.

Keywords: Conduction mechanism, Poole-Frenkel mechanism, chalcogenide

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DS 24.14 Tue 15:00 P2

Infrared spectroscopy of metallic nanostructures — •T. Kolb[1], M.E. Toimil-Molares[2], T.W. Cornelius[2], F. Neubrech[1], F. Kost[1], S. Karim[3], R. Neumann[2], A. Pucci[1], and G. Fahsold[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg — [2]Gesellschaft für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — [3]Fachbereich Chemie, Philipps-Universität Marburg, Biegenstr. 10, 35032 Marburg

We investigated the IR-optical properties of single metal nanowires and nanoslits in metal thin films. The wires were prepared by template directed growth of metal in etched ion track polycarbonate membranes.

We dispersed these several ten micrometer long wires on IR-transparent substrates. Applying a shadowing technique the dispersed Cu wires were also used as masks for the preparation of nanosized slits in ultrathin Au films. Investigations of broadband IR optical properties of single nanowires and nanoslits were performed by IR spectroscopic microscopy at the synchrotron radiation source ANKA (Forschungszentrum Karlsruhe). Using this contact free measurement technique we can distinguish between a metallic and a non-metallic behaviour of a single nanowire. For quantitative analysis we try to simulate the spectra to determine the value of conductivity. Our results for the corresponding nanoslits with a width of a few hundred nanometers and a length in the ten micrometer range show a transmission which increases with wavenumber and which exceeds the transmission of the continous Au film in the mid-infrared range. We compare this behaviour to calculations of the small-slit transmission coefficient from classical electromagnetic scattering theory.

DS 24.15 Tue 15:00 P2

Reactively sputtered TiO_2 layers on SnO_2:F substrates: a Raman and SPS study — •Julius Mwabora[1], Klaus Ellmer[2], Abdelhak Belaidi[2], Jörg Rappich[2], and Thomas Dittrich[2] — [1]Department of Physics, University of Nairobi, P.O. Box 30197-00100 Nairobi, Kenya — [2]Hahn-Meitner-Institut, Glienicker Str. 100, 14109 Berlin, Germany

Reactively sputtered TiO_2 layers on SnO_2:F substrates were investigated by Raman and surface photovoltage spectroscopy (SPS). The deposition temperature, the O_2 / (O_2 + Ar) ratio and the deposition time were changed systematically. With increasing temperature, the layers become crystalline while rutile is dominating. Anatase starts to form at prolonged deposition and at lower O_2 / (O_2 + Ar) ratios. The workfunction and its light induced change show only well defined trends for the temperature dependent deposition (increase with increasing deposition temperature). Since the SPS saturates under absorption, the SPS signal is related to the density of states in the spectral region near the band gap of the TiO_2. The values of the band gap and of the energy parameter of the exponential tails decrease from about 3.28 and 140 meV to 3.14 and 60...80 meV with increasing deposition temperature of about 30 °C to 380 °C. The TiO_2 layers deposited at 380 °C are of high electronic quality as demonstrated with SnO_2:F / TiO_2 / graphite Schottky-diodes.

DS 24.16 Tue 15:00 P2

Mechanisms of electron emission from silver cluster films under femtosecond laser excitation — •A. Gloskovskii, D.A. Valdaitsev, S.A. Nepijko, and G. Schönhense — Institut für Physik, Johannes Gutenberg - Universität, 55099 Mainz

The electron yield from metal cluster films upon fs-laser irradiation is several orders of magnitude larger than for bulk metal. Depending on various parameters, electrons can be emitted due to different processes. *Multiphoton photoemission* (*n*PPE) is basically rather well understood. For the case of metal clusters *n*PPE can be governed by the strong enhancement of the optical near field caused by plasmon excitation. In this contribution we focus on the alternative emission processes, i.e. *thermionic emission, thermally assisted n*PPE and *optical field emission*. In order to understand the differences between the competing channels it is necessary to consider the details in the thermalization of the initially excited electron system. Further, a quantum-statistical model gives a quantitative estimation of the different regimes of emission mechanisms.

A FOCUS PEEM with retarding field imaging energy filter was used in combination with a Spectra Physics laser [MaiTai tunable between 750 and 850 nm ("red", 100 fs) and frequency doubled ("blue", 200 fs)]. UHV-deposited Ag/Si cluster films of various mass thicknesses have been investigated using "blue"and "red"excitation. The Fermi level onset is sharp (less than 150 meV wide) in the "blue"photoelectron spectra, while it is smeared out under "red"laser excitation. A contribution of *thermally assisted 2*PPE and *optical field emission* was found in addition to pure *3*PPE under "red"laser excitation.

DS 24.17 Tue 15:00 P2

Growth and electronic structure of ultrathin KCl layers on Cu(111) — •Robin Ohmann[1], Michael Vogelgesang[1], Oguzhan Gürlü[1], Lars Diekhöner[2], M. Alexander Schneider[1], and Klaus Kern[1] — [1]Max-Planck-Institut, Nanoscale Science Department, Stuttgart, Germany — [2]Aalborg Universitet, Institut for Fysik og Nanoteknologi, Aalborg, Denmark

Thin films of insulating materials on conducting surfaces are of great interest as decoupling layers for adsorbates. In the single to few monolayer regime these films can still be investigated by Scanning Tunneling Microscopy and Spectroscopy (STM/STS). Ideally the insulating layer should not provide any electronic structure within its electronic gap. This was checked for the case of ultrathin KCl layers grown in UHV on Cu(111) by low-temperature STM/STS measurements. The Cu(111) surface state is shown to evolve into an interface state with an almost identical dispersion relation in contrast to findings in the NaCl/Cu(111) system (1). Therefore the electronic changes introduced by the KCl are found to be minimal; the layer behaves like an additional tunneling barrier. KCl covered Cu is yet still clearly distinguishable from the Cu(111) surface by measuring the image-potential states. At voltages of 2.7V we identify the onset of a conduction band derived state of the KCl layer. This state is followed by the Stark-shifted series of image-potential states. A detailed discussion of the observed STS spectra at high positive sample bias will be presented.

[1] J. Repp, G. Meyer, K. H. Rieder, PRL 92, 036803 (2004)

DS 24.18 Tue 15:00 P2

Electrical transport mechanisms in growing Pd thin films - modified by hydrogen loading — •Stefan Wagner, Olof Dankert, and Astrid Pundt — Institut für Materialphysik, Georg- August- Universität Göttingen, Friedrich- Hund- Platz 1, 37077 Göttingen

During thin film growth the electrical resistivity of the film changes within orders of magnitude. Different conduction mechanisms can be identified, dominating the conductivity in the different stages of growth. These stages depend on the substrate that, on the one hand, modifies the shape of the islands and, conversely, contributes differently to the conduction mechanisms.

Resistance measurements during thin film growth are presented and divided into regimes where charge tunnelling, island percolation and thin film properties are dominating. The conduction regimes are described in terms of thermally activated tunnelling, percolation theory and modified Fuchs- Sondheimer theory, and the model parameters are determined.

The influence of hydrogen loading on the conduction behaviour of a discontinuous film is shown and appears strongly substrate dependent. It will be discussed in terms of magnitude, reversibility and switching time.

DS 24.19 Tue 15:00 P2

Characterisation of thin PTFE-like fluorocarbon films produced using plasma deposition processes — •Vasil Yanev[1,2], Marcel Himmerlich[1,2], Stefan Krischok[1,2], Gabriel Kittler[2], Oliver Ambacher[2], and Juergen A. Schaefer[1,2] — [1]Institut für Physik, TU Ilmenau, P.O. Box 100565, 98684 Ilmenau, Germany — [2]Zentrum für Mikro- und Nanotechnologien, TU Ilmenau, P.O. Box 100565, 98684 Ilmenau, Germany

Fluorocarbon (FC) thin films are attractive for optical, tribological, microelectronics and Micro-Electro-Mechanical Systems (MEMS) applications because of their unique surface and physical properties. Thin PolyTetraFluoroEthylene-like (PTFE-like) films were deposited on Si(111) using plasma polymerisation at various process conditions. To characterise the properties of these films different techniques such as X-ray Photoelectron Spectroscopy (XPS), ellipsometry, electrical and contact angle measurements were applied. XPS spectra (C1s peaks) indicate the presence of CF_3, CF_2, CF, and C–C bonds typical for crosslinked and/or branched PTFE-like plasma polymer structures. All FC coatings show a very low surface free energy (sessile contact angle with water varying between 103° and 115°), very low refractive indexes varying between 1.35 and 1.44 and excellent dielectric properties (measured dielectric constant, thin film breakdown voltage, field strength and leakage current).

DS 24.20 Tue 15:00 P2

Tuning the surface plasmon resonance in polymer-bimetallic (Au-Ag) nanocomposites — •Venkata Sai Kiran Chakravadhanula, Haile Takele, Henry Greve, Mady Elbahri, Vladimir Zaporojtchenko, and Franz Faupel — Chair for Multicomponent Materials, Technical Faculty of the CAU Kiel, Kaiserstr. 2, 24143 Kiel, Germany.

Nanocomposite thin films with noble metal nanoparticles embedded in or on top of a dielectric material show attractive optical properties at the surface plasmon resonance (SPR) wavelength due to dielectric and quantum confinement effects. Their optical response at SPR can be used in various applications like Raman Spectroscopy, surface enhanced fluorescence, color filters, sensors and optical switching devices. In this

work, we applied a vapor phase tandem deposition method to generate polymer-metal nanocomposites. We observed core-shell type structures after tandem deposition of Au and Ag on polystyrene. Thermal annealing of these led to SPR shift due to alloy formation. We also produced sandwich structures consisting of nanoclusters of different metals separated by a thin polymer barrier. By tailoring parameters like metallic concentration and by sandwiching the Au/Ag particles between polymer with different thickness, the multiple plasmon resonances can be tuned over a wide visible wavelength range.

DS 24.21 Tue 15:00 P2

Optical and electrical detection of hydrogen at room temperature based on MgNi switchable mirrors — •Baker Farangis, Jennifer Stiebich, Bruno K. Meyer, and Dietmar Hasselkamp — I. Physikalisches Institut, Justus Liebig Universität, Heinrich Buff Ring 16, 35392 Giessen

Metallic films of MgNi including a thin palladium cap-layer prepared by RF sputtering exhibit a reversible switching behavior from a highly reflecting to a transmitting state upon hydrogenation and dehydrogenation. The principle of a switchable mirror can be used in an optical sensor to detect hydrogen gas. It bases on a reversible metal-insulator-transition (MIT) upon hydrogen absorption. The MIT also changes the electrical conductivity, therefore in an electrical sensor, the change in conductivity can be used for hydrogen detection. The signal intensity before and after hydrogen take up (4% H_2 in Argon and at room temperature) is stable, and the hydrogen absorption is a fast process. It reaches for the optical sensor within 10 seconds 90% of the maximum value (t_{90}), and for the electrical sensor it is 1 second, considerably faster. The sensitivity of the sensors as a function of the hydrogen concentration was investigated (1-4% H_2 in Ar) and shows an exponential connection.

DS 24.22 Tue 15:00 P2

Electrical and optical properties of electrodeposited Cr ultra-thin films on Si (100) substrate — •Violeta Georgescu and Cristina Sirbu — Faculty of Physics, Al. I. Cuza University, Iasi, Romania

Electronic transport properties of ultra-thin films and of nanometer-sized crystallites of metals deposited onto semiconductors play an important role for the development of nanoscaled electronic devices. In this work, we report the electrical and optical properties of ultra-thin films (2 nm * 50 nm) composed of Cr nano-crystal electrodeposited onto silicon single crystal. The films were prepared by electrodeposition from a solution based on CrO_3 under potentiostatic conditions. Atomic force microscopy has been employed to investigate the morphology of ultra-thin films and the distribution of the Cr nano-crystals grown by this method on n-type Si (100) substrate P-doped. Reflection spectra for ultra-thin Cr/Si films with various thicknesses were recorded in the photon energy range 1.18*3.1eV using a computer controlled STEAG-ETA Optic Spectrometer. Electronic transport behavior performed at room temperature in the plane of the films revealed the type of electrical conduction. Analysis of photo-resistance for various samples allows us to detect the onset of metallic conductivity due to percolation of island-like Cr metal films onto semiconductor substrate. In the case of very small Cr nano-crystals one can observe specific quantum size effects

DS 24.23 Tue 15:00 P2

Annealing effects on VO_2 thin films deposited by reactive sputtering — •Ganhua Fu, Angelika Polity, Niklas Volbers, and Bruno K. Meyer — I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392, Giessen

Due to the switching of the optical properties at semiconductor-metal phase transition, VO_2 can be used as infra-red light (IR)-switching or bolometric devices or as intelligent energy conserving window coating. In this work, two VO_2 film systems (bare VO_2 film on float glass and W doped VO_2 film with a TiO_2 capping layer) were deposited by radio-frequency reactive sputtering. Their thermal stability was investigated by annealing the films in air at different temperatures. It was found that the VO_2 thin film is quite stable in air below 200 °C. However, after annealing in air at 300 °C, the pure VO_2 film was oxidized to a V_2O_5 film. The W doped VO_2 layer with a TiO_2 capping layer lost its switching property after annealing at 400 °C for 10 min due to inter-diffusion.

DS 24.24 Tue 15:00 P2

Indentation and shear of thin fluorocarbon films on silicon substrate — •Yonghe Liu, Mikhail Kosinskiy, Vasil Yanev, Stefan Krischok, and Juergen A. Schaefer — Institut für Physik und Zentrum für Mikro- und Nanotechnologien, Technische Universität Ilmenau, 98693 Ilmenau, Germany

Deposition of a thin polytetrafluoroethylene-like fluorocarbon (FC) film on Si can reduce its adhesion to various substances including water significantly, and thus has potential applications in microelectromechanical systems. However, the adhesion of FC on Si substrate is also weak, which might lead to debonding and other damages of the films under both compression and shear. We report the indentation and shear behaviour of FC films with various thickness prepared by plasma enhanced polymerization. The measurements were performed by a microtribometer with a sphere-on-plane setup. A prescribed load was applied to a glass cantilever through which an atomically smooth Si sphere was in contact with a Si specimen covered with FC film. The normal load-displacement curves in loading and unloading were employed to study the indentation behaviour. Lateral force measured at various normal loads and strain rates were analyzed with contact models to study the shear properties. The topography of residual impression and the wear scars left by shear deformation were observed by a confocal scanning laser microscope and correlated with the indentation and shear measurements.

DS 24.25 Tue 15:00 P2

Parameter screening for the chemical vapour deposition of BN films in the system B-N-H-F — •Jens Matheis, Dimitrios Sapounas, and Achim Lunk — Institute for Plasma Research, University of Stuttgart, Pfaffenwaldring 31, 70569 Stuttgart, Germany

Cubic boron nitride (c-BN) is still an interesting material for protection layers as well as for applications in electronics. Up to now, a lot of different approaches where made to deposit c-BN layers in a μm range without internal stress. Mostly depositions were realized by plasma enhanced physical vapour deposition (PEPVD), using high energy ion bombardment. The stress can be reduced by lowering ion energy in com-bination with plasma enhanced chemical vapour deposition (PECVD). For the application of PECVD we have performed a parameter screening, varying the gas mixtures and the fluxes in the system B-N-H-F for BN-deposition.

Equilibrium state calculations were performed with different gas mixtures of the B-N-H-F-system. The programs CEA and KINTECUS were applied. Also the system Ar-BF_3-N_2-H_2 was calculated for comparison with data from literature. The results achieved in the system BF_3-N_2-H_2 show a good agreement with those obtained by EKVICALC.

For different gas mixtures we present and discuss the parameter ranges where deposition of BN is possible up to temperatures of 1500 K. We found that the relations of B to F as well F to H are crucial parameters for the BN formation. In a further step results will be presented of calculations outside of the thermodynamical equilibrium, including surface reactions and plasma stimulated reactions.

DS 24.26 Tue 15:00 P2

Substrate Temperature Control for Diamond Film Deposition — •Nicolas Wöhrl, Markus Degenhardt, and Volker Buck — Thin Film Technology Group, Dept. of Physics, University of Duisburg-Essen, Universitätsstr. 3-5, 45141 Essen, Germany

The substrate temperature is a critical process parameter for the deposition of diamond. A temperature above 500°C is needed for a reasonable deposition rate and should not extend 1300°C because above this temperature the films become more and more graphitic. Also the film properties are affected by the deposition temperature (e.g. morphology or residual stress).

Another important aspect of the diamond deposition is that the deposition rate of diamond films is scaling with the power used for the plasma. From this results that for high deposition rate the substrate must be cooled (For usual deposition rates mainly self-heating or even external heating are common). Therefore the control of the substrate temperature and an effective substrate cooling is crucial for the understanding of the deposition process and a high rate deposition of diamond.

Thus an aerosol water cooling of the substrate holder was build to meet the needs of the diamond deposition. The setup uses an IR-pyrometer to measure the substrate temperature.

The nanocrystalline diamond films shown in this work were deposited at different substrate temperatures from an $Ar/H_2/CH_4$ plasma in a MW-CVD plasma chamber. The performance of the aerosol water cooling and the influence of the substrate temperature on the film properties are shown.

DS 24.27 Tue 15:00 P2

Investigation of the normal force dependency of the static friction on the micro-scale — •Maksim Karniychuk[1], Thomas Chudoba[2], Volker Linss[2], and Frank Richter[1] — [1]Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany — [2]ASMEC Advanced Surface Mechanics GmbH, Bautzner Landstr. 45, 01454 Radeberg, Germany

So far most of the tribological investigations are performed at load and length scales compatible with macroscopic devices. With recently developed techniques such as friction force microscopy (FFM) and different nano-tribological tests it is possible to study the friction on the nano- and micro-scale. In contrast to the investigation of kinetic friction by these new techniques the estimation of static friction is complicated. For the evaluation of the static friction on the micro-scale the lateral force must be applied to small surface areas with high lateral resolution, which can be achieved by a new Lateral Force Unit. Thus, the static friction force and, consequently, static friction coefficient can be determined.

In general the friction depends on adhesion and volume deformation. However, many other factors can influence the friction behavior on the micro-scale. For instance, the effect of the normal force on the kinetic friction was adequately studied on the micro-scale for many materials, for example, by FFM. Now the new device allows additionally investigating the influence of the normal force on the static friction behavior on the micro-scale.

DS 24.28 Tue 15:00 P2

Fabrication of ohmic Cr/Au contacts on top of cubic Boron Nitride thin films — •H. Yin, H.-G. Boyen, and P. Ziemann — Abteilung Festkörperphysik, Universität Ulm, 89069 Ulm

Cubic boron nitride (c-BN) is a superhard material with a hardness just second to diamond. In addition to many other attractive properties, c-BN also promises interesting applications as a high temperature electronics material due to its wide band gap (about 6eV), good thermal conductivity and good transmittance over a large spectral range from UV to visible. In this context, it is important to note that c-BN, unlike diamond films, can be doped both n- and p-type [1]. To arrive at such applications, however, high quality samples with a low level of defects are necessary. A significant step towards this goal has been achieved recently by the epitaxial growth of single phase c-BN films on top of diamond substrates applying ion beam-assisted deposition (IBAD) [2].

A further necessary intermediate step for electronic applications, however, is the preparation of corresponding ohmic electrical contacts on top of c-BN films. In the present work, Pulsed Laser Deposition (PLD) and Evaporation were tested to fabricate Cr/Au contacts through a mask on top of c-BN films. It turned out that evaporated films had to be additionally ion bombarded at room temperature with 300 keV Ar+ ions to guarantee mechanical stability whereas the PLD films were stable without further bombardment. The resulting I-V characteristics for both types of contacts exhibit the required ohmic behavior.

[1] O. Mishima et.al., Appl Phys Lett 53 (1988) 962 [2] XW Zhang et.al., Nature Materials 4 (2003) 312

DS 24.29 Tue 15:00 P2

Production and characterization of bandwidth- and phase-optimised La/B_4C-multilayer-mirrors for the reflection of ultra short X-ray pulses at 180eV — •Stefan Hendel, Ulrich Neuhäusler, Wiebke Hachmann, Ulf Kleineberg, and Ulrich Heinzmann — Faculty of Physics, University of Bielefeld, D-33615 Bielefeld

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 call for new material combinations. For the photon energy range of about 180eV Lanthanum (La) is favoured as the absorber material and Boroncarbide (B_4C) as the spacer material. Thin periodic layer systems of those materials with double layer periods of 3.5nm are produced by UHV Electron Beam Evaporation combined with Ion Polishing. The characterization of the layer purity is done by Sputter Auger Spectroscopy, whilst structural analysis is performed by X-ray Diffraction, Transmission Electron Microscopy and Ellipsometry. A further goal is the production of aperiodic (chirped) La/B_4C-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 theoretical as well as experimental results.

DS 24.30 Tue 15:00 P2

Interfaces in Complex Organic Structures Investigated by Spectroscopic Ellipsometry — •Sascha Hermann, Ovidiu Gordan, Marion Friedrich, and Dietrich R.T. Zahn — Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany

Organic multilayers and mixed layers were prepared by organic molecular beam deposition in high vacuum on hydrogen passivated Silicon(111) substrates at room temperature. The structures consist either of N,N-Di(naphthalene-1-yl)-N,N‘-diphenyl-benzidine (α-NPD) and tris(8-hydroxyquinoline) aluminium (Alq_3) or 3,4,9,10-perylene-tetracarboxylic dianhydride (PTCDA) and copper phthalocyanine (CuPc). The samples were studied by spectroscopic ellipsometry in the range of 0.73 eV to 5 eV and infrared spectroscopy (IR). The optical response of the multilayers consisting of Alq_3 and α-NPD could be modelled using the isotropic dielectric functions of single layers assuming sharp interfaces. The PTCDA/CuPc multilayers were described using the anisotropic dielectric functions of the constituents including interface-mixing and surface roughness. The deviation between the best simulation and the experiment suggest an electronic interaction due to coupling between the π-orbitals of CuPc and PTCDA at the interfaces. This coupling influences the optical properties and the orientation of CuPc molecules.

DS 24.31 Tue 15:00 P2

Hf silicide growth on Si(100) studied by angle-scanned photoelectron diffraction — •A. de Siervo[1,2], S. Dreiner[1], C. Flüchter[1], D. Weier[1], M. Schürmann[1], U. Berges[1,3], M. F. Carazzolle[4], A. Pancotti[4], R. Landers[2,4], G. G. Kleiman[4], and C. Westphal[1,3] — [1]Experimentelle Physik 1 - Universität Dortmund, Otto-Hahn-Str. 4, 44227 Dortmund, Germany — [2]Laboratório Nacional de Luz Síncrotron, C.P. 6192, 13084-971 Campinas, SP, Brazil — [3]DELTA, Universität Dortmund, Maria-Goeppert-Mayer-Str. 2, 44227 Dortmund, Germany — [4]Instituto de Fisica, Universidade Estadual de Campinas, C.P. 6165, 13083-970 Campinas, SP, Brazil

Presently, alternative materials are extensively studied to replace the classical SiO_2 in new generation semiconductor devices. HfO_2 is one promising candidate. However, up to now, only very few studies on HfSi films are available and a structure determination is completely missing.

We present the results of a photoelectron diffraction study of Hf silicide growth on Si(100). The films were prepared in UHV by evaporating Hf to clean silicon surfaces and subsequent annealing. Full 2π angle scanned photoelectron diffraction patterns of Hf 4f and Si 2p signals were measured using conventional Mg K_α and synchrotron radiation. Diffraction patterns for low electron kinetic energies were obtained using photon energies of hν=180 eV of the undulator beamlines U250 and U55 of DELTA (Dortmund). At these energies, multiple scattering effects occur and a data analysis was only possible within a comprehensive multiple scattering calculation. We compare experimental and calculated results and present a structure model for the silicide films.

DS 24.32 Tue 15:00 P2

Application of white beam high energy X-ray diffraction to the analysis of near surface gradients — •Ingwer Denks, Manuela Klaus, and Christoph Genzel — Hahn-Meitner-Institut Berlin (c/o BESSY), Albert-Einstein-Straße 15, D-12489 Berlin

Energy dispersive (ED) diffraction using X-rays up to 100 keV or so is usually applied to the analysis of bulk properties of technical parts such as long range residual stress-, texture- or microstructure gradients. However, the small diffraction angles of some 5 to 10 deg used in high energy diffraction and the high photon flux provided by modern 3rd generation synchrotron radiation sources also allow depth resolved investigations of thin surface layers. So using very narrow slits in the primary and the diffracted beam, rhombohedral volume gauges of large aspect ratio and a small dimension less than 10 microns may be defined. In the contribution a new method is proposed, which is based on a fixed attachment of the slits to the sample system in such a way that the long side of the gauge is always parallel to the sample surface. It will be demonstrated that using such an experimental arrangement, high resolution depth profiling becomes possible even after sample tilt, i. e. for different orientations of the diffraction vector with respect to the sample system.

DS 24.33 Tue 15:00 P2

High-resolution elemental depth profiling of PIII&D deposited multilayer coatings by ion beam techniques combined with EFTEM — •Florian Schwarz[1,2], Jörg Lindner[1], Maik Häberlen[1], Götz Thorwarth[1,2], Claus Hammerl[2], Walter Assmann[3], and Bernd Stritzker[1] — [1]Institut für Physik, Universität Ausgburg, 86135 Augsburg, Germany — [2]AxynTeC Dünnschichttechnik GmbH, Am Mittleren Moos 48, 86167 Augsburg, Germany — [3]Sektion Physik der LMU München, Am Coulombwall 6, 85748 Garching, Germany

The emergence of multilayered and nanostructured coatings requires analysis methods capable of high spatial resolution as well as high depth range. While traditional ion beam analysis methods are capable of accurate, standards-free determination of sample composition, methods such as energy filtered transmission electron microscopy (EFTEM) offer the desired short-range resolution, yet are deficient in the quantitative assessment of the elemental contributions. We demonstrate the combination of IBA (ERDA, RBS) measurements with EFTEM data for analysis of two protective multilayer-type coatings grown by plasma immersion ion implantation and deposition (PIII&D) resulting in high resolution elemental depth profiles.

DS 24.34 Tue 15:00 P2

Preparation of TEM cross-sections and HRTEM structure determination of thin $La_{0.7}Sr_{0.3}MnO_3$ films — •Thomas Riedl, Thomas Gemming, and Klaus Wetzig — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

For the determination of lattice distortions of crystalline films by means of HRTEM well prepared TEM specimens are required. The quality of specimen preparation can be quantified in terms of amorphization, impurity content and specimen morphology. Conventional preparation using ion milling as well as the focussed ion beam H-bar technique have been applied to produce cross-sections of $La_{0.7}Sr_{0.3}MnO_3$ /$SrTiO_3$ samples interesting for magnetoelectronics. Thickness maps near the specimen rim indicate that under the applied parameters particularly the Bal-Tec RES ion mill produces large thin areas with small wedge angles and bending. Low-energy milling at 0.5keV reduces amorphized rims below 1nm leading to an enhanced atomic-column contrast in HRTEM images. The lattice distortions within the $La_{0.7}Sr_{0.3}MnO_3$ films have been studied by the analysis of HRTEM geometric phase [1]. As expected the lattice planes perpendicular to the interface are expanded whereas the parallel planes are compressed relative to the bulk [2].

[1] M. J. Hytch et al.: Ultramicr. 74 (1998) 131

[2] We acknowledge the DFG for financial support via FOR 520, project GE 1037/8.

DS 24.35 Tue 15:00 P2

Modeling asymetric polarization hysteresis of $BaTiO_3$-ZnO heterostructures — •V. M. Voora[1], N. Ashkenov[1], T. Hofmann[2], M. Lorenz[1], M. Grundmann[1], and M Schubert[2] — [1]Institut für Experimentelle Physik II, Universität Leipzig, Leipzig, Germany — [2]CMRA, University of Nebraska-Lincoln, Lincoln, USA

The spontaneous polarizations of appropriately oriented wurtzite and perovskite material layers cause bound charges at their interfaces. Whereas the wurtzite-type polarization is inherently tied to one distinct lattice direction, the spontaneous polarization can be reversed within the perovskite lattice upon application of external electric fields. We have successfully grown high-quality Pt-$BaTiO_3$-ZnO-Pt layer structures by Pulsed Laser Deposition on Si-substrate and investigated the structural, electrical, and optical properties of these structures. The asymetric polarization hysteresis of the Si-Pt-$BaTiO_3$-ZnO-Pt heterostructures show distinct fingerprints of a Schottky-type junction formed at the $BaTiO_3$/ZnO interface. For positive voltage direction the hysteresis is dominated by a clear reverse diode behavior, whereas for the negative voltage direction the clear switching behavior of $BaTiO_3$ is present. A quantitative model analysis of the electrical measurements is presented.

DS 24.36 Tue 15:00 P2

Coherent X-Ray Reflectivity at the Energy Dispersive EDR-Beamline at BESSY II — •Tobias Panzner[1], Gudrun Gleber[1], Tushar Sant[1], Ivan Vartanyants[2], and Ullrich Pietsch[1] — [1]Universität Siegen, Fachbereich 7, Festkörperphysik, Emmy-Noether-Campus, Walter-Flex-Str. 3, 57068 Siegen — [2]DESY Hamburg

3rd generation storage rings provides partly coherent radiation allowing for new kind of x-ray experiments. Adapting knowledge and techniques from the photon correlation spectroscopy with visible light (PCS) many successful experiments are published where sample became under investigation which are opaque in PCS. The advantage of coherent x-ray experiments is the reconstruction of surfaces on micrometer to nanometer length scale (static speckle experiments) or the observation of dynamic processes (XPCS) at surfaces and interfaces on the same length scale. One major drawback of standard x-ray experiments is that only intensities can be measured. In case of coherent x-ray scattering this problem can be overcome by reconstruction of the missing phase information by the so-called phase retrieval procedure. In our poster we show this procedure for energy-dispersive coherent scattering where the development of phase is considered along the whole beam passage from the incoming pinhole through the scattering by sample up to the detector. Taking the known phase information of the pinhole into account we are able to reconstruct the true surface of the illuminated sample area more precisely.

DS 24.37 Tue 15:00 P2

FT-IR studies of Ag/MgO(001) — •Fanzhen Meng, Daniel Seibel, Gerhard Fahsold, and Annemarie Pucci — Kirchhoff-institut für Physik, Heidelberg University, Im Neuenheimer Feld 227, D-69120 Heidelberg, Germany

We present the IRRS (Infrared reflection spectra) of Ag films measured during their growth on MgO(001) at room temperature, at 100 K, and at 50 K. We get a reflectance minimum at a certain thickness. This thickness is comparable to the percolation threshold that we know from our previous IR transmittance measurements [1]. Beyond the percolation threshold, the IRRS of room temperature prepared films show structures quite different to those grown at low temperature. Also, we will show the effect of gas exposure during metal deposition on IR spectra and film morphology at room temperature. For the Ag/MgO(001) system, CO does not show an effect, different to Cu/MgO(001) [2]. However, we detected that hydrocarbon exposure leads to enhanced film roughness. From surface enhanced IR absorption (SEIRA) of adsorbates we get additional information on film morphology.

[1] F. Meng, G. Fahsold and A. Pucci, Phys. Stat. sol.(c), accepted.

[2] M. Lust, A. Priebe, G. Fahsold and A. Pucci, Surf. Interface Anal.33, 487 (2002).

DS 24.38 Tue 15:00 P2

Effect of film thickness on the microstructures of Indium - Indium oxide composite films — •Deniz Deger and Kemal Ulutas — Istanbul Univ., Science Faculty, Physics

Pure indium metal thermally evaporated in the presence of oxygen atmosphere, with partial pressure of $5x10^{-4}$ Torr, onto glass substrates and onto C-Cu grid at room temperature. The structural characteristics of these optically transparent and electrically conducting thin films were investigated using XRD and TEM techniques and the results are discussed on the base of the differences in their morphologies and thicknesses. Cubic In_2O_3 and tetragonal In phases, with crystal structures and lattice parameters as reported in the literature, have been identified in the thinnest film having 1000 Å thickness. The tendency for amorphization of the cubic and tetragonal phases becomes evident as the film thickness increases.

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DS 24.39 Tue 15:00 P2

Direct Observation of Intermediate Phases of Pyrolytic Carbon by Atomic Force Microscopy — •Andreas Pfrang[1], Yong-Zhong Wan[1], and Thomas Schimmel[1,2] — [1]Institute of Applied Physics, University of Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institute of Nanotechnology, Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany

Although it is technologically highly relevant, the mechanism of pyrolytic carbon deposition is not yet fully understood. Especially the role and even the existence of intermediate phases of carbon during deposition are not clear. In our experiments, islands and layers of pyrolytic carbon were deposited on planar substrates in a hot-wall reactor from methane / argon mixtures. Combined scanning force techniques were applied to reveal two types of islands by different chemical contrast. This observation can be interpreted in terms of an intermediate phase of pyrolytic carbon [1]: for deposition in a regime where the nucleation mechanism dominates, an intermediate phase of pyrolytic carbon was predicted which is expected to have deviating mechanical properties in good agreement with our results of island removal experiments carried out using atomic force microscopy.

Moreover, on layers deposited at sufficiently high methane pressures where adsorption saturation is reached, additional carbon structures exhibiting different chemical contrast were found. This is further experimental evidence for the existence of an intermediate phase of carbon postulated for deposition in the nucleation mechanism.

[1] Z.J. Hu, K.J. Hüttinger. Carbon 40 (2002), 617-636

DS 24.40 Tue 15:00 P2

FTIR-ATR study of the interface between Al_2O_3 and H-terminated SiC(0001) and Si(111) — •F. Speck, K.Y. Gao, K. Emtsev, Th. Seyller, and L. Ley — Lehrstuhl für Technische Physik, Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, D-91058 Erlangen, Germany

Aluminum oxide (Al_2O_3) is an insulator which can be regarded as an alternative to thermally grown SiO_2 as gate dielectric for MOSFETs on Si as well as on SiC. We have studied the composition of the interface between the dielectric Al_2O_3 and the semiconductors Si and SiC. Al_2O_3 films were grown by atomic layer deposition (ALD) on hydrogen-terminated SiC(0001) and Si(111) substrates. Surface hydrogenation of SiC(0001) was performed by annealing in ultrapure hydrogen. On Si(111) a wet-chemical treatment by etching in NH_4F was employed. The interfaces were investigated for Si-H bonds by Fourier-transform infrared attenuated total reflection spectroscopy (FTIR-ATR). The spectra show that on both SiC(0001) and Si(111) Si-H entities are present at the interface after the ALD process. The characteristic absorption line of the Si-H stretching vibration is broadened and red-shifted as compared to Si-H modes on the hydrogenated substrates. Shift and broadening are probably due to electrostatic interactions at the interface. The presence of Si-H bonds suggests that substrate atoms not connected to the aluminum oxide remain saturated by hydrogen atoms.

DS 24.41 Tue 15:00 P2

Ultra thin Aluminium oxide films on silicon — •Mandana Roodbari Sh. and Ali Bahari — Physics Department, Mazandran University, Iran

Ultra thin aluminium oxide films, have been identified as potential candidates to replace conventional silicon oxide gate dielectrics in current and future CMOS. Because a shrinking of the silicon oxide thickness with one atomic layer for the next generation will lead to a couple of orders of magnitude increase in tunneling current. Another critical issue for future generations is gate oxide degradation due to boron penetration into the oxide from the poly-silicon gate electrode. We have demonstrated a number of new processes to grow ultra thin aluminium oxides. These sudies have demonstrated a number of new processes to grow ultra thin aluminium oxides.

Two step processes have been employed including evaporation of aluminium to less than monolayer coverage followed by oxygen oxposure. For these investigations of nano-properties and atomic growth processes, the availability of synchrotron radiation with high quality and stability, as met at ASTRID, Aarhus in Denmark, has been important.

Therefore, the present method can be used to deposit uniform aluminium oxide layers of the relevant effective thickness for coming generations of devices directly on silicon surfaces, with atomically sharp interfaces.

DS 24.42 Tue 15:00 P2

Abscheidung von siliziumhaltigen Schichten auf Mikroteilchen in dielektrisch behinderten Plasmen unter Atmosphärendruck — •Marcel Hähnel, Volker Brüser, and Holger Kersten — INP Greifswald, F.-L.-Jahn Straße 19, 17489 Greifswald

Die vorliegende Studie befaßt sich mit der Abscheidung von homogenen und geschlossenen SiO_2-haltigen Schichten auf Mikroteilchen. Diese Schichten wurden aus Hexamethyldisiloxan (HMDSO) und Tetraethylorthosilicat (TEOS) unter Beimischung verschiedener Gaszusammensetzungen deponiert. Die Untersuchungen zur Abscheidung solcher SiO_2-haltigen Schichten erfolgte auf Kaliumbromidpulver in der Größenordnung von 10 bis 80 Mikrometer. Für die Beschichtung wurde eine dielektrisch behinderte Oberflächenentladung verwendet, die durch Modifikationen auch für eine kontinuierliche Arbeitsweise geeignet ist. Die Entladung wurde gepulst mit Spitzenspannungen von 14 kV bei einer Pulswiederholrate von 10 kHz betrieben. Als Spannungsquelle diente ein Fourier-Synthese Impulsgenerator mit einer Ausgangskapazität von 200 pF.

Die Bewertung der Schichten erfolgte durch Oberflächenanalytik (FTIR, REM), sowie makroskopischer Tests zur Bestimmung der physikalisch-chemischen Eigenschaften.

DS 24.43 Tue 15:00 P2

Electrophysical properties of TiN thin films deposited by plasma treatment — •Elena Shcherbakova — Minsk, Belarus

In this work the dependence of resistivity of titanium nitrides thin films upon changes in their structure and phase composition as a result of processing with hydronitrogen plasma was found. By means of transmission-electron microscopy and electron diffractometry regularity of structural and phase transformations in titanium thin films irradiated with plasma of arc discharge were investigated. Conditions of processing by plasma for formation of titanium nitrides thin films with resistivity 50 μOhm/cm were determined.

The results of studies show that the titanium films obtained have resistivity ≈110 μOhm/cm. This films polycrystalline and fine-grained, with the average grain size of 5-10 nm. When the films is exposed to hydronitrogen plasma at 500 °C, TiN and Ti_2N are formed and resistivity is increased to 210 μOhm/cm. As treatment temperature is increased to 600°C, the nitride phase having a small amount of nitrogen disappears, and a film of golden colour, consisting entirely of TiN, is formed. Further increasing of temperature to 750°C does not change phase composition, but the average grain size is increased to ≈120 nm. At temperatures up 600 to 750°C titanium nitride films had a small resistivity of 50-60 μOhm/cm.

DS 24.44 Tue 15:00 P2

Structural evolution in reactively sputtered copper nitride films — •F. Uslu[1], M. Luysberg[2], K. Sarakinos[1], P. Karimi[1], and M. Wuttig[1] — [1]I.Physikalisches Institut, RWTH Aachen, 52056 Aachen — [2]IFF, Forschungszentrum Jülich, 52425 Jülich

Early transition metal nitrides such as TiN or ZrN are well known for their applications, which include hard coatings due to their high hardness and high melting temperatures. Much less is known about the physical properties of late transition metal nitrides such as copper-nitride. Reactive dc magnetron sputtering has been applied to prepare copper-nitride films on glass and silicon substrates as well. To elucidate the microstructural features of copper nitride films several methods such as X-ray diffraction, grazing incidence geometry and X-ray reflectometry have been employed. In addition transmission electron microscopy has been utilised to obtain a thorough understanding of the microstructural evolution in copper-nitride films. To this end specimens deposited at two different nitrogen flow rates of 12 and 50 sccm N_2 respectively, were analysed. The x-ray investigations reveal that the (111) and (200) grain orientations are stronger than the other ones, where the (111) orientation is dominant. It was possible to decrease this (111) preferred orientation and increase of the (200) orientation by increasing the sputtering current. This is attributed to an enhanced incident ion flux and hence to a bombardment with nitrogen ions. A further effect of this bombardment is reflected in the mechanical properties, where the films reveal compressive stress. The enhanced bombardment leads to an increase of the cell size with increasing nitrogen flow rate.

DS 24.45 Tue 15:00 P2

Self-organised pattern formation upon femtosecond laser ablation — •Olga Varlamova[1,2], Florenta Costache[1,2], Markus Ratzke[1,2], and Jürgen Reif[1,2] — [1]LS Experimentalphysik II, BTU Cottbus, Karl-Wachsmann-Allee 1, 03046 Cottbus — [2]IHP/BTU JointLab, Karl-Wachsmann-Allee 1, 03046 Cottbus

Upon multi-shot femtosecond laser ablation from different materials, self-organised regular patterns are observed at the crater bottom. By irradiation with linearly polarised light, it has been shown that long periodic ripples with many bifurcations develop, the orientation of which is determined by the polarisation direction, though the fundamental nature of this correlation is not yet known. To investigate this phenomenon closer, we performed corresponding experiments using circularly and elliptically polarised light. Surface morphology investigation reveals that, again, a variety of self-organised patterns is obtained, from arrays of nanoparticles to bifurcating longer lines. Experiments with laser beams of elliptical polarisation have shown that ripples' orientation is sensitive to the major axe of the polarization ellipse. However, for circularly polarized light the orientation of these structures is random. Furthermore, electrical measurements done with a Scanning-Probe Microscope on the ablated area reveal the existence of a spatial variation in the electric field response correlated with the patterns' modulation on the crater bottom.

DS 24.46 Tue 15:00 P2

Femtosecond Laser Ionization Mass Spectrometry for Analysis of Multi-layered Structures — •Lei Zhu[1,2], Florenta Costache[1,2], Markus Ratzke[1,2], and Jürgen Reif[1,2] — [1]LS Experimentalphysik Brandenburgische Technische Universität Cottbus, Karl-Wachsmann-Allee, 03044, Cottbus — [2]IHP/BTU JointLab Cottbus, Karl-Wachsmann-Allee, 03044, Cottbus

Using a femtosecond laser as the ionization source, a Time-of-Flight Laser Ionization Mass Spectrometer (ToF-LIMS) is explored with respect to its potential for elemental analysis and depth profiling of multi-layered samples, an alternative to the classical SIMS. For this investigation, we used a structure of type Metal-Oxide-Semiconductor (MOS): a layer of high-k dielectric of Pr_6O_11 grown by Pulsed Laser Deposition (PLD) on Si (100), covered by an aluminum contact layer.
High lateral and depth resolution could be attained by using small laser spot sizes provided by laser fluences below the ablation threshold for a single pulse. The characteristics of the emitted positive ions give valuable information on the layers quality such as composition, stoichiometry, interface constituents, oxidation and aging. By simultaneously monitoring the layers' ion product yields over a large number of pulses, anti-correlated ion signals revealing sharp interfaces were identified.
Furthermore, we investigated the morphology of the resulting craters by Atom Force Microscopy. The results indicate that by using ToF-LIMS a depth resolution in the nanometer range could be reached.

DS 24.47 Tue 15:00 P2

Structural and magnetic investigations on Mn-implanted beta-Iron-Disilicide — •Frank Stromberg[1], Helfried Reuther[2], and Werner Keune[1] — [1]Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany — [2]Forschungszentrum Rossendorf, 01314 Dresden, Germany

100 nm thick epitaxial beta-Iron-Disilicide films were grown on Si(100) substrates by MBE and ex-situ implanted with Mn-ions at energies of 90 and 150keV.

The doses varied from 1E16 to 1E17. X-Ray and Mössbauer spectroscopy confirmed the amorphization of the implanted films.

Hall measurements exhibit n-type behavior of the implanted samples whereas literature states that they should be p-type conducting.

The conductivity of the implanted samples is strongly enhanced but for the sample with the highest dose it drops.

Anomalous Hall effect and Magnetoresistance measurements were performed but a conclusive hint pointing at magnetic effects is only possible after SQUID measurements which are currently performed.

DS 24.48 Tue 15:00 P2

The New Neutron Reflectometer-NeRo — •Danica Solina, Dieter Lott, Ursula Tietze, Oliver Frank, Vincent Leiner, and Andreas Schreyer — GKSS Forschungszentrum GmbH, Max-Planck Str. 1; D-21502 Geesthacht, Germany

2005 saw the opening of the new NEutron ReflectOmeter (NeRo) at the GKSS research centre in Geesthacht, Germany for the investigation of magnetic and non-magnetic systems as well as soft matter nanostructures.

NeRo operates with a monochromatic beam of neutrons of wavelength 0.433 nm with a resolution better than 2%. An angular range of $20° < 2\theta < 100°$ allows for both reflectometry and high angle diffraction measurements to be made on NeRo. NeRo has both a position sensitive detector and a pencil detector installed for flexibility when making specular and diffuse measurements.

NeRo has been designed to accommodate heavy sample environments such as cryo-furnaces and various kinds of magnets. Polarization analysis is available for the investigation of magnetic nano-structures. A super mirror stack with a wide angular acceptance range will be available in 2006 for time efficient measurements of magnetic diffuse reflectivity.

Further information and proposal forms can be obtained online at http//:genf.gkss.de.

DS 24.49 Tue 15:00 P2

Effect of the Heat Treatment on the Structural and Optical Characteristics of Polycrystalline ZnTe Thin Films — •Rusu Gheorghe and Prepelita Petronela — Faculty of Physics Al. I. Cuza University, Iassy, R-700506, Romania

ZnTe thin films have been intensively studied in the last years. ZnTe thin films (d =230 - 2150 nm) were deposited onto glass substrates by the quasi-closed volume technique under vacuum. It was established that the films with stable structure can be obtained if they, after deposition, are subjected to a heat treatment. The structure analysis of the films was performed by X-ray diffraction (XRD) technique and atomic force microscopy (AFM). The structural investigations performed by means of XRD technique showed that the films have a polycrystalline and blende (cubic) structure. They are highly oriented with the (111) planes parallel to the substrate. AFM images showed that have a grain like surface morphology. The values of the optical parameters (refractive index and absorption coefficient) were determined from transmission spectra (in the spectral range 500-1400nm) using Swanepoels method. The effect of heat treatment on the shape of the transmission and absorption spectra is studied for samples with different thickness. Optical energy gap, calculated from the absorption spectra was in the range 1.9eV-2.4eV.

DS 24.50 Tue 15:00 P2

Magnetic and transport properties of electrodeposited Fe-Pt thin films — •Violeta Georgescu[1], Cristina Sirbu[1], and Mihaela Daub[2] — [1]Faculty of Physics, Al. I. Cuza University, Iasi, Romania — [2]Max-Planck-Institute for Microstructure Physics, Halle, Germany

We present a comparative investigation of the surface, structural, magnetic and electric properties of electrodeposited Fe-Pt films in a composition range close to (L12) $FePt_3$ ordered phase. The system of Fe-Pt was chosen because of the "competition" between ferro- and antiferromagnetism in these alloys, which is favouring the GMR effect. Only a relatively few studies of the magnetic properties of electrodeposited Fe-Pt films exist up to now. The Fe_xPt_{1-x} films, with x=(30-38)% and thickness of 250-300 nm, were electrochemically deposited on Cu (100) textured foils. XRD and AFM showed that the electrodeposited films were nanocrystalline alloys in a disordered or a partially ordered chemical state. By using a torque magnetometer in fields up to 300 kA/m at room temperature, the easy magnetization direction was observed to be perpendicular to the film plane. The magnetoresistance was measured by applying the current perpendicular to the plan (CPP) and the magnetic field perpendicular or parallel to the film plane. For films with x of around 30%, the magnetoresistance was (7.8-11.8)% in CPP geometry, indicating the possibility of interesting technological applications.

DS 24.51 Tue 15:00 P2

Reflectance Anisotropy Spectroscopy in the VUV range for the characterisation of thin organic layer — •Philipp Myrach[1,2], Christoph Cobet[2], Regina Passmann[2,1], Norbert Esser[2], and Wolfgang Richter[1] — [1]Technische Universität Berlin, Inst. f. Festkörperphysik, PN6-1, Hardenbergstr. 36, 10623 Berlin — [2]Institut for Analytical Science, Albert Einstein Str. 9, D-12489 Berlin

In the last couple of years organic-based electronics becomes increasingly important. So organic functionalization is relevant to develop new semiconductor devices. To investigate the molecules attachment and the formation of the thin layers the method of Refletance Anisotropy Spectroscopy(RAS) should be very useful. This method allows to give an fast, non-destructive and in-situ characterisation of the optical and electronic properties.

Optical characterisation of semiconductors is usually done in the visible-UV spectral range. But ab-initio calculations show that the characteristic HOMO-LUMO transitions of many relevant organic molecules and transitions between substrate and organic layer stats are located in the VUV range(above 5eV). Due to this predictions, we have extented the RAS to the VUV spectral range.

When using an optically isotropic substrate material, RAS technique is very sensitive to surfaces or interfaces. Thus RAS measures the difference of reflectance between the thin film optical axies. Therefore its possible to study organic layers with an single layer sensitivity.

DS 24.52 Tue 15:00 P2

Electrochemical Growth and Properties of Thin Polyaniline Films on p-Si (111) and Au (111): A Comparative Study — •Lidiya Komsiyska[1], Georgi Staikov[1], and Vessela Tsakova[2] — [1]Institute of Thin Films and Interfaces (ISG3), and cni-Centre of Nanoelectronic Systems for Information Technology, Research Centre Jülich, 52425 Jülich, Germany — [2]Institute of Physical Chemistry, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria

Due to their electronic properties and stability, polyaniline (PANI) layers are attractive for application in various micro- and nano-devices for electronics and sensorics. In this contribution we report a comparative study on electrodeposition of thin PANI layers on single crystal

p-Si(111) and Au(111) substrates. The mechanism of formation and the properties of electrodeposited polymer films are investigated by means of transient measurements, cyclic voltammetry, electrochemical impedance spectroscopy (EIS) and atomic force microscopy (AFM). The analysis of potentiostatic current transients obtained on both substrates show different growth mechanisms in the initial deposition stages. PANI layers on Au(111) are characterized by a smoother surface, compactness and higher electrochemical stability. Cyclic voltammetric and impedance measurements show that the redox switching of PANI layers is influenced strongly by the electronic band structure of the substrate. The possibility for an additional modification of the PANI layers by electrochemical deposition of Au nanoparticles is also demonstrated.

DS 24.53 Tue 15:00 P2

Effect of the Base Pressure on OMBD grown BCP Layers Studied by Spectroscopic Ellipsometry — •Daniel Lehmann and Dietrich R. T. Zahn — Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany

Bathocuproine (BCP) layers are used in organic opto-electronic devices such as organic light emitting devices (OLEDs) and organic photovoltaic (OPV) solar cells as electron conducting, exciton blocking layers enhancing the device efficiency. The layers in this study were grown using Organic Molecular Beam Deposition (OMBD) on cleaned silicon substrates with a layer of natural silicon oxide. Two layers with different thicknesses (10 nm and 100 nm) were prepared for each base pressure step. After preparation they were studied *ex situ* with Variable Angle Spectroscopic Ellipsometry (VASE) in the energy range from 0.73 eV to 5.00 eV and the dielectric functions were determined. The results show that the base pressure, ranging from 10^{-5} mbar to 10^{-8} mbar has a strong impact on the dielectric function and therefore also on light absorption and refraction.

DS 24.54 Tue 15:00 P2

Temperature Controlled Deposition of Thin Plasma Polymer Films Containing Hydroxyl Groups — •Jan Schäfer and Jürgen Meichsner — Institute of Physics, Ernst-Moritz-Arndt-University of Greifswald, Domstraße 10a, D-17489 Greifswald

Thin functional plasma polymer films from ethylene glycol (EG) are deposited in the RF plasma reactor Nevada. The films are characterized by a high content of hydroxyl functional groups.

A mixture of EG vapour and argon was used as a reactive process gas system. By the IR Reflection Absorption Spectroscopy (IRRAS) of the temperature tuneable surface we characterised the (p,T)- phase diagram of the mixture. Following we localized that area of the diagram where an irreversible reaction process between the plasma and the EG liquid condensate results in the solid polymer film.

The in situ IRRAS was applied for an analysis of changes in the molecular structure of the films. Depending on the position in the phase diagram the molecular composition of the films varied, in particular the proportion between hydroxyl and carbonyl groups. This is in correlation with the temperature behaviour of the film during the plasma surface interaction.

The nature of the Poly(EG)-like films by means of the new deposition method is discussed concerning biochemical applications.

DS 24.55 Tue 15:00 P2

Growth Studies on Organic Charge Transfer Materials: $(ET)_2Cu(NCS)_2$ — •Kerstin Keller, Florian Roth, Yoon-Jeong Lee, and Michael Huth — University Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt am Main

The growth of organic thin films of Pentacene and BEDT-TTF (ET) prepared by organic molecular beam deposition (OMBD) is studied and the evaporation process is modeled by Monte Carlo simulations. By co-evaporation of ET and $Cu(NCS)_2$ the formation of the charge transfer salt $(ET)_2Cu(NCS)_2$ is investigated, where the superconducting kappa-phase is of special interest. The thin films are characterized by x-ray diffraction. With in-situ shadow mask technique different functional device structures such as field effect transistors (FET) and tunneling contacts can be prepared. This enables us to investigate the electronic properties with low temperature measurements.

DS 24.56 Tue 15:00 P2

Surface morphology of solid supported phospholipid membranes on self-organized, nanostructured semiconductor substrates — •Gerald Trummer, Christian Hofer, Gregor Hlawacek, and Christian Teichert — Institute of Physics, University of Leoben, A-8700 Leoben, Austria

Self-organization effects during heteroepitaxy or ion bombardment of semiconductors frequently result in large area nanostructured substrates, which can be used as templates for further deposition of thin films. [1]

Here, we utilize nanofaceted SiGe films as well as ion bombarded Si and SiGe samples as templates for phospholipid (POPE) membranes. Atomic-force microscopy is applied to study the resulting film morphology as a function of deposition techniques and template geometry.

Areas of low lipid coverage show typical terrace structures. The height of single bilayers varies between 4 nm and 7 nm depending on hydration. Phase imaging allows identification of the boundary layer between substrate and lipid. For certain templates, the substrate morphology controls the film roughness and/or the lateral shape of the bilayer islands.

[1] C. Teichert, Appl. Phys. A 76, 653 (2003)

DS 24.57 Tue 15:00 P2

Optical and structural properties of perylene films — •Stephan Kremers, Phenwisa Niyamakom, Maryam Beigmohamadi, Azadeh Farahzadi, Thomas Michely, and Matthias Wuttig — I. Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany

Highly symmetric organic molecules such as perylene tend to grow crystalline which give rise to high carrier mobility. This property makes them feasible for low-cost electronic device. We have therefore investigated the properties of thin films of the perylene deposited on various substrates such as silicon, glass and gold with different deposition rates and film thicknesses. Subsequently their structural properties were measured employing both AFM to determine the film roughness and surface morphology as well as XRD to determine their micro strain, texture and grain size. Finally their optical properties were determined with ellipsometry and UV-VIS spectroscopy. The structure investigation shows that highly textured films with specific defects form above a critical thickness. This has a profound impact on the growth morphology. The combination of AFM and XRD enables the identification of the defects. The highly textured films show a pronounced optical anisotropy. Efforts to simulate this anisotropy are presented.

DS 24.58 Tue 15:00 P2

Perfluorinated and nonfluorinated Vanadyle Phthalocyanine on gold - interface properties of two dipolar materials — •Indro Biswas[1], Heiko Peisert[1], Kanai Kaname[2], Nakano Tomohito[2], Seki Kazuhiko[2], Danilo Dini[3], Michael Hanack[3], and Thomas Chassé[1] — [1]Institut für Physikalische und Theoretische Chemie, Universität Tübingen, Auf der Morgenstelle 8, 72076 Tübingen, Germany — [2]Nagoya University, Graduate School of Science, Division of Materials Science, Furo-cho, Chikusa-ku, Nagoya 464-8602, Japan — [3]Institut für Organische Chemie, Universität Tübingen, Auf der Morgenstelle 18, 72076 Tübingen, Germany

The interface properties of vanadyle phthalocyanine (PcVO) and its perfluorinated derivative (F_{16}PcVO) on gold are compared to the corresponding copper phthalocyanines (PcCu, F_{16}PcCu), using photoemission spectroscopy and Kelvin probe measurements. Similarly to F_{16}PcCu, the ionisation potential of F_{16}PcVO is more than 1 eV higher than of the unsubstituted material, and thus a downward (PcVO) or upward (F_{16}PcVO) energy shift is observed. Due to their nonplanar molecular shape both vanadyle phthalocyanines have permanent dipoles. The molecular dipole moment of F_{16}PcVO is influenced by the high electronegativity of the substituting fluorine atoms. For the understanding of energetic shifts at the metal-organic interface the orientation of molecular dipoles is crucial. Different growth modes and π-π interactions are discussed.

DS 24.59 Tue 15:00 P2

Plasma stabilization and increase of the deposition rate during reactive sputtering of metal oxides — •Daniel Severin[1], Oliver Kappertz[2], Tomas Nyberg[2], Sören Berg[2], Andreas Pflug[3], Michael Siemers[3], and Matthias Wuttig[1] — [1]I. Institute of Physics (1A), Aachen University, Germany — [2]Solid State Electronics Division, Uppsala University, Sweden — [3]Fraunhofer IST, Braunschweig, Germany

Reactive sputtering is an attractive technique for the deposition of metal oxides. One of its main drawbacks, however, is the hysteresis and process instability encountered in the transition from the metallic to the compound mode, where films can be deposited most rapidly with desirable properties. Here we present a method to stabilize the undesirable abrupt transition between metallic and compound mode. The addition of nitrogen in the plasma gas leads to supplanting of oxygen by nitrogen on the target's surface and coverage with the corresponding nitride. Due to the lower reactivity of the nitride compared to the oxide and a smaller effective target area the hysteresis vanishes. In addition a higher deposition rate is achieved since the sputtering rates of the nitrides are generally higher than those of the corresponding oxides. The observed behaviour can be qualitatively explained and theoretically predicted using an extention of Berg's model to two different reactive gases. Although the nitrogen addition leads to pronounced changes of the plasma, the incorporation of nitrogen atoms in the growing film is very small as predicted by theory.

DS 24.60 Tue 15:00 P2

Reaktives Plasmajet-Ätzen - Wechselwirkungen mit Si-Oberflächen — •Thomas Arnold und Axel Schindler — IOM e.V., Permoserstr. 15, 04318 Leipzig

Lokale Trockenätzverfahren auf der Basis reaktiver Plasmajets stellen eine vielversprechende Technologie für die Bearbeitung und Formgebung von Oberflächen aus siliziumhaltigen Materialien dar.

Die Untersuchungen zum plasmachemischen Hochrateätzen mit einem nichtthermischen $Ar/SF_6/O_2$-Plasmajet mit Mikrowellenanregung konzentrieren sich auf die lokale Verteilung von Teilchenflüsse der ätzaktiven Spezies (Fluoratome) sowie auf die komplexe SF_6-Chemie im Plasmajet. Desweiteren werden die aus der Plasmachemie folgenden Effekte im Wechselwirkungsbereich zwischen Si-Substratoberfläche und Plasmajet untersucht. Die Reaultate zeigen, dass trotz der komplizierten Abhängigkeit der Teilchenflüsse von den Prozessparametern reproduzierbare Ätzergebnisse möglich sind.

DS 24.61 Tue 15:00 P2

Development of Corrosion Resistant Mg-Alloys using Ion Beam Sputter Technologies — •Yvonne Bohne[1], Stephan Mändl[1], Bernd Rauschenbach[1], Carsten Blawert[2], and Wolfgang Dietzel[2] — [1]Leibniz-Institut für Oberflächenmodifizierung, Leipzig, Germany — [2]Center for Magnesium Technology, GKSS Forschungszentrum Geesthacht GmbH, Germany

Magnesium alloys offer a high potential for use as lightweight structural material in transport applications as automotive and aerospace. However, magnesium is a reactive metal, therefore corrosion protection is an issue of great importance. By ion beam sputtering (IBS) solid solution magnesium alloys can be deposited on various substrates such as commercial magnesium alloys or Si. This employed method has decisive advantages, insertion of alloying elements above the equilibrium solubility is are possible and phases far away from the thermodynamic equilibrium can be obtained, both with improved corrosion resistance. Binary (Mg-Al, Mg-Ti and Mg-Si) and ternary alloys were deposited in this experiment. For characterization, the layers were investigated by RBS, ERDA and SIMS to determine the chemical composition and by REM and XRD to study the microstructure and phase composition. For the new unconventional alloys based on Mg-Ti and Mg-Si (high Si concentrations) the corrosion properties were studied by potentiodynamic polarization, polarization resistance and electrochemical impedance techniques. For the Mg-Al system effects of the microstructure on the corrosion behaviour was studied by comparing as cast material and coatings. (Supported by the DFG in the course of the priority program 1168)

DS 24.62 Tue 15:00 P2

Mechanical Properties of CoCr Alloys After Nitrogen PlasmaImmersion Ion Implantation — •Inga-Maria Eichentopf, Antje Lehmann, Jürgen W. Gerlach, and Stephan Mändl — Leibniz-Institut für Oberflächenmodifizierung, Leipzig, Germany

Nitrogen implantation at low energies, high fluences and elevated temperatures into CoCr alloys, suitable for medical applications, leads to the formation of modified surface layers by a combination of ion implantation and thermally activated diffusion. After implantation at 25 kV acceleration voltage at temperatures of 300 - 600 °C into HS188 and L605, modified surface layers with a thickness between 300 and 5000 nm were found. However, a strong apparent reduction of diffusivity, respective, the activation energy for diffusion was found between 500 and 600 °C. A detailed investigation of the phase formation by X-ray diffraction and metallographic cross-section revealed a changing phase composition with CrN and Cr_2N dominating at higher temperatures, thus the assumption of a single diffusion process is misleading. The hardness of the surface layer increased from about 300 HV by a factor of 3 – 5.

DS 24.63 Tue 15:00 P2

Correlation between Plasma Homogeneity and Lateral Ion Flux Distribution in Plasma Immersion Ion Implantation — •Johanna Lutz, Oliver Otto, and Stephan Mändl — Leibniz-Institut für Oberflächenmodifizierung, Leipzig, Germany

Plasma immersion ion implantation (PIII) is a modern technology for surface modification allowing the simultaneous implantation into complex shaped objects, thus facilitating the formation of functional surfaces for several technologically important areas like biomedicine, automotive and textile industry. However, the local ion flux density, which cannot be measured directly, strongly depends not only on the plasma parameters but additionally on the sample geometry and the applied pulse voltage. In this experiment, the variation of the lateral ion flux density was studied using circular samples ranging from 60 to 150 mm, consisting of thin SiO_2 on Si. Argon as well as nitrogen plasma was used with acceleration voltages between 5 and 10 kV. The amount of material removed by the impinging ions was determined by spectroscopic ellipsometry. For comparison, the ion flux density was calculated from the plasma sheath dynamics using plasma densities and electron temperatures measured with a Langmuir probe. Good agreement between both values was observed using sputter yields from SRIM calculations. Next to a strong correlation between plasma density variations and the flux distribution, additional influences of the sample size and the plasma sheath width were found.

DS 24.64 Tue 15:00 P2

Grain Size as Proxy for Intragrain Nitrogen Diffusion in Ion Nitrided Austenitic Stainless Steel — •Darina Manova, Dietmar Hirsch, Stephan Mändl, Horst Neumann, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung, Leipzig, Germany

Nitrogen insertion at low energies and temperatures between 350 and 380 °C in austenitic stainless steel results in the formation of thick modified layers with outstanding mechanical properties and excellent corrosion resistance. The main characteristics of these layers are an anisotropic lattice expansion a concentration dependent diffusion rate. In this investigation nitrogen plasma immersion ion implantation was performed into austenitic stainless steel X5CrNi18.10 (DIN 1.4301) for different microstructures of the base material. This was achieved by annealing the as-received material at different temperatures ranging from 900 to 1200 °C. Results from investigations of metallographic cross sections are presented together with nitrogen depth profiles obtained from SIMS measurements. Additionally, XRD spectra are shown. A strong influence of microstructure on the nitrogen diffusivity in austenitic stainless steel was found as a smaller grain size increases diffusion. However, an additional effect of defects like twin boundaries and dislocations must be employed as the diffusion occurs within single grains (nitrogen range 1 – 5 μm vs. grain size of 10 – 40 μm) and the grain size is only a proxy of the underlying effect.

DS 24.65 Tue 15:00 P2

Chemical Behavior and Corrosion Resistance of Medical Grade Titanium after Surface Modification by Means of Ion Implantation — •Frank Schrempel[1], Gerhard Hildebrand[2], Marion Frant[2], Klaus Liefeith[2], and Werner Wesch[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany — [2]Institut für Bioprozess- und Analysenmesstechnik, Rosenhof, D-37308, Heilbad Heiligenstadt, Germany

This work presents data on topographical structure, chemical surface composition and physicochemical properties of medical grade titanium after implantation of 30 keV Na-, Ca- and P-ions with fluences in the order of 10^{17} cm^{-2}. Atomic force microscopy was used for surface analysis. The chemical composition was investigated using Rutherford backscattering spectrometry. Physicochemical investigations were carried out using contact angle and zetapotential measurements. The corrosion resistance was examined in simulated body fluid using cyclic voltametry. Whereas the depth distribution of P-atoms agrees with calculations, the concentration of Na- and Ca-atoms in the maximum of the depth distribution is significantly lower and the distribution extends to higher depths compared to the predictions. This finding is associated with a strong incorporation

of oxygen. According to topographical and chemical changes different contact angles as well as zetapotentials have been detected compared to pure titanium. Electrochemical examinations indicate that the implantation has no negative influence on the corrosion resistance. The results show that ion implantation with certain ions can be used to design tailor made titanium surfaces.

DS 24.66 Tue 15:00 P2

Burying Au-Nanoparticles into Si-Substrates by Ion-Irradiation — •Andreas Klimmer[1], Johannes Biskupek[2], Hans-Gerd Boyen[1], Ute Kaiser[2], and Paul Ziemann[1] — [1]Abt. Festkörperphysik, Universität Ulm — [2]ZE Elektronenmikroskopie, Universität Ulm

Arrays of Au nanoparticles, arranged hexagonally on top of Si substrates, were irradiated with 200 keV Ar^+ and Xe^+ ions of various fluences up to 10^{16} ions/cm^2. Characterisation of the bombarded samples was carried out using SEM, AFM and TEM measurements.

Above certain fluences (depending on the ion species) cross-sectional TEM measurements demonstrate that complete Au nanoparticles are buried within the Si substrate with their spherical shape conserved. A possible explanation of this effect refers to a viscious flow of the underlying substrate as a consequence of the ion irradiation [1]. In this model, the Au particles are driven into the Si substrate by capillary forces resulting from the difference between the Au surface energy and the interface energy of SiO_2-Au or Si-Au, respectively. As a consequence, the particles should not sink further, once they are completely covered by substrate material.

The above described ion induced particle sinking is studied in detail using Au nanoparticles with diameters ranging from 2 nm to 10 nm, applying ion irradiation at room temperature as well as at low temperatures (30 K).

[1] Y. Zhong et al., J. Appl. Phys. **94** 4432 (2003)

DS 24.67 Tue 15:00 P2

Interface optimization and templated self-organisation of Ni/Ag — •J. Petersen and S. G. Mayr — I. Physikalisches Institut, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

The systematic processing of surface or interface structures is of special interest particularly in the field of magnetic recording media and nanotechnology where either smooth or specifically patterned surfaces are required. We investigated the interface modification and structural changes during ion bombardment of Ni/Ag thin film bilayers, as well as the deposition on a prepatterned substrate.

For appropriate fluences the interface roughness of the bilayers shows a local minimum as has previously been observed for surfaces, indicating the interplay of smoothing and roughening effects. The underlying mechanisms are identified as radiation induced viscous flow, which is driven by the interface energy, as well as disordering by ion beam mixing.

We further report about a nanoscale ripple pattern, which is generated by ion bombardment under oblique incidence and is used as a template for the separation process of the immiscible system Ni/Ag.

We acknowledge K. Zhang, II. Physikalisches Institut, University of Göttingen for help with ion irradiation, as well as the SFB 602 TP B3 for financial support.

DS 24.68 Tue 15:00 P2

Characterization of 1/f-Noise during the Transition from Crystalline to the Amorphous State of the Binary Metal Alloy $AuIn_2$ by Ion Bombardment at Cryogenic Temperatures — •Moritz Trautvetter, Thomas Müller, and Paul Ziemann — Abteilung Festkörperphysik, Universität Ulm, D-89069 Ulm

Patterned polycrystalline $AuIn_2$ films (typical thickness 40 nm) were bombarded under cryogenic conditions (80 K) with 300 keV Argon and Helium ions. Under these conditions, the damage induced by the heavy Argon ions leads to complete amorphization of the film while for light Helium ions a defect rich but still polycrystalline state is obtained.

To characterize the 1/f-noise accompanying the ion induced stepwise amorphization, noise spectra are measured in situ at 80 K. For this purpose, a special type of correlation measurement technique is applied to detect the contribution of the 1/f-noise even below the thermal noise background. Further insight in what type of defects is causing the observed increase of the 1/f-noise due to ion irradiation can be obtained by combined annealing experiments, which reveal a significant reduction of the 1/f-noise whereas the accompanying resistance change is only small. In case of annealing the ion bombarded film at an elevated temperature close to crystallization, the previously ion induced 1/f-noise enhancement can be completely removed while the resistance of the still amorphous sample varies only by 2% due to this process.

DS 24.69 Tue 15:00 P2

Ion beam technology as a solution for EUV lithography — •Jens Dienelt[1], H. Neumann[1], M. Kramer[1], E. Schubert[1], B. Rauschenbach[1], M. Nestler[2], A. Tarraf[2], and M. Schultze[3] — [1]Leibniz-Institut für Oberflächenmodifizierung e.V. (IOM), Permoserstr. 15, 04318 Leipzig, Germany — [2]Roth & Rau Oberflächentechnik AG, Gewerbering 3, 09337 Hohenstein Ernstthal, Germany — [3]AIS Automation GmbH, Otto-Mohr-Straße 6, 01237 Dresden, Germany

A novel ion beam sputter deposition tool (Seg-IonSys-1900) for EUV mask blank fabrication and the pertaining deposition equipment will be presented. The main goal of this tool concept is to avoid the particle generation in the PVD deposition process by a special substrate motion and transfer system without losing the other required properties of the Mo/Si multilayer stack. The basis of this new concept idea is the application of a linear ECR ion beam source with a segmented grid system for beam profile control. The use of this ion beam source allows to minimize the substrate motion without loss of layer homogeneity and thickness stability in the deposition process itself. The ion beam source is equipped with a focused three grid extraction system, where high ion current densities results and with it deposition rate of 3.5 $Å s^{-1}$ for Si and 2.5 $Å s^{-1}$ for Mo. Based on this rates a total deposition time for a 50 multi layer stack of less than 45 min will be possible. With respect to this source and motion concept a special handling and transfer mechanism is demonstrated and the target drum construction with 16 single targets will be discussed in respect to the new concept and layer quality demands. Results of EUV-multilayer stacks with 50 pairs are discussed by reflectivity data (Cu-Kα and at EUV wavelength of 13.4 nm), TEM and AFM measurements.

DS 24.70 Tue 15:00 P2

Characterization of ion implanted titanium surfaces for medical application — •Stefan Krischok[1,2], Claudia Blank[3], Michael Engel[1,2], Richard Gutt[1,2], Gernot Ecke[2], Jens Schawohl[2], Lothar Spiess[2], Klaus Liefeith[3], Gerhard Hildebrand[3], and Juergen A. Schaefer[1,2] — [1]Institut für Physik, TU Ilmenau, P.O. Box 100565, 98684 Ilmenau — [2]Zentrum für Mikro- und Nanotechnologien, TU Ilmenau, P.O. Box 100565, 98684 Ilmenau — [3]Institut für Bioprozess- und Analysenmesstechnik e.V., 37308 Heiligenstadt

Titanium and its alloys are among the most biocompatible materials and therefore commonly used for orthopaedic and dental implants. They provide excellent biomechanical properties and chemical stability in biological systems. Main problems are the osteointegration and long term stability. Surface modifications like plasma spraying used in medical applications do not guarantee the desired long term stability. The implantation of ions into the near surface layer is a new approach to improve the osteointegration. We examined the surface topography, concentration profile of the observed elements as well as their chemical state and the crystallographic structure of ion (Ca, P, Na) implanted titanium surfaces. The characterization was performed by atomic force microscopy, X-ray photoelectron spectroscopy, X-ray diffraction and Auger electron spectroscopy depth profiling before and after exposing the samples to specific simulated body fluid supplemented with minerals. A strong influence of the surface properties on the cell response is observed; best results of the accomplished tests (biological and physical) were achieved for the co-implantation of calcium and phosphorus.

DS 24.71 Tue 15:00 P2

Nanostructure formation on ion eroded SiGe and Si surfaces — •Christian Hofer[1], Christian Teichert[1], Markus Wächter[2], Thomas Bobek[2], Heinrich Kurz[2], Klara Lyutovich[3], and Erich Kasper[3] — [1]Institute of Physics, University of Leoben, Austria — [2]Institute of Semiconductor Technology, RWTH Aachen, Germany — [3]Institute of Semiconductor Engineering, University of Stuttgart, Germany

Atomic Force Microscopy has been applied to study the morphological evolution of heteroepitaxial SiGe/Si(001) films and Si(001) substrates under normal incidence noble gas ion bombardment. For self organized films we investigate the influence of different starting morphologies and ion energies on the subsequent pattern formation. In general, two different energy regimes were found. For ion energies above 500 eV up to 1000 eV the surface smoothens, whereas in the low energy regime the

surface roughens and craters with a diameter of 70 nm evolve [1]. For samples with pyramidal pits surrounded by {105} faceted islands, the different sputter velocities of protrusions and pits could be revealed. The ion erosion of Si(001) results in the dot formation with inhomogeneous distribution. Here, the lateral dot sizes range from 30 nm to 40 nm with dot heights of 2 nm. The influence of the ion energy and sputter depth on the pattern formation is discussed.

Research supported in the framework of the EC project NAMASOS (Nanomagnets by Self-Organisation, STRP 505854-1) and by FWF Austria, P14009-TPH. www.unileoben.ac.at/˜spmgroup

[1] C. Hofer et al., Nucl. Instrum. Meth. B. 216, 178 (2004).

DS 24.72 Tue 15:00 P2

Growth of thin epitaxial titanium nitride films by using hyperthermal particle fluxes — •A. Wolfsteller, J.W. Gerlach, T. Höche, and B. Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung (IOM) e.V., Permoserstr. 15, D-04318 Leipzig

In order to achieve a higher complexity and versatility of the conventional ion beam assisted deposition of metal nitride films, the metal component having thermal energies can be replaced with the metal component possessing hyperthermal energies. Here, results on the ion beam assisted deposition of thin TiN films by using hyperthermal titanium ions are presented. Hyperthermal titanium ions were produced by a pulsed dc vacuum arc metal plasma source, while a constricted glow-discharge plasma source delivered hyperthermal nitrogen ions The TiN films were deposited at various substrate temperatures on $Al_2O_3(0001)$ and MgO(100) substrates, simultaneously. Thus, substrate influences on the film growth could be identified and separated from influences arising from the ion beam parameters. During the deposition, the surface structure of the films was monitored by RHEED. The crystallographic structure and texture was investigated by XRD. High resolution TEM was used to examine the morphology and defect structure of the films. The results show that the TiN films are epitaxial even at room temperature, indicating the beneficial effect of the hyperthermal energy of the particles involved in the deposition process. The influences of the different substrates and the ion beam parameters on the crystalline quality of the films are discussed.

DS 24.73 Tue 15:00 P2

Properties of multiferroic $BiFeO_3$ thin films grown by pulsed laser deposition — •Patrick Schützendorf[1], Regina Dittmann[1], Bernd Holländer[2], Hermann Kohlstedt[1], and Rainer Waser[1] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, D- 52425 Jülich — [2]Institut für Schichten und Grenzflächen, Forschungszentrum Jülich GmbH, D- 52425 Jülich

Thin films of the multiferroic material $BiFeO_3$ (BFO) exhibit huge remnant polarization values up to $150\mu C/cm^2$ [1]. The maximum polarization is obtained for the (111) orientation with the polarization being up to twice as large as the polarization along the (100) axis [2].

To further investigate the different polarization directions, we have grown BFO thin films on $SrRuO_3$ buffered STO(100) and STO(111) substrates by PLD. The influence of the deposition conditions on the growth of BFO thin films was investigated using XRD, AFM, RBS and TEM.

Below the decomposition temperature of about 800°C, between 700°C and 650°C we obtained (111) and (100) oriented films for (111) and (100) oriented substrates, respectively. We achieved rocking curves widths of about 0.11°. For 600°C a second phase was observed in BFO thin films grown on (100) substrates. For (111) oriented films we obtained a surface roughness of about 7 nm whereas for (100) oriented films a surface roughness of about 0.25 nm could be achieved.

We will present the electrical behaviour of the BFO thin films as a function of deposition conditions and the orientation of the films.

[1] K.Y. Yun et al., Jpn. J. Appl. Phys. **43**, L647 (2004)
[2] J. Wang, et al., Sciene **299**, 1719 (2003)

DS 24.74 Tue 15:00 P2

Microstructure and mechanical properties of pulsed laser deposited PMMA and PMMA-metal structures — •Thorsten Scharf, Johanna Röder, Erik Süske, Jörg Faupel, and Hans-Ulrich Krebs — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

Thin films of composite materials are of high interest for a wide range of applications. Especially nano-composites consisting of different material classes, e.g. polymers and metals, are difficult to prepare. Here pulsed laser deposition (PLD) is an interesting preparation technique due to its flexibility. On this poster the growth mechanisms of different metals on laser deposited PMMA will be discussed with a focus on the possibility to modify the growth. By depositing metals of different reactivity acting as nucleation seeds it is possible to control the cluster size distribution and therefore for instance the optical properties. The mechanical properties, especially of the polymeric part of the films, are changed during deposition due to the PLD process. They can be measured by mechanical spectroscopy, which was performed using an new *in-situ* setup. Experimental details as well as results will be presented and discussed in this contribution.

DS 24.75 Tue 15:00 P2

Process characterization of pulsed laser deposited PMMA — •Britta Lösekrug, Thorsten Scharf, Erik Süske, and Hans-Ulrich Krebs — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

The pulsed laser deposition (PLD) is a flexible and effective method for producing thin films of different materials, also polymers like PMMA poly (methyl methacrylate), which is an attractive coating material. Thin films of PMMA consist of two components, one fraction with molecular weight well below that of the target material and a second fraction, which is cross-linked. The non-cross-linked fraction forms droplets on the flat surface of the cross-linked part. Origins in the deposition process of these two components are different and show different angular distributions. By varying the laser fluence during deposition the amount of cross-linking is changed. Another possibility to influence the deposition process is a variation of the absorption coefficient by embedding a strong absorbing material. In this contribution the influence of these different parameters on the laser deposited PMMA films is presented and discussed.

DS 24.76 Tue 15:00 P2

Laser Nitriding of Titanium with various Lasers and Investigation of the Produced TiN_x Coatings — •Daniel Höche, Hendrik Schikora, and Peter Schaaf — Universität Göttingen, II. Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Pure titanium has been nitrided with different lasers under nitrogen atmosphere. This opens the possibility of comparing various parameters and their influence on the nitriding effect and the properties of the produced TiN coatings. Consecutively the properties of these TiN_x coatings have been measured and characterized through their macroscopic features like hardness and wear resistance and their microscopic properties like texture, nitrogen profile and so on. Solving the time dependent partial differential equation of the heat problem:

$$\rho\frac{\partial H}{\partial t} = \nabla\cdot(\kappa\nabla T) + \alpha e^{-\alpha z}(1-R)I(r,t)$$

nitrogen diffusion and growing mechanism have been described. Additional information about the relationships between growing direction (dendrites), texture and laser resp. processing parameters will be shown. Finally it is the aim to give an overview about the complicated effects for laser nitriding of titanium.

DS 24.77 Tue 15:00 P2

Synthesis of FeCo thin films by advanced PLD — •Christian Lange, André Holz, Hendrik Schikora, and Peter Schaaf — Universität Göttingen, II. Physikalisches Institut, 37077 Göttingen, Germany

FeCo alloys of near-equiatomic composition offer exceptional magnetic properties. In this work, FeCo thin films were synthesized using advanced pulsed laser deposition, i.e. ion beam assisted deposition and different bias voltages were applied to study the influences on microstructure and magnetic properties of the films.

Structure analyses were performed with Rutherford backscattering spectrometry (RBS), X-Ray Diffraction (XRD) and conversion electrons Mössbauer spectroscopy (CEMS), while magnetic properties were examined by magneto-optical Kerr effect (MOKE) and magnetic orientation Mössbauer spectroscopy (MOMS).

Results show a strong correlation between deposition parameters (gas atmosphere and pressure, deposition rate) and the magnetic properties of the synthesized thin films.

DS 24.78 Tue 15:00 P2

Pulsed laser deposition and ordering of thin FePt films — •André Holz, Christian Lange, and Peter Schaaf — Universität Göttingen, II. Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Thin FePt-multilayer films with different film-thicknesses of the individual layers (0.5 nm - 10 nm) have been produced on MgO(100)-substrates by Pulsed Laser Deposition (PLD) with an Excimer laser. Annealing at different temperatures, ion-beam implantation with Xenon and ion-beam assisted deposition with Argon-ions for increased mobility on the substrate have been used in order to obtain an ordered FePt film with $L1_0$ structure and to study the necessary ordering effects. The films were examined by XRD, RBS, MOKE, Mössbauer spectroscopy, MOMS and SEM. Texturing effects and magnetic anisotropy were observed.

DS 24.79 Tue 15:00 P2

Charakterisierung von Mikrostrukturen mittels ortsaufgelöster RBS- und PIXE-Analyse — •Tilo Reinert and Christoph Meinecke — Institut für Experimentelle Physik II, Universität Leipzig Linnéstr.5, 04103 Leipzig

Die DFG-Forschergruppe 522 "Architektur von nano- und mikrodimensionalen Strukturelementen" beschäftigt sich mit der Herstellung, Charakterisierung und Analyse neuartiger Architekturen, die als funktionelle Grundbausteine für zukünftige Anwendungen in der Nanomechanik, Sensorik, Photonik und Elektronik studiert werden. Neben der funktionellen Charakterisierung ist auch eine morphologische und stoffliche Analyse essentiell für das Verständnis ihrer neuartigen Eigenschaften. Dabei stoßen herkömmliche Ionenstrahl-Analysemethoden (RBS, PIXE) wegen der nano- und mikroskaligen, drei-dimensionalen Untersuchungsobjekte an ihre Grenzen. Erst die Verwendung von fokussierten MeV-Ionenstrahlen (He^+, H^+) mit einer lateralen Ortsauflösung im sub-Mikrometerbereich ermöglicht die Analyse heterogener Mikro- und Nanostrukturen. An der Leipziger Hochenergie-Ionen-Nanosonde LIPSION wird deshalb die Entwicklung einer quantitativen und hochempfindlichen Analytik zur 3D-Charakterisierung verfolgt. Im ersten Schritt wurde die laterale Ortsauflösung bei RBS und PIXE auf unter 500 nm verbessert. Damit konnten bereits einige Strukturen (Kylindrit, GaAs/GaInAs/AlAs, optische Mikroresonatoren) analysiert werden. Ein zweiten Schritt ist in Vorbereitung. Durch die Verwendung eines facettierten Teilchendetektors für RBS wird die Tiefenprofilierung und damit die 3D-Charaktrerisierung verbessert.