HL 26: Poster Session: Heterostructures - Preparation and Characterization - Impurities / Amorphous Semiconductors

Time: Monday 16:00–19:00 Location: Poster D

HL 26.1 Mon 16:00 Poster D

MOVPE growth of lattice-matched GaNP/Si(100) for photoelectrochemistry — •Oliver Supplie[1], Matthias M. May[1], Henning Döscher[1,2], and Thomas Hannappel[1,2,3] — [1]Helmholtz-Zentrum Berlin, Institut Solare Brennstoffe und Energiespeichermaterialien, D-14109 Berlin — [2]TU Ilmenau, Institut für Physik, Fachgebiet Photovoltaik, D-98693 Ilmenau — [3]CiS Forschungsinstitut für Mikrosensorik und Photovoltaik, D-99099 Erfurt

III-V dilute nitrides grown lattice matched on Si(100) are considered as a candidate for both hydrogen and oxygen evolution within one single photoelectrochemical tandem device. Heteroepitaxial GaP/Si(100) quasisubstrates combine high quality and inexpensive silicon technology on the one hand (with a band gap close to the optimum for tandem solar cell applications) and a high band gap III-V film with low lattice mismatch to Si on the other hand. Incorporation of N and As in GaP films allows band gap engineering [1] for higher absorbtion and perfect lattice matching to silicon.
We applied reflection anisotropy spectroscopy (RAS) in situ in vapor phase ambient to study both the surface preparation of Si(100), GaP/Si(100) and GaNP/Si(100) as well the growth of the GaNP films. We correlate RA spectra to UHV based surface science techniques accessible via a contamination-free transfer system. For instance, III- and V-rich surface terminations exhibit characteristic RA spectra corresponding to specific surface reconstructions measured with low energy electron diffraction.
[1] Wu et al., PRB **65**(2002)241303.; Geisz et al., EPVSEC **19**(2004).

HL 26.2 Mon 16:00 Poster D

Using of solid solution and rust of AlGaAs for creating optoelectronic devices — •Lia Trapaidze[1], Raphiel Chikovani[2], Gela Goderdzishvili[2], and Maia Jgenti[2] — [1]Dep. of Physics, Tbilisi State University, 3 Chavchavadze Ave 0128, Tbilisi, Georgia — [2]Dep. of Physics, Georgian Technical University, 77 Kostava 0175, Tbilisi, Georgia

Among the semoconductive devices one of the important are many elements indicators of light emission. High efficiency of indicators emission and increasing of quality elements was investigated. For increasing efficiency of indicators emission very perspective using heterostructures based on AlGaAs. It is recommended to use own thermal rust of GaAs and GaAlAs in the GaAs-AlAs heterostructures. Method of thermal treatment is very interesting to use in integral optics, because GaAs and GaAlAs has very important properties.

HL 26.3 Mon 16:00 Poster D

Laser-induced lattice distortions in III-V and II-VI quantum heterostructures — •Sebastian Tiemeyer[1], Michael Bombeck[2], Michael Paulus[1], Christian Sternemann[1], Florian J. Wirkert[1], Johannes Möller[1], Julia Nase[1], Oliver H. Seeck[3], Manfred Bayer[2], and Metin Tolan[1] — [1]Fakultät Physik / DELTA, TU Dortmund, D-44221 Dortmund, Germany — [2]Experimentelle Physik II, TU Dortmund, D-44221 Dortmund, Germany — [3]HASYLAB, DESY, D-22607 Hamburg, Germany

Optically excited low dimensional semiconductor heterostructures have shown strong evidence for lattice distortions triggered by exciton-phonon interactions. This effect was observed for the III-V group systems InAs/GaAs and InN/GaN by means of high resolution continuous wave or non-linear time-resolved optical spectroscopy. A local change in the lattice constant due to the creation of electron-hole pairs was as well monitored for II-VI quantum structures.

We have investigated the laser-induced lattice distortions in InAs/GaAs quantum dots and CdSe/CdS core/shell quantum rods by means of anomalous x-ray single crystal diffraction and x-ray powder diffraction, respectively. The presented data were collected at the beamlines BL9 (DELTA, TU Dortmund) and P08 (HASYLAB, DESY Hamburg).

HL 26.4 Mon 16:00 Poster D

The absorption spectra of PrSb2 thin films of golden colour — •Ia Trapaidze[1], Zaur Jabua[1], Iago Kupreishvili[1], Akaki Gigineishvili[1], Giorgi Iluridze[1], Tamaz Minashvili[1], and Ketevan Davitadze[2] — [1]Dep.of physics,GeorgianTechnical University,77 kostava,Tbilisi,Georgia — [2]Georgian Aviation University,Tbilisi,Georgia

Single-phase crystalline films of PrSb2 were prepared by vacuum thermal evaporation from two independence sources on various substrate. That is shown the temperature of Sb evaporator influence on colour and accordingly on valence of Pr ion of PrSb2 thin films. The films have golden, black and blue dark colour. Absorption spectra of golden colour of PrSb2 thin films were measured at 300 K and photon energy was 0.05-5.5 eV.

HL 26.5 Mon 16:00 Poster D

Noise spectroscopy of two-dimensional-electron systems in GaAs/AlGaAs heterostructures — •Berit Körbitzer[1], Pintu Das[1], Y. Ohno[2], H. Ohno[2], and Jens Müller[1] — [1]Goethe-Universität, Frankfurt am Main, Germany — [2]Tohoku University, Sendai, Japan

Because of their high mobility, two-dimensional-electron gases (2DEG) formed at the heterostructure interface of GaAs/AlGaAs are often used as high-resolution Hall magnetometers. Since the noise level has a considerable influence on the sensitivity of these sensors, it is important to study their noise characteristics. Therefore, we have investigated the low-frequency dynamics of charge carriers in such 2DEGs in the temperature range of 10 K to 300 K by using fluctuation spectroscopy. This technique allows to gain information about the energetics of different defects, as e.g. the well-known DX centers [1, 2].

In this work we have measured resistance and Hall-voltage noise as a function of the size of Hall structures, which were prepared by standard photolithography techniques. We will also discuss the dependence of the fluctuation properties on the gate voltage.
[1] Jens Müller et al., PRL **96**, 186601 (2006)
[2] Jens Müller et al., PRB **74**, 125310 (2006)

HL 26.6 Mon 16:00 Poster D

Investigation of the polarisation properties of the polariton emission — Steve Linke, •Steffen Richter, Chris Sturm, Helena Franke, Rüdiger Schmidt-Grund, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig, Germany

Strong light-matter coupling between excitons and photons leads to the formation of exciton-polaritons revealing a modified dispersion relation with respect to the pure excitonic or photonic ones. Stokes-vector analysis of the emission from non-resonantly excited exciton-polaritons in a ZnO-based microcavity was used to obtain information about their spin polarisation. The TE-TM splitting of the lower polariton branch (LPB) and the Stokes vector of its emission were investigated in angular-resolved photoluminescence spectra as a function of temperature and detuning.

Resulting from a large TE-TM splitting of the cavity mode, the LPB shows a separation of the two orthogonal linear polarisation states of up to 12meV. The splitting increases with more negative detuning, i.e. a more photonic-like character of the polaritons. The contribution of elliptical polarisation follows roughly the k-dependent behavior of the TE-TM splitting. It increases also with more negative detunings. This elliptically polarised contribution is most likely caused by coherent TE-TM state interactions and/or in a non-negligible coupling with the neighboring D^0X donor bound exciton. For a given detuning, the degree of circular polarisation decreases with increasing temperature, probably connected with a higher scattering rate into the ground state.

HL 26.7 Mon 16:00 Poster D

Electronmicroscopical preparation of nanowires grown perpendicular to the substrate without loss of orientation information — •Sally Riess[1,2], Martin Mikulics[1,2], Beata Kardynal[1,2], Anna Haab[1,2], Fabian Haas[1,2], Hilde Hardtdegen[1,2], and Detlev Grützmacher[1,2] — [1]Peter Grünberg Institut - 9, Forschungszentrum Jülich, 52425 Jülich, Germany — [2]JARA-Fundamentals of Future Information Technology

The structural properties of nanowires and the templates they are attached to give insights into their formation process. It is therefore important to analyze the wires by transmission electron microscopy (TEM) without removing them from their initial position. To this end

the nanowire samples need to be transparent to the electron beam and are therefore thinned down to a few tens of nanometers. They are filled up first with a preferably conductive material for mechanical stability. Thin lamellae are then prepared by focused ion beam methods (FIB). Usually metals are used as the filling material - a time consuming and complex procedure. Additionally the metals could unintentionally alter the sample and impair the investigation of other metals on the wires' surfaces. A fast and inexpensive alternative process to fill up the wires is by spin-coating the sample with a conductive polymer. We will present the development of this process as well as the result after optimization: a lamella with nanowires fully encompassed in conductive polymer produced in only a few minutes time. The method may also be employed in future in contacting schemes for nanowires.

HL 26.8 Mon 16:00 Poster D

Electronic and transport properties of In_2O_3 single crystals — •Valentina Scherer[1], Christoph Janowitz[1], Alica Krapf[1], Dorothee Braun[1], Helmut Dwelk[1], Klaus Irmscher[2], Zbigniew Galazka[2], and Recardo Manzke[1] — [1]Humboldt-Universität zu Berlin, Institut für Physik, Newtonstr. 15, Berlin, Germany — [2]Leibniz-Institut für Kristallzüchtung, Max-Born-Str. 2, Berlin, Germany

The macroscopic and microscopic electronic properties of high quality In_2O_3 single crystals grown by two methods, namely chemical vapor transport (CVT) and melt growth, were investigated. The temperature dependent transport properties such as resistivity and Hall coefficient were compared. Additionally the In_2O_3 crystals were annealed in oxygen flow for different time spans to study effects on the doping due to different oxygen contents. Subsequently the temperature dependent mobility and resistivity of the annealed crystals were compared. Furthermore the electronic properties of In_2O_3 crystals from the melt and from CVT growth were investigated using angle resolved photoemission (ARPES), enabling a comparison of the band structure. In_2O_3 crystals from both growth methods revealed very similar band structure with a very broad valence band and a partially filled conduction band (CB) at the Γ-point. The partially filled CB bent below the Fermi energy is characteristic of a degenerate semiconductor. Additionally the temperature dependence of the band structure and the band gap were determined by ARPES.

HL 26.9 Mon 16:00 Poster D

Preparation of donor doped $ZnO_{1-x}S_x$ layers and their application in hetero diode structures — •Achim Kronenberger, Julian Benz, Angelika Polity, Peter J. Klar, and Bruno K. Meyer — I. Physics Institute, Justus-Liebig-University, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

The ternary system $ZnO_{1-x}S_x$ can be prepared without any miscibility gap by sputter deposition techniques. ZnO1-xSx shows a strong band gap bowing which is caused by variations of the energetic position of the valence and conduction band. This can be utilized to minimize or eliminate disturbing band offset effects in hetero structure solar cells or to control the emission energy of light emitting hetero diodes. In our work aluminum and gallium doped $ZnO_{1-x}S_x$ thin films were deposited from ceramic targets by radio frequency sputtering on glass, sapphire and p-type GaN substrates. Using oxygen as reactive gas in the sputtering process allowed to adjust the composition of the alloy. We present our results on the structural, optical and electrical properties of the $ZnO_{1-x}S_x$ films and report on the performance of $ZnO_{1-x}S_x$/GaN hetero diodes.

HL 26.10 Mon 16:00 Poster D

Deposition and characterization of zincoxynitride — •Elisabeth A. Zolnowski, Johannes Bieber, Gunther Haas, Andreas Laufer, Sebastian Eisermann, Stefan Lautenschläger, and Bruno K. Meyer — I. Physikalisches Institut Giessen, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, 35392 Giessen, DE-Germany

The first solely ZnO based light-emitting diode was produced in 2005 with PLD on $ScAlMgO_4$-substrates by the group of Tsukazaki et al. For special applications, like blue or ultraviolet diodes, p-type ZnO is necessary. But the acceptor doping of ZnO and the production in industrial scales and methods, like chemical vapor deposition (CVD), is still a current problem. A promising approach is to incorporate group V impurities into the ZnO lattice. Due to its ionic and covalent radii nitrogen seems to be the most promising candidate. Thus, we tried to deposit highly doped ZnO:N with a homebuilt CVD setup by varying the type of substrate, the substrate temperature, the oxygen precursor and its flow. We investigated the epitaxialy grown ZnO:N layers by secondary ion mass spectrometry (SIMS), raman spectroscopy and x-ray diffraction (XRD).

HL 26.11 Mon 16:00 Poster D

Thermally oxidized copper thin films — •Philipp Hering, Martin Becker, Philipp Schurig, and Bruno K. Meyer — 1. phys. Inst., JLU Giessen, Heinrich-Buff-Ring 16, 35392 Giessen

Cuprous oxide (Cu2O) constitutes, despite the relatively large band gap (2.17 eV), a very promising absorber material in photovoltaic devices due to the high absorption coefficient, non-toxicity and great abundance of the composing elements. To investigate high quality cuprous oxide films, copper was deposited on quartz substrates via sputtering and then oxidized in a controlled nitrogen/oxygen atmosphere at temperatures ranging from 800 to 1050 °C. The resulting film quality was analyzed by XRD, AFM and Raman measurements. Electrical properties were investigated with Hall and admittance measurements.

HL 26.12 Mon 16:00 Poster D

Cu_2O thin films grown by chemical vapour deposition — •Johannes Bieber, Sebastian Eisermann, Stefan Lautenschläger, Achim Kronenberger, Andreas Laufer, Gunther Haas, and Bruno K. Meyer — I. Physics Institute, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, DE-Germany

Today the world energy demand is mainly covered by limited resources, like oil, coal or gas. So it becomes more and more important to find an alternative, renewable energy source. Solar cells could be the solution or a part of it, when they are cheap, sustainable and clean. The p-type semiconductor cuprous oxide (copper(I) oxide, Cu_2O) with a direct band gap of 2.17 eV is a suitable candidate, because it is a cheap and nontoxic optoelectronic material system. The theoretical efficiency is approximately 23 % which makes it a possible candidate for a top cell in cascade solar cells. For that reason the aim of this study was to investigate the heteroepitaxial growth of cuprous oxide by CVD with different copper and oxygen precursors, various growth parameters and different substrates. The effects of different growth conditions on the crystalline, electrical, optical and vibrational properties as well as the incorporated impurities were examined.

HL 26.13 Mon 16:00 Poster D

Ab-initio phase diagram of the copper-oxygen system — •Bianca Eifert, Markus Heinemann, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany

The different oxides of copper are of great interest as semiconductor materials, but it is experimentally challenging to produce the desired stoichiometry. The copper-oxygen system consists of metallic copper, gaseous oxygen and the three oxide phases cuprite (Cu2O), tenorite (CuO) and paramelaconite (Cu4O3). Full structural relaxations of all phases were performed employing first-principles density functional theory (DFT) calculations with different exchange-correlation functionals, and phase diagrams were constructed from these results. The *ab-initio* approach allows us to examine phases at chemical potentials at which they are not thermodynamically stable in order to better understand the energetic situation of the system.

HL 26.14 Mon 16:00 Poster D

Hall Mobility Measurements on Amorphous Phase-Change Materials — •Matthias Kaes, Hanno Volker, and Matthias Wuttig — I. Physikalisches Institut (IA), RWTH Aachen, 52056 Aachen

Phase-change materials (PCMs) exhibit a rapid crystallization of their amorphous phase and a related change in electrical conductivity of several orders of magnitude. Studies of the electronic structure in the crystalline phase have revealed a surprising tendency of quasibinary PCM alloys $(GeTe)_x(Sb2Te3)_{1-x}$ to display a disorder-induced metal-insulator transition ([1]). In contrast, the study of electronical properties of amorphous-phase change materials has, so far, been confined to the study of DC-conductivity and photoconductivity, which have revealed p-type conduction as well as the presence of deep defects and shallow defects in the mobility gap ([2]).

Here, we present Hall measurements on amorphous quasibinary PCM-alloys employing an AC-Hall technique. Modulating not only the external magnetic field but also the voltage applied on the sample,

an excellent signal to noise ratio can be achieved. The extracted Hall mobilities are anomalously signed and in the range of 0.1 cm^2/Vs at 300 K. In addition, the Hall mobility increases with temperature and displays stoichiometric trends. The results are discussed in light of two-channel and small-polaron transport models.

[1] T. Siegrist et al., Nature Materials 10, p. 202-8 (2011).
[2] J. Luckas et al., Journal of Applied Physics 110, p. 013719 (2011).

HL 26.15 Mon 16:00 Poster D

Electronic and optical properties of amorphous semiconductors: a-SiO_2 and a-TiO_2 bulk, solid solution, and interface — •Marc Landmann[1], Thomas Köhler[2], Eva Rauls[1], Thomas Frauenheim[2], and Wolf Gero Schmidt[1] — [1]Lehrstuhl für Theoretische Physik, Universität Paderborn, 33095 Paderborn — [2]Bremen Center for Computational Materials Science, Universität Bremen, 28359 Bremen

Both titania (TiO_2) and silica (SiO_2) are oxides whose extraordinary physical and chemical properties are demonstrated by manifold traditional fields of application. For gaining a basic estimation of the technological potential of SiO_2/TiO_2 hybrid materials a detailed understanding of the electronic and optical properties of such materials is required. Here, we have calculated the electronic structure and optical response of the SiO_2 and TiO_2 crystalline and amorphous bulk [1,2], solid solution, and interface. The calculations have been done by standard (PBE) and hybrid (HSE06) exchange-correlation functional density-functional theory (DFT). The HSE06 hybrid functional's suitability to correct for a large part of the DFT intrinsic band gap underestimation and to give a reliable approximation of quasiparticle properties is demonstrated. The optical spectra are calculated in independent particle approximation (IPA) from the DFT band structure and compared to existing experimental data.

[1] M. Landmann et al., submitted to PRB (2011).
[2] M. Landmann et al., to be published.