O 20 Epitaxy and growth II

Time: Tuesday 11:15–13:00 Room: WIL B321

O 20.1 Tue 11:15 WIL B321

In-situ diffraction studies of homoepitaxial electrochemical growth on Au(100) — •Klaus Krug, Jochim Stettner, and Olaf M. Magnussen — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität, 24098 Kiel

The surface structure and growth behaviour of Au(100) electrodes during electrodeposition in $HAuCl_4$-containing HCl solution has been studied in-situ by high-energy surface x-ray diffraction in transmission geometry. Using a "hanging meniscus" cell structural data can be obtained parallel to electrochemical measurements. To distinguish the effects of the interface structure on the deposition process from effects caused by different deposition rates, measurements were performed under diffusion limited deposition conditions. By time-dependent measurements of the x-ray intensity at selected positions along specular and non-specular crystal truncation rods a complex potential-dependent growth behavior was found: With decreasing potential transitions from step-flow deposition to layer-by-layer growth, manifested by layering oscillations in the x-ray intensity, then to 3D growth, and finally back to layer-by-layer growth were observed. The latter occurred parallel to the formation of the "hex" reconstruction on the Au(100) surface. This growth behavior can be explained by the effect of Cl adsorbates and the Au surface structure on the mobility of Au adatoms.

O 20.2 Tue 11:30 WIL B321

surface Debye Temperatur of thin Bi(111) on Si(001) — •Rabih Khanafer, Andreas Janzen, Boris Krenzer, Giriraj Jnawali, Hichem Hattab, and Michael Horn-von Högen — Universität-Duisburg-Essen, Institut für experimentelle Physik, 47057 Duisburg

Experiments with time resolved electron diffraction at surfaces require materials with a low surface Debye temperature to ensure high sensitivity for transient surface temperature changes upon excitation by ultrashort laser pulses. In order to study the heat dissipation in thin films from monolayer thickness up to bulk properties additionally require high quality heteroepitaxial growth. Bismuth films on Si(001) act as ideal model system for such investigations.

Bismuth with a bulk Debye temperature of 119 K shows a surface Debye temperature of only 48 K [1].Deposition of Bismuth at room temperature on Si(001) results in the formation of continuous, smooth and well oriented Bi(111) films even for a thickness as low as 3 nm. The surface Debye temperature has been determined by LEED, SPA-LEED and RHEED as function of film thickness and electron energy. Between 80 and 100 eV a decrease of the surface Debye temperature from 46 K to 33 K is observed followed by an increase to 48 K at 190 eV. This behaviour agrees well with the maximum of surface sensitivity around 100 eV.

The use of these films in a ultrafast electron diffraction experiment will be presented.

[1] R. M. Goofman, G. A. Somorjai, J. Chem. Phys. **52, 6325 (1970)**

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O 20.3 Tue 11:45 WIL B321

Epitaxial growth of Bi(111) on Si(001) studied by SPA-LEED: Morphology and Lattice Accomodation — •Giriraj Jnawali, Hichem Hattab, Boris Krenzer, and Michael Horn von Hoegen — Universität Duisburg-Essen, Fachbereich Physik, Lotharstr. 1, 47057 Duisburg

Deposition of Bismuth at 150 K results in the formation of epitaxial films. The LEED pattern shows diffuse spots reflecting a hexagonal orientation in two Bi(111) domains rotated by 90°. With increasing coverage only a ring of intensity remains, reflecting rotational disorder. The ring disappears after annealing to 200 K. Annealing to 350 K reduces surface roughness and very flat surfaces are obtained with sharp LEED spots. Further annealing to 470 K leads to dewetting of the film which can be observed from LEED pattern. The surface morphology is studied by Spot Profile Analysing Low Energy Electron Diffraction during deposition and annealing. The lattice constant $a_{0,Bi(111)} = 4,54$ Å of Bi(111) matches perfectly by a factor of 11:13 with the lattice constant $a_{0,Si(001)} = 3,84$ Å of the Si(001) surface in one direction. In the perpendicular direction the row distance $a_{0,Bi(111)} \sin 60° = 3,94$ Å of the Bi(111) film almost matches the Si(001) lattice constant. For the films thicker than 2 nm the remaining lattice mismatch of 2.5 % is relieved by a disordered array of interfacial dislocations which is observed by spot splitting in the LEED pattern. From the distance between the satellite spots we conclude an almost strain relieved growth of the Bi(111)-film on the Si(001) surface.

O 20.4 Tue 12:00 WIL B321

Epitaxial growth of thin Fe-films on GaAs(110) at 80K — •L. Winking, M. Wenderoth, J. Homoth, and R. G. Ulbrich — Universität Göttingen, IV. Physikalisches Institut

The best conditions for the eptiaxial growth of Fe on GaAs(001) or GaAs(110) were reported to be at substrate temperatures of about 175°C [1]. Nevertheless the highest spin injection efficiencies were reported for films grown at 10-15°C, due to the reduced intermixing at the Fe/GaAs heterointerface [2]. At lower substrate temperatures Fe films showed an increasing number of defects towards a nanoclustered film.

We present a combined LEED and STM study of thin Fe films that were deposited at 80K on in-situ cleaved GaAs(110). The film thickness ranges from a sub-monolayer coverage up to several monolayers. After annealing to RT Fe films of more than 3 ML thickness show the well known LEED pattern of Fe(110) and demonstrate the good epitaxial quality of the film. STM topographies of these annealed films show clear evidence for a 2D layer-by-layer growth, in contrast to the well known 3D cluster growth of thin Fe films deposited at RT or above. Our study demonstrates that low temperature deposition of Fe on GaAs leads to thin epitaxial films of good quality. Due to the low substrate temperature the described preparation scheme may be a key technique to suppress intermixing at the Fe/GaAs heterointerface.

This work was supported by the SFB 602 TP A7.

[1] P. M. Thibado et al., PRB 53, R10481 (1996)
[2] A. T. Hanbicki et al., APL 80, 1240 (2002)

O 20.5 Tue 12:15 WIL B321

Influence of strain on the dynamics of III – V semiconductor surfaces — •Hannes Guhl and Frank Grosse — Halbleitertheorie, Institut für Physik an der Humboldt-Universität Newtonstr. 15, 12489 Berlin

Thermodynamic equilibrium and growth kinetics of the InAs(001) surface under static homogeneous or inhomogeneous strain is investigated by kinetic Monte Carlo simulations. Its input, a strain dependent cluster expansion for the In and As interaction energies, is solely determined by ab initio density functional theory calculations. The surface interactions can be simplified under anneal conditions and mapped onto a multi-state Potts model with generalized interactions. The As-interaction along the As-dimer rows changes from attractive (compressive strain) to repulsive (tensile strain). Furthermore, the overall increased binding of As-dimers on compressed surfaces leads to slower As-dynamics and an increased density. The main step in the island nucleation is the formation of In pairs on the As-dimers rows [1]. Their increased binding energy under tensile strain leads to an increased island density in the initial stages of growth.

[1] F. Grosse, W. Barvosa-Carter, J. Zinck, M. Wheeler, M.F. Gyure, Phys. Rev. Lett. 89, 116102 (2002).

O 20.6 Tue 12:30 WIL B321

Kinetic roughening during polymer film growth: Monte-Carlo simulations and experiments — •Christian Vree[1], Johanna Röder[2], Hans-Ulrich Krebs[2], and S. G. Mayr[1] — [1]I. Physikalisches Institut, Universität Göttingen — [2]Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Surface evolution during polymer thin film deposition is investigated with the help of Monte-Carlo simulations and compared with experiments. Vapor deposition of chainlike model polymers onto a substrate is simulated where the polymer chains are implemented as linear chains of inseparably bonded particles which subsequently relax via a reptation type of dynamics after deposition. We investigate the impact of processing parameters on kinetic roughening, and find a crossover from single particle behavior to continuous growth behavior in early growth stages which has been observed in former experiments as well. The continuous growth behavior is characterized by a growth exponent $\beta = 0.20 \pm 0.02$ and a roughness exponent $\alpha = 0.38 \pm 0.02$ for most preparation conditions. In the high thickness regime a strong roughening and concurrent structural change of morphologies is observed. On the experimental side

polycarbonate films are prepared with pulsed laser deposition and characterized with scanning force microscopy. We find a growth exponent $\beta = 0.23 \pm 0.04$ and a roughness exponent $\alpha = 0.68 \pm 0.04$. We acknowledge the SFB 602, TP B3 for financial support.

O 20.7 Tue 12:45 WIL B321

Optical in situ monitoring of deoxidation of III-V-semiconductors in MOVPE — •A. Oestereich[1], C. Kaspari[1], M. Pristovsek[1], and W. Richter[2] — [1]Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, 10623 Berlin — [2]Università degli Studi di Roma "Tor Vergata", Via della Ricerca Scientifica 1, 00133 Roma, Italy

In epitaxial growth the removal of the unavoidable oxide layer on the substrat is a very important matter. We have studied thermal oxide desorption in MOVPE with Reflectance Anisotropy Spectroscopy (RAS) and Spectroscopic Ellipsometry (SE). The aim was to clarify the influence of the carrier gas, precursor, temperature ramp and of pre-growth treatment like wet etching. In all studied cases we observed a gradual transition of the RAS signal in a temperature range of 50K to 200K between the beginning of oxide removal and the formation of a clean reconstruction. In the case of InAs the deoxidation starts approximatly at 240°C and is complete at ∼480°C. For GaP the start temperature is ∼510°C and the clean surface is formed around 620°C. The desorption temperature increases with the bond energy of the material.