HL 3: Preparation and Characterization

Time: Monday 10:15–11:45 Location: H14

HL 3.1 Mon 10:15 H14

In situ AFM characterization of e-beam exposed PMMA — Hans Koop[2], •Daniel Schnurbusch[1], Michael Müller[1], Tobias Gründl[1], Markus C. Amann[1], Khaled Karrai[2], and Alexander W. Holleitner[1] — [1]Walter Schottky Institut und Physik Department, TUM Garching, Germany — [2]attocube systems AG, Königinstraße 11a RGB, 80539 München, Germany

PMMA (poly-methyl methacrylate) is a standard polymer used as a resist for high-resolution e-beam lithography. We demonstrate how to probe in-situ the exposure properties of PMMA by an atomic force microscope (AFM). To this end, an AFM is integrated in a scanning electron microscope, and the PMMA is characterized by the AFM after e-beam exposure. Our method allows us to directly image and characterize the exposed areas of the PMMA before the resist is developed. We present a systematic investigation of this novel approach, which may result in a reliable way to evaluate e-beam exposed resists before further post-processing.

HL 3.2 Mon 10:30 H14

Focused ion beam lithography for rapid prototyping of metallic films — •Patrick Osswald, Josef Kiermaier, Markus Becherer, and Doris Schmitt-Landsiedel — Lehrstuhl für Technische Elektronik, TU München, Munich, Germany

We present FIB-lithography methods for rapid and cost-effective prototyping of metal structures covering the deep-submicron- to the millimeter-range in a single lithography cycle.

Focused ion beam (FIB) systems are widely used in semiconductor industry and research facilities for both analytical testing and prototyping. A typical application is to apply electrical contact to micronsized sensors/particles by FIB induced metal deposition. However, as for E-beam lithography, patterning times for large area bonding pads are unacceptably long, resulting in cost-intensive prototyping.

In this work, we optimized FIB lithography processing for negative and positive imaging mode to form metallic structures for large-areas down do the sub-100 nm range. For negative lithography features are defined by implanting Ga^{+}-ions into a commercial photo resist, without affecting the underlying structures by impinging ions. The structures are highly suitable for following lift-off processing due to the undercut of the resist.Metallic feature size of down to 150 nm are achievable. For positive lithography a PMMA resist is exposed in FIB irradiation. Due to the very low dose ($3 \cdot 10^{12}$ ions/cm^2) the writing time for an e.g. 100 μm x 100 μm square is approx. 15 seconds. The developed resist is used for subsequent wet chemical etching, obtaining a 100 nm resolution in metal layers.

HL 3.3 Mon 10:45 H14

In situ PES analysis of ultra-thin ZnO layers grown by atomic layer deposition — •Eike Janocha and Christian Pettenkofer — Helmholtz-Zentrum Berlin für Materialien und Energie, Hahn-Meitner-Platz 1, 14109 Berlin

Atomic layer deposition (ALD) is known for being a deposition technique allowing the growth of very thin films with excellent thickness and stoichiometry control due to its self-limiting growth characteristics. Zinc oxide (ZnO) layers have been grown by alternating exposure of highly reactive diethylzinc (DEZ) as a metal-precursor and water as oxidizing agent in an UHV environment on Si(111) substrates. After the deposition process, in situ X-ray photoelectron spectroscopy (XPS) and ultraviolet photoelectron spectroscopy (UPS) has been carried out without removing the samples out of the UHV environment. This allows a reliable analysis of the film thickness and interface chemistry and gives us the possibility of determining the temperature regime where the atomic layer deposition process shows its self-limiting character, known as the ALD window. Furthermore, we investigated the initial growth of the ZnO layers on various substrates and we are able to show that there is layer-by-layer growth, characteristic for atomic layer deposition, after formation of the first ZnO monolayer.

HL 3.4 Mon 11:00 H14

In situ characterization of VPE prepared Si(100) surfaces via RAS — •Sebastian Brückner, Henning Döscher, Anja Dobrich, Oliver Supplie, Christian Höhn, and Thomas Hannappel — Helmholtz- Zentrum Berlin für Materialien und Energie, Hahn-Meitner-Platz 1, 14109 Berlin

The epitaxial growth of III-V semiconductors on silicon substrates is a major challenge for the integration of opto- and micro-electronic devices. The first crucial step in the III-V on Si hetero epitaxy consists of a substrate preparation ensuring complete removal of oxides and a suitable atomic surface structure. It has been shown in UHV that reflection anisotropy spectroscopy (RAS) is a powerful tool to characterize Si(100) surfaces. The spectra of nominal and vicinal Si(100) substrates differ strongly due to the influences of terrace and step structures on the signal. Also adsorbates like hydrogen and oxygen show a strong impact on the spectra. We applied in situ RAS in our MOVPE reactor to characterize and control the preparation of Si(100) with 0.1°, 2° and 6° offcuts towards <111> direction. During the oxide removal process the RA spectra change from a baseline spectrum of the oxidized surface to the typical clean Si(100) spectrum. We were able to observe this change in situ by transient RAS measurements. In addition the adsorption of hydrogen on the Si surface during cool down was studied. A dedicated contamination free sample transfer system from MOVPE environment to UHV enabled us to benchmark the RA spectra with results from various surface science instruments.

HL 3.5 Mon 11:15 H14

Strain measurements on semiconductors: Raman experiments and simulation — •Andreas Talkenberger[1], Gert Irmer[1], Martin Abendroth[2], Christian Röder[1], and Cameliu Himcinschi[1] — [1]TU Bergakademie Freiberg, Institute for Theoretical Physics, Leipziger Str. 23, 09596 Freiberg, Germany — [2]TU Bergakademie Freiberg, Institute for Mechnics and Fluid Dynamics, Lampadiusstr. 4, 09596 Freiberg, Germany

The characterisation of strains in semiconductors is crucial for microelectronic and photovoltaic applications. However, even for some widely used semiconductors the elastic properties are not well understood. For example, due to the lack of high-quality GaN bulk material it was not yet possible to determine the elastic constants with good precision.

Using Raman scattering we present a method which allows the determination of phonon deformation potentials in semiconductors derived from phonon frequency shifts under biaxial stress. The stress was applied by three-point bending and calculated by means of beam theory. In order to establish the technique we first investigated well studied semiconductor materials, e.g. silicon and gallium arsenide. The phonon deformation potentials found are in good agreement with earlier published values. Additionally, the strain fields were calculated by finite element methods.

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HL 3.6 Mon 11:30 H14

High temperature dielectric function of Silicon, Germanium and GaN — •Martin Leyer, Markus Pristovsek, and Michael Kneissl — Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, 10623 Berlin

In the last few years accurate values for the optical properties of silicon, germanium and GaN at high temperatures have become important as a reference for in-situ analysis, e.g. reflectometry. Precise temperature dependent dielectric measurements are necessary for the growth of GaInP/GaInAs/Ge triple-junction solar cells and the hetero epitaxy of GaN on silicon and sapphire.

We performed spectroscopic ellipsometry (SE) measurements of the dielectric function of silicon, germanium and GaN between 1.5 eV and 6.5 eV in the temperature range from 300 K to 1300 K. The Samples were deoxidized chemically or by heating. High resolution SE spectra were taken every 50 K while cooling down to room temperature. The temperature dependence of the critical energies is compared to literature. Measurements for germanium showed a shift of the E_2 critical point of ∼0.1 eV toward lower energies. The reason for this behavior is a non-negligible oxide layer on the samples in the literature.