DS 11: Poster Session I: Application of thin films; Ion beam induced surface patterns; Ion and electron beam induced processes; Micro- and nanopatterning (jointly with O)

Time: Monday 17:00–20:00 Location: Poster B1

DS 11.1 Mon 17:00 Poster B1

Optical and structural properties of $ZnCo_2O_4$ under different growth conditions — •Vitaly Zviagin, Tammo Böntgen, Rüdiger Schmidt-Grund, Michael Lorenz, and Marius Grundmann — Universtät Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, Germany

We present an investigation of optical and structural properties of $ZnCo_2O_4$ thin films in dependence on the growth conditions. The films were grown on an a-sapphire substrate by pulsed layer deposition at different oxygen partial pressures. The optical properties were determined by spectroscopic ellipsometry (SE) in the range from 0.5 eV to 9.0 eV. A model was developed for the measured dielectric function (DF) of the $ZnCo_2O_4$. Our model consists of Gauss- and critical-point-functions located at the optical transition energies. Transmission measurements in the same spectral range were carried out and reveal weak absorption bands below the band gap. The positions of the bands correspond to d-d transition of Co^{2+} known to arise in $ZnCo_2O_4$[1]. The thickness of the thin films and surface topology, estimated from atomic force microscopy and scanning electron microscopy, are comparable to the SE estimations. The crystal structure of the films was determined from the wide-angle X-ray diffraction scans which are presented and compared in dependence on the oxygen partial pressure of the film deposition. It was determined that the partial pressure during the deposition induces a distinct shift in the observed transition energies as well as clear dependence in the crystallography and surface topology of the thin films. [1] Wang et al., J. Alloys Compd. 520 (2012) 158.

DS 11.2 Mon 17:00 Poster B1

Controlling sputter yield during multilayer preparation for high resolution multilayer zone plates — •Christian Eberl[1], Florian Döring[1], Tobias Liese[1], Felix Schlenkrich[1], Volker Radisch[1], Hans-Ulrich Krebs[1], Anna-Lena Robisch[2], Aike Ruhland[2], Markus Osterhoff[2], Sarah Hoffmann[2], Matthias Bartels[2], and Tim Salditt[2] — [1]Institut für Materialphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Röntgenphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Due to the deposition of energetic particles, pulsed laser deposition (PLD) is a suitable technique to produce high-quality multilayers without cumulative roughness. Even surface roughness of a wire, on which aperiodic multilayers were grown for multilayer zone plates (MZP), could be smoothed. Unfortunately, the transferred energetic ions induce resputtering of deposited material, especially on such curved surfaces. Not loosing layer thickness or interface quality, both a fundamental understanding and controlling of the underlying processes are essential. For this purpose, the interface behaviours of very different materials, such as W and Si, have been investigated. In this context, resputtering of W (up to 2 nm) was observed by both in-situ deposition rate monitoring and x-ray reflectivity measurements and could be verified by dynamical simulations. This effect could successfully be controlled by adjusting the laser fluence for both Si and W. With this knowledge, a highly precise MPZ could be fabricated showing hard x-ray focusing with focal width of less than 10 nm (FWHM).

DS 11.3 Mon 17:00 Poster B1

Nanostructured TiO_2 thin films and structural composites for photocatalysis — •Bodo Henkel, Sebastian Zabel, Thomas Strunskus, and Franz Faupel — Institute for Materials Science, Kiel, Germany

Pulsed DC Magnetron Sputtering and various temperature treatments were used to produce improved photocatalytically active TiO_2 layers on quartz glass. Two approaches were used to improve decomposition of the test substance methylene blue. First, a structured liquid-diffusion open surface for larger interaction area was produced. At second, a synergetic multilayer combining the advantages of different TiO_2 structures was manufactured. This combination of different layers provides new insight on how the functional unit should be optimized to take into account the different physical processes important for photocatalysis. For measuring photocatalytic efficiency, decomposition of methylene blue in combination with in situ UV-vis measurement was used. An UV LED with 369 nm wavelength was taken to irradiate the TiO_2 layer. To analyze the correlation of dye decomposition rate to surface and crystal structure SEM, XRD, UV-vis and Raman spectroscopy measurements have been done.

DS 11.4 Mon 17:00 Poster B1

Turning graphene into the world's thinnest heater (It's nearly invisible!) — •Siamak Nakhaie, Stefanie Unseld, Jules Dake, and Carl Krill — Institute of Micro and Nanomaterials, Ulm University, Germany

The recent discovery of graphene and characterization of its extraordinary properties have ignited a firestorm of activity across the scientific community and corporate research world — many believe that graphene represents the basis for the smallest, fastest possible transistor. Of the various production methods currently under investigation, chemical vapor deposition (CVD) appears to be the most feasible for the large-scale production of graphene, and the number of CVD recipes that exist in the literature for single-layer graphene is nearly equal to the number of publications on the subject. We have systematically varied the various CVD process parameters, including temperature, pressure, gas flow rates and concentrations. In doing so, we were able to obtain amorphous, nanocrystalline, multi-layer or single-layer graphene samples. We also demonstrate how graphene can be used as a large-area, transparent electrode. By applying an electric current to our samples under ambient conditions, we were able to heat one square centimeter of single-layer graphene, supported on a glass substrate, to over 220°C.

DS 11.5 Mon 17:00 Poster B1

Nanosecond time-resolved temperature measurements — •Johann Berres, Elke Scheer, Paul Leiderer, and Johannes Boneberg — Department of Physics, University of Konstanz, Germany

Temperature evolution is studied in a thin silicon film after heating with a ns-laser pulse. For that purpose the reflectivity of a cw-laser is measured. Due to changes of the dielectric constants with temperature the interference conditions in the thin silicon film and thus the reflectivity vary, which allows the determination of the temperature with ns time-resolution. The measurements are compared with heat flow simulations. Finally examples for temperature evolution in samples which are illuminated by an interference pattern are shown.

DS 11.6 Mon 17:00 Poster B1

Immobilization of Gold Nanoparticles on Polyethylene glycol brushes for SERS sensing applications — •Claudine Dawson[1], Petra Uhlmann[1], Dieter Fischer[1], Guido Wilke[2], and Manfred Stamm[1,3] — [1]Leibniz-Institut für Polymerforschung Dresden e.V., Dresden, Germany — [2]Hochschule Esslingen, University of Applied Sciences, Esslingen, Germany — [3]Technische Universität Dresden, Dresden, Germany

Recent studies demonstrated that polymer brushes can be exploited for the formation of nanoassemblies with metallic nanoparticles for SERS applications1,2. Multifunctional polymer brushes offer multiple binding sites on which metallic nanoparticles can either be reduced in situ1 or preformed nanoparticles can be bound covalently2, coordinatively3 or electrostatically4 by tuning their surface chemistry. We demonstrate how coordinative binding of gold nanoparticles to polyethylene glycol brushes grafted on silica substrates can be used to control the immobilized amount and distribution of the particles by variation of the polymer grafting density and -chain length. Additionally the size of the bound gold nanoparticles was varied. The influence of these parameters on the signal enhancement in SERS was probed by using the dye Rhodamine 6G and correlated to the gold nanoparticle arrangement in the nanoassemblies which was investigated by scanning electron microscopy and atomic force microscopy.

1. Adv. Funct. Mater. 2010, 20, 1756*1761 2. J. Mater. Chem. 2012, 22, 5155*5163 3. ACS Nano 2009, 3, 807-818 4. J. Am. Chem. Soc. 2004, 126, 15950-15951

DS 11.7 Mon 17:00 Poster B1

Measurement of magnetoresistance effects in nanoscale metallic conductors — •Tobias Warnatz, Sebastian Wintz,

Rantej Bali, Ulrich Wiesenhütter, Jochen Grebing, Jürgen Lindner, Jürgen Fassbender, and Artur Erbe — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The magnetic characterization of nanoscale magnetic structures is one of the main prerequisites for the development of magnetoelectric memories and sensors. Here we present magnetoresistance effects of nanostructured metallic films and particles, which can exhibit anisotropic magnetoresistance or giant magnetoresistance effects. The structures are built from a variety of materials and they are measured at low temperatures in magnetic fields up to 1.5 T. We correlate the microscopic structure of the materials with the observed magnetic properties. Thus, a deeper understanding of switching and storage of the magnetic state in such nanostructures can be gained.

DS 11.8 Mon 17:00 Poster B1

Generating ultrashort circularly polarized XUV pulses from gas high harmonics by means of a multilayer quarter-waveplate — •Jürgen Schmidt[1], Alexander Guggenmos[2], Niklas Mutz[1], and Ulf Kleineberg[1,2] — [1]LMU München, Physik, 85748 Garching — [2]Max-Planck-Institut für Quantenoptik, 85748 Garching

Coherent linearly polarized XUV pulses from High Harmonic Generation in noble gas are routinely used for ultrafast pump-probe experiments to examine electron dynamics in solids or gases. The availability of circularly polarized high harmonic pulses with selectable helicity would extend the possible spectroscopic methods applicable to those pulses towards electron spin dependant or circular dichroism experiments and would give access to the investigation of temporal electron spin dynamics on a time scale of 1 fsec or even below. However, current concepts which aim at generating ultrashort elliptically polarized pulses from gas harmonics directly promise only a small ellipticity. We thus designed, fabricated and tested ultrathin multilayer-based quarter wave retarders at a photon energy of 66.2eV (Ni-3p state) to transform linearly polarized XUV pulses into circularly polarizd pulses . We investigate the polarization state of the pulses and the transmission characteristics of the quarter waveplate by means of a Rabinovich-type polarimeter with a multilayer analyzer mirror and an XUV spectrometer. A trade-off between pulse duration (i.e bandwidth) and degree of ellipticity is discussed and future experimental application in time-resolved ARPES experiments is described.

DS 11.9 Mon 17:00 Poster B1

Ion beam patterning of Si(001): from the amorphous to the crystalline regime — •Martin Engler, Moritz Will, and Thomas Michely — II. Physikalisches Institut, Universität zu Köln

It is well known that under room temperature irradiation Si ion beam amorphizes, while it remains crystalline during ion exposure at about 500 °C and above. In the present work we tune temperature through the amorphous-crystalline phase transition and investigate the effect of this transition on ion beam induced pattern formation. Scanning tunnelling microscopy and low energy electron diffraction are used to investigate the Si(001) morphology after 2 keV Kr^+ ion irradiation. With increasing temperature a sharp transition from a flat amorphous surface to crystalline mound and crater morphology is observed. The crystalline pattern displays a step and terrace structure with Si-dimer rows. The amplitude of the evolving crystalline pattern is highest right at the phase transition and decreases with increasing temperature within the crystalline regime. The opposite is true for the the lateral length scale of the pattern.

DS 11.10 Mon 17:00 Poster B1

On the origin of surface ripple propagation — •Hans Hofsäss, Kun Zhang, Omar Bobes, and Hans-Gregor Gehrke — II. Physikalisches Institut, U(niversität Göttingen, Germany

The Bradley-Harper theory predicts a lateral propagation of ripples in direction opposite to the incident ion beam dirdction [1]. However, a small or negligible ripple velocity was predicted [2,3]. Aat large incidence angles the propagation velocity should become large and positive, i.e. propagation along the beam direction. Several studies with Ga focused ion beams revealed ripple propagation at high velocities (+0.4 - +0.8 nm per 10$\hat{1}$5 ions/cm2) also for small incidence angles <65°, and a model able to explain the correct direction and magnitude of ripple propagation was proposed [4]. Wei et al. explained the positive propagation velocity by angle dependent sputtering of asymmetric ripple profiles [5]. We propose an additional mechanism for positive ripple propagation velocities based on ion-induced mass transport. We have measured the ripple propagation velocity for 10 keV Xe on Si and find a velocity of +3 nm per 10$\hat{1}$5 ions/cm$\hat{2}$ at 70° incidence angle.

[1] R. M. Bradley and J. M. E. Harper, J. Vac. Sci. Technol. A 6, 2390 (1988).
[2] G. Carter, V. Vishnyakov, Phys. Rev. B 54, 17647 (1996).
[3] G. Carter, V. Vishnyakov, M.J. Nobes, Nucl. Instr. Meth. B 115 (1996) 440.
[4] P.F.A. Alkemade, Phys. Rev. Lett. 96, 107602 (2006).
[5] Q. Wei, J. Lian, L. Boatner, L.M. Wang, R.C. Ewing, Phys. Rev. B 80, 085413 (2009).

DS 11.11 Mon 17:00 Poster B1

Designing Si surface nanopatterns by low energy ion beams with metal surfactant sputtering — •Kun Zhang, Omar Bobes, and Hans Hofsäss — II. Physikalisches Institut, Universität Göttingen, Germany

Low energy ion sputtering can produce large area periodic self-organized surface nanostructures with potential applications. Recently we have demonstrated that metallic surfactants induce pronounced dot and ripple patterns on Si substrates during normal ion incidence sputter erosion. In the absence of metal co-deposition, uniform flat surfaces are obtained. We have shown that the produced surface nano-patterns strongly depend on the ion fluence and the deposition ratio, and their wave vectors are always parallel to the deposition direction. Based on these achievements, we further develop in this work the surfactant sputtering technique to produce self-organized surface nanostructures on Si with well defined symmetry, such as 4-fold, 5-fold or 6-fold symmetric dot nano patterns. In our experiments Si substrates were irradiated with 1 keV Ar ions at normal incidence and ion fluences up to 2.5x10$\hat{1}$8 ions /cm$\hat{2}$ under continuous deposition of Fe atoms coming from a few Fe sputtering targets around the Si substrates with a certain geometrical arrangement.

DS 11.12 Mon 17:00 Poster B1

Ion beam enhanced etching of $LiNbO_3$ containing silver nano clusters for plasmonic waveguide applications — •Felix Felgenträger, Jura Rensberg, Steffen Milz, Carsten Ronning, and Werner Wesch — Institute of Solid State Physics, Friedrich Schiller University Jena

Plasmonic structures, consisting of nanometer sized metal clusters embedded in dielectric host materials, have been in the point of interest for the last two decades, due to their wide range of possible applications, like sensing, fast information transfer and the confinement of light. One of the most promising combinations for new plasmonic devices is lithium nobiate ($LiNbO_3$) as host material and incorporated noble metal nano clusters i.e. silver because of its distinct surface plasmon resonance in the visible range. In this contribution $LiNbO_3$ was implanted with a high amount of Ag^+ ions to form embedded Ag clusters. In situ as well as post implantation annealing was carried out to reduce radiation damage and recover the structure of the host material due to the preferential etching of amorphous $LiNbO_3$ with HF during waveguide fabrication. Argon ions were implanted selectively through a mask of photoresist prepared by standard photolithography for the ion beam enhanced etching step. Consequently μm-seized waveguide structures are formed by the unirradiated parts after etching. Cross-sectional STEM investigations were made in order to determine the waveguide structure and cluster size distribution. The optical properties of the Ag clusters were examined by the means of polarization-dependent UV-VIS absorption spectroscopy.

DS 11.13 Mon 17:00 Poster B1

Comparison of low- and room-temperature damage formation in Ar ion implanted GaN and ZnO — •E. Wendler[1], W. Wesch[1], A. Yu. Azarov[2], N. Catarino[3], A. Redondo-Cubero[3], E. Alves[3], and K. Lorenz[3] — [1]Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik, Max-Wien-Platz 1, D-07743 Jena, Germany — [2]University of Oslo, The Department of Physics, P.O. Box 1048 Blindern, NO-0316 Oslo, Norway — [3]IST/ITN - Instituto Tecnológico e Nuclear, Instituto Superior Técnico,Universidade Técnica de Lisboa. Estrada Nacional 10, P-2686-953 Sacavém, Portugal

GaN and ZnO are implanted at 15 K and 295 K with 300/200 keV Ar ions. Damage analysis is performed with RBS in channelling configuration quasi-insitu at the respective temperature. The difference in minimum yield is taken as a measure of the amount of damage produced. The most striking result of our work is that in GaN and ZnO the ion-induced damage formation is only weakly influenced by the implantation temperature. For the discussion of our findings, results on

damage formation in these materials obtained by other authors applying TEM are taken into account. Eventually it can be concluded that in these materials extended defects form not only at room temperature but also at a temperature of 15 K. This clearly suggests that the formation of extended defects is not driven by the thermal mobility of point defects. It is supposed that in GaN and ZnO damage-induced strain plays a dominant role and the formation of extended defects seems to be energetically favourable in comparison to the formation of larger randomly ordered agglomerates of defects.

DS 11.14 Mon 17:00 Poster B1

Binary Pt-Si nanostructures prepared by focused electron-beam-induced deposition: Simulation and experiment — •Marcel Winhold[1], Christian H. Schwalb[1], Fabrizio Porrati[1], Roland Sachser[1], Kaliappan Muthukumar[2], Harald O. Jeschke[2], Roser Valenti[2], and Michael Huth[1] — [1]Physikalisches Institut, Goethe-Universität, Max-von-Laue-Str.1, 60438 Frankfurt am Main — [2]Institut für Theoretische Physik, Goethe-Universität, Max-von-Laue Str. 1, 60438 Frankfurt am Main

Binary systems of Pt-Si were prepared by focused electron-beam-induced deposition (FEBID) using the two precursors $MeCpPt(Me)_3$ and $Si(SiH_3)_4$ simultaneously. This new approach for the preparation of binary systems with FEBID allows for the variation of the relative flux of the two precursors during deposition. The composites which contain Pt, Si, C and O in different ratios were analyzed by means of energy dispersive X-ray spectroscopy, atomic force microscopy, electrical transport measurements, and transmission electron microscopy. The results show strong evidence for the formation of an amorphous, metastable Pt_2Si_3 phase, leading to a maximum of the conductivity for a Si:Pt ratio of 3:2.[1] For the stoichiometric proportion of Si:Pt = 3:2 theoretical simulations applying an evolutionary algorithm (USPEX) predict the formation of Pt_2Si_3 layers separated by graphene-like planes. Micro-Raman measurements will be presented to experimentally study the Pt, Si, C and O structural configuration.
[1] Winhold et al., ACS Nano, 2011, 5 (12), pp 9675-9681

DS 11.15 Mon 17:00 Poster B1

Influence of electron beam parameters on the composition and conductivity of deposits prepared via focused electron-beam-induced deposition — •Paul M. Weirich, Marcel Winhold, Christian H. Schwalb, and Michael Huth — Physikalisches Institut, Goethe-Universität, Max-von-Laue-Str.1, 60438 Frankfurt am Main

Focused electron-beam-induced deposition (FEBID) is a high resolution one-step technique, which allows producing micro- and nanostructures. In many cases it becomes necessary to prepare structures with a high metal content, e.g. for contacting nanowires which for many precursors strongly depends on the deposition parameters. For the precursor tungsten hexacarbonyl $W(CO)_6$ it has already been shown, that the metal content of the deposits can be tuned by changing the electron beam parameters acceleration voltage and beam current [1]. Based on those experiments we further investigated the influence of the scanning parameters of the electron-beam - dwell-time and pitch - on conductivity and metal content of the tungsten deposits. The deposits were analyzed by means of in-situ electrical conductivity measurements, energy dispersive X-ray spectroscopy, atomic force microscopy and electrical transport measurements. The results show that by choosing the ideal combination of scanning parameters the metal content of the deposits can be raised from 25 at% up to 40 at% which leads to an increase of conductivity by almost two orders of magnitude.
[1] F. Porrati, R. Sachser and M. Huth, Nanotechnology 2009, 20, 195301

DS 11.16 Mon 17:00 Poster B1

Submicrometer precise machining of metal surfaces with excimer laser radiation — •Martin Ehrhardt, Frank Frost, Pierre Lorenz, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany

In recent decades, the patterning of surfaces with nanostructures is of rapid growing interest due to the large range of applications of these improved surfaces in the fields of, e.g. optics, biology, and microelectromechanical systems. Imprint techniques are promising for low-cost and large-area pattering. However, imprint techniques which allow submicrometer structuring of hard materials like metals have to be combined with an etching step up to now. Laser embossing is a novel high strain rate imprint technique which allows overcoming this limitation. The process bases on laser pulses which generate a high pressure by ablation of an auxiliary material. The high pressure is used to compress a structured mould form onto metal surfaces which take the shape of the mould. In the present study it will be shown that submicrometer structures can be successfully transferred from the mould into polycrystalline and single crystal copper. The structures generated that way will be analyzed by scanning electron microscopy (SEM) and atomic force microscopy (AFM). The results will be correlated with the laser parameters used and the dimensions of the mould structures.

DS 11.17 Mon 17:00 Poster B1

Molecule aggregate position control on patterned surface — •Wenchong Wang, Hong Wang, Harald Fuchs, and Lifeng chi — Physikalisches Insitut, Westfälische-Universität Münster, Wilhelm-klemm-Str. 10, 48149 Münster, Germany

Small molecular weight organic molecules are of great interest owing to their intensive applications. However, techniques for producing organic patterns, like photolithography in inorganic semiconductors, is still urgently sought for in device processing.

Considering a molecule deposited on a substrate surface at elevated temperature, the molecule could nucleate either at defect locations, step edges or aggregate together to form a stale nuclei. Previously, we have demonstrated to grow molecules on the pre-defined *defects* and *step edges* by using template induced growth strategies. However, molecule aggregate position control is extremely difficult owing to the statistic diffusion process of molecule on surface. Here we present a way to create molecule density distribution over a limited surface. The molecules nucleate initially at locations with highest density, leading to an aggregate position control.

Reference:
1. W. C. Wang, and L. F. Chi, Acc. Chem. Res., 2012, 45, 1646.
2. W. C. Wang, L. F. Chi, et al, Small, 2011, 7, 1403.
3. W. C. Wang, L. F. Chi, et al, Adv. Mat. 2010, 22, 2764.
4. W. C. Wang, L. F. Chi, et al, Adv. Mat. 2009, 21, 4721.
5. W. C. Wang, L. F. Chi, et al, Phys. Rev. Lett., 2007, 98, 225504.

DS 11.18 Mon 17:00 Poster B1

Optimization and characterization of liquid metal ion sources for focused ion beam technology — •Alexander Schwinger, Rüdiger Schott, and Andreas D. Wieck — Lehrstuhl für angewandte Festkörperphysik, Ruhr-Universität Bochum

Focused ion beam devices are widely used for maskless ion implantation and milling on a nanometer scale. In order to increase the performance and stability of liquid metal ion sources (LMIS) commonly used in focused ion beam (FIB) systems, we produced and compared multiple needle type LMIS. Preparation of tip and surface of the LMIS was done by gradual electrochemical etching of tungsten wire, the resulting surface topology and tip geometry were investigated with SEM. After filling the LMIS with the source material, the dependency of the emitted ion current on the extraction voltage was measured. Long-term emission stability was then evaluated by measuring the variation of the ion current over time while applying a constant extraction voltage.

DS 11.19 Mon 17:00 Poster B1

Fabrication, characterisation and optimization of liquid alloy ion sources for nano structuring and lithography — •Michael Kwiatek[1], Rüdiger Schott[1], Paul Mazarov[2], and Andreas D. Wieck[1] — [1]Ruhr-Universität Bochum — [2]Raith GmbH, Dortmund

Focussed Ion Beam (FIB) and ion lithography systems are tools gaining more attention in R&D and industrial applications. The source material mostly used in those systems is Gallium (Ga). But for common applications one need other implantation materials like Silicon (Si) or Gold (Au) that are electrical interesting and for some applications important - bio compatible. Furthermore materials with a low atomic weight (a.w.) are interesting for less destructive and sharper imaging with the FIB column. So there started a trend to non-Ga-FIBs in the past few years. Our solution to this problem are Liquid Alloy Ion Sources (LAIS) containing not only one but 2 to 3 different materials in one alloy which's composition is picked in an eutectic point for a relative low melting point. Those sources require a mass filter in the beam column but the new possibilities outweight that as you have an emission stable source that contains e.g. a good sputtering material (high a.w.) and a good imaging material (low a.w.) that can be used without changing the source. This brings a field of new possibilities and usages. We optimized an AuSiLi and an AuSiBe ternary source for sputtering-implanting-imaging purpose to get in the emission stability regions of pure Ga sources.

DS 11.20 Mon 17:00 Poster B1

Nanolithography using Electron Field Emission from Nanotips — •Steve Lenk, Marcus Kästner, Tzvetan Ivanow, and Ivo Rangelow — Institut für Mikro- und Nanoelektronik, Technische Universität Ilmenau, Germany

The emission of low-energetic electrons from a scanning probe nanotip is a promising method to produce nanometer-scale semiconductor devices [1]. We study the electron emission from metallic and semiconducting nanotips with regards to the application in nanolithography experimentally and theoretically. The operation regime for the electron lithography, i.e. applied voltages up to 50V and operation at room temperature, is between field and thermionic emission. In addition to the calculation of the field emission current, we are solving Laplace's equation for the electric field distribution around the nanotip and the trajectories of the emitted electrons. To achieve an additional focusing of the electron beam, we include a volcano-type gate [2]. In nanolithography applications semiconductor tips are often used and, therefore, we consider the effects of field-induced changes of band bending, surface charges as well as the effect of screened image charges and emission from surface states together with a volcano gate. The theoretical results were compared with Fowler-Nordheim measurements. These measurements and calculations are the basis for study the interactions of the emitted electrons with the resist material and, thus, to the mechanisms of nanolithography.

[1] M. Kaestner and I. Rangelow, Microelectron. Eng. 97 (2012) 96
[2] T. Ivanov, J. Vac. Sci. Technol. B 19 (2001) 2789

DS 11.21 Mon 17:00 Poster B1

Scanning Tunnelling Spectroscopy of FIB-induced Local Phase Changes in Tetrahedral Amorphous-Carbon — •Frederik Klein[1], Peter Philipp[2], Lothar Bischoff[2], and Thomas Mühl[1] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden — [2]Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden-Rossendorf

Ion irradiation of tetrahedral amorphous-carbon leads to both an ion implantation and a local phase change of the carbon. The latter is equivalent to an increase of the carbon sp2/sp3 bond ratio. It is caused by the deposition of the ion energy and leads to an increased electrical conductivity. We perform spatially resolved scanning tunneling spectroscopy in order to investigate the impact of different ion species (Ga, Si, Ge, Au). A direct contribution of the implanted metal will be carefully considered.

DS 11.22 Mon 17:00 Poster B1

Dewetting of silver films on Al-doped ZnO for plasmonic nanofilm formation — •Patrick Hofmann[1], Mykola Vinnichenko[2], Steffen Cornelius[2], Barbara Abendroth[1], Karl-Heinz Heinig[2], Sibylle Gemming[2], and Dirk-Carl Meyer[1] — [1]Institut für Experimentelle Physik, Leipziger Straße 23, 09599 Freiberg, Deutschland — [2]Institut für Ionenstrahlphysik, Helmholtz Zentrum Dresden Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Deutschland

Up to now all thin film solar cells exhibit only low efficiency around 6 to 8 %. This low value stems mainly from their thin absorbing layer; hence light management is a real challenge. One possibility to increase light absorption is the development of scattering mechanisms for light, which nears the backside of the solar cell and leads to an effective increase of the light path in the absorber. This work presents an approach to the fabrication of plasmonic Ag-Nanoparticles in ZnO:Al matrices by dc magnetron sputtering and subsequent dewetting treatment. For this purpose, both vacuum annealing and millisecond high power diode laser processing were tested. The dewetting of Ag layers is investigated by scanning electron microscopy. Depending on the processing parameters, the morphologies ranging from percolated network of islands to completely dewetted films were obtained. Spectral photometry in transmission and reflection showed stronger plasmonic features for laser annealed Ag-AZO composite layers in comparison with thermal vacuum annealed samples. The plasmonic effects become more pronounced with increasing laser power density and dwell time.

DS 11.23 Mon 17:00 Poster B1

Continuous wave UV-laser sintering of ink-jet printed ZnO nanoparticle thin films at low laser powers — •Alice Sandmann[1], Jens Theis[2], Axel Lorke[2], Christian Notthoff[1], and Markus Winterer[1] — [1]Nanoparticle Process Technology and CeNIDE, Universität Duisburg-Essen, Lotharstr.1, 47057 Duisburg, Germany — [2]Fachbereich Physik and CeNIDE, Universität Duisburg-Essen, Lotharstr.1, 47057 Duisburg, Germany

We present continuous wave UV-laser sintering experiments of ZnO nanoparticle thin films prepared by ink-jet printing. The ZnO nanoparticles are printed on interdigital gold structures on quartz substrates and characterized by conductivity and microphotoluminescence measurements. The microstructure of the nanoparticle thin films is obtained by scanning electron microscopy. We show that laser sintering can be observed even at laser powers as low as 30 mW, using an UV-laser at 325 nm focused to a 10 μm spot. Furthermore, we describe the laser heating process numerically using an iterative finite element algorithm, which couples the heat equation with a simplified sintering model. The numerical and experimental results match well and reveal two key parameters responsible for the effective heating and sintering process: The laser wavelength in relation to the wavelength corresponding to the band gap of the material and the initial porosity of the film.