# O 39 Nanostrukturen IV

Zeit: Dienstag 10:45–13:00 Raum: TU EB420

O 39.1 Di 10:45 TU EB420

**Formation and decay of Si/Ge nanostructures at the atomic level** — •Bert Voigtländer, Neelima Paul, Vasily Cherepanov, and Josef Mysliveček — 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. Also different kinds of two-dimensional Si/Ge nanostructures like alternating Si and Ge nanodots and nanorings having a width of 5-10 nm were grown. One atomic layer of Bi terminating the surface is used to prevent intermixing between Si and Ge and to distinguish between these elements. A difference in apparent height is measured in scanning tunneling microscopy (STM) images for Si and Ge, respectively. 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.

O 39.2 Di 11:00 TU EB420

**STM contrast between Ge and Si atoms incorporated in the Si(111)-$\sqrt{(3)} \times \sqrt{(3)}$-Bi surface** — •Josef Mysliveček, Neelima Paul, and Bert Voigtländer — Institut für Schichten und Grenzflächen (ISG 3) and cni - Center of Nanoelectronic Systems for Information Technology, Forschungszentrum Jülich, 52425 Jülich, Germany

The termination of the Si(111) surface by 1 ML Bi prevents intermixing between subsequently deposited Ge and Si atoms that incorporate below the Bi layer. At the same time, apparent height difference between the incorporated Ge and Si monolayers is observed in the scanning tunneling microscope, allowing the control of the formation of lateral Ge-Si nanostructures on the Si(111)-$\sqrt{(3)} \times \sqrt{(3)}$-Bi surface. Using scanning tunneling spectroscopy techniques we study the origin of this apparent height difference. While the densities of electronic states measured over the incorporated Ge and Si layers do not differ significantly, a significant lowering of the inverse decay length is observed for the unoccupied electron states over the incorporated Ge layer. This indicates, that the presence of the incorporated Ge layer on the Si(111)-$\sqrt{(3)} \times \sqrt{(3)}$-Bi surface decreases the electron affinity on this surface.

O 39.3 Di 11:15 TU EB420

**Strukturelle Untersuchungen von Dysprosiumsilizid-Nanodrähten auf vizinalen Si(001)-Oberflächen mittels Rastertunnelmikroskopie und LEED** — •N. Tschirner, S. K. Becker, H. Eisele und M. Dähne — Technische Universität Berlin, Institut für Festkörperphysik, PN4-1, Hardenbergstr. 36, 10623 Berlin

Seltenerdsilizid-Nanodrähte zeichnen sich durch eine geringe Schottkybarriere auf der Si(111)- und der Bildung von Nanodrähten auf der Si(001)-Oberfläche aus. Wie aus früheren Untersuchungen bekannt[1], lassen sich durch Anpassen der Präparationsbedingungen verschiedene Arten von Drähten bilden. Bei niedrigen Temperaturen bilden sich dünne Drähte mit einer 2×7-Uberstruktur, bei höheren Temperaturen formen sich breitere und längere Drahttypen aus.

Auf vizinalen Oberflächen kann man ein paralleles Wachstum der Drähte aufgrund von Doppelstufen beobachten. Diese Drähte wurden mit LEED als auch mit STM untersucht und ihre atomare Struktur für unterschiedliche Wachstumstemperaturen und Dysprosium-Bedeckungen analysiert.

[1] C. Preinesberger, S. Vandré, T. Kalka, and M. Dähne. J. Phys. D: Appl. Phys **31**, L43 (1998)

O 39.4 Di 11:30 TU EB420

**Local electronic properties of the one-dimensional Si(557)-Au surface** — •M. Sauter[1], M. Schöck[2], R. Hoffmann[1], C. Sürgers[1], and H. v. Löhneysen[1,3] — [1]Physikalisches Institut and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institut for Fysik og Astronomi, Aarhus Universitet, DK-8000 Århus, Denmark — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany

The local electronic properties of the Si(557)-Au surface, obtained by deposition of 0.2 monolayers Au on vicinal Si(111) and subsequent annealing, are investigated by scanning tunneling microscopy (STM) and spectroscopy at different temperatures. Images taken at room temperature show the characteristic surface structure of chains adjacent to diffuse stripes. At $T = 77$ K the images show a voltage dependent contrast which disagrees with the previously reported interpretation in terms of a Peierls-like transition occurring below 260 K [1]. The voltage-dependent contrast is is confirmed by atomically-resolved tunneling spectra which indicate metallic or semiconductor-like behavior depending on the type of protrusion. The results are discussed by comparison with a recent calculation of the electronic surface-band structure of Si(557)-Au [2].

[1] J. R. Ahn et al., Phys. Rev. Lett. **91**, 196403 (2003)

[2] D. Sánchez-Portal et al., Phys. Rev. Lett. **93**, 146803 (2004)

O 39.5 Di 11:45 TU EB420

**Lead on hydrogen terminated Si(111)1x1: STM and surface x-ray diffraction** — •C. Rettig[1], V. Chamard[2], T.-L. Lee[3], J. Zegenhagen[3], and H. Hövel[1] — [1]Universität Dortmund, Experimentelle Physik I, D-44221 Dortmund — [2]CNRS, laboratoire de thermodynamique et physico-chimie metallurgique, B.P. 75, F-38402 St Martin d'hères — [3]European Synchrotron Radiation Facility (ESRF), B.P. 220, F-38043 Grenoble

We studied the growth of Pb on Si(111):H 1x1. The hydrogen termination leads to a chemically inert surface and results in a well defined modification of the Pb/Si interface if we compare our data to experiments for Pb on Si(111)7x7 deposited at T<270K in UHV. Recently for this system a uniform-height island growth was observed due to quantum well states, which lead to energy minima every second ML in height [1]. We characterised the growth mode of Pb on Si(111):H 1x1 at room temperature, changing the deposition amount from 2ML to 20ML, by using STM and SXRD (Surface X-Ray Diffraction) without breaking insitu UHV conditions. The SXRD data show the growth of exclusively Pb(111) planes parallel to the Si(111) plane and exhibit a beating pattern similar to the results of Pb on Si(111)7x7 [2], which may indicate a quasibilayer growth of the Pb clusters already at room temperature. In addition we characterised the morphology for different deposition temperatures (10K, 50K, 150K, 300K) with STM at 77K. In all cases we observed a 3D island structure of the Pb deposit.

[1] M. Hupalo et al., Phys. Rev. B **64**, 155307 (2001).

[2] P. Czoschke et al., Phys. Rev. Lett. **93**, 036103 (2004).

O 39.6 Di 12:00 TU EB420

**Annealing induced 2D nano-patterning of Ga/Si(111) studied by STM** — •Subhashis Gangopadhyay, Thomas Schmidt, and Jens Falta — Institute of Solid State Physics, University of Bremen, P. O. Box 330440, Bremen 28334, Germany

Annealing induced two dimensional nano-patterning was observed on Si(111) after submonolayer deposition of Ga at room temperature (RT) followed by annealing cycles. The evolution of the surface structure was studied using variable temperature scanning tunneling microscope (VT-STM). After RT Ga deposition, self-organized Ga induced magic clusters are found. Excess Ga leads to the formation of small 2D islands. The magic clusters are thermally stable up to 400°C (transition temperature). Depending on Ga deposit, two types of 2D pattern formation are observed located at the surface steps and the domain boundaries of the former Si(111)-7×7 reconstruction. For Ga coverages below 1/3 ML, Si(111)-7×7 domains are surrounded by $\sqrt{3}\times\sqrt{3}$-Ga structure which decorates the former domain boundary and step edges. If the Ga coverage exceed 1/3 ML, domains of $\sqrt{3} \times \sqrt{3}$-Ga structure are found surrounded by a 6.3×6.3-Ga structure.

O 39.7 Di 12:15 TU EB420

**Stöchiometriebestimmung von III-V Halbleiternanostrukturen mittels Querschnittsrastertunnelmikroskopie** — •Holger Eisele[1], Rainer Timm[1], Andrea Lenz[1], Oliver Flebbe[1], Ernst Lenz[2], Ferdinand Streicher[1] und Mario Dähne[1] — [1]Inst. F. Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 Berlin — [2]Inst. f. Technische Informatik u. Mikroelektronik, Technische Universität Berlin, Einsteinufer 17, D-10587 Berlin

Verspannte III-V Halbleiternanostrukturen bauen nach dem Spalten einer Querschnittsfläche ihre Verspannungsenergie über eine Relaxation dieser Spaltfläche ab. Diese Relaxation kann sowohl lateral in der Oberfläche als auch vertikal zu ihr mit dem Rastertunnelmikroskop gemessen werden.

Über die laterale Ralaxation erhält man Informationen, die mit der durchmischungkonzentrattion der Nanostrukturen in der Querschnittsfläche korreliert sind. Aus der vertikalen Verspannungrelaxation erhält man weiterhin Aussagen über die Konzentration und Form der weiter unterhalb der Spaltfläche liegenden berteiche der Nanostrukturen. Mit hilfe numerische Verfahren kann sowohl die laterale als auch vertikale Verspannungsrelaxation zur Konzentrationsbestimmung von durchmischten III-V Halbleiternanostrukturen genutzt werde.

O 39.8 Di 12:30 TU EB420

**Querschnitts-Rastertunnelmikroskopie an stickstoffhaltigen InAs/GaAs-Heterostrukturen** — •M. Müller[1], A. Lenz[1], L. Ivanova[1], R. Timm[1], H. Eisele[1], M. Dähne[1], O. Schumann[2], L. Geelhaar[2] und H. Riechert[2] — [1]Technische Universität Berlin, Institut für Festkörperphysik, PN4-1, Hardenbergstr. 36, 10623 Berlin — [2]Infineon Technologies, Corporate Research Photonics, 81730 München

Die Rastertunnelmikroskopie an Querschnittsflächen ist eine geeignete Methode zur Untersuchung vergrabener Heterostrukturen, ihrer Struktur und chemischen Komposition[1]. Untersucht wurden mittels Molekularstrahlepitaxie gewachsene, vergrabene InAs/GaAs Quantenpunkt-Dopplestapel, die unter verschiedenen Wachstumsparametern, insbesondere Stickstoffbeimengungen in der Quantenpunktschicht und der Zwischenschicht hergestellt wurden.

Beobachtet wurde eine zunehmende Veränderung der Quantenpunktform und eine teilweise Auflösung der Benetzungsschicht. Ferner wurden Oberflächendefekte beobachtet, die beim Spalten des Kristalls aufgrund von Verspannungen durch den Stickstoffeinbau entstehen[2]; ebenso konnte der Einbau von Stickstoff in das GaAs-Substrat auf atomarer Ebene untersucht werden.

[1] A. Lenz, R. Timm, H. Eisele, M. Dähne et al.,
Appl. Phys. Lett. **81**, 5150 (2002)
[2] H. A. McKay, R. M. Feenstra, J.Vac.Sci.Technol. B **19**, 1644 (2001)

O 39.9 Di 12:45 TU EB420

**Raman spectroscopy on double-walled carbon nanotubes** — •Wencai Ren[1,2], Feng Li[1], Huihong Qian[3], Hui Qian[3], Thorsten Staedler[2], Achim Hartschuh[3], Xin Jiang[2], and Hui-Ming Cheng[1] — [1]Institute of Metal Research,Chinese Academy of Sciences, Shenyang 110016, China — [2]Chair of Surface and Materials Technology, University of Siegen, Siegen 57068, Germany — [3]Department of Chemistry, University of Siegen, Siegen 57068, Germany.

Double-walled carbon nanotube (DWNT) provides a new platform for fundamental studies and nanodevice applications, due to their special double wall structure and one-dimensional (1D) character. In this work, we developed a sulfur-assisted floating catalytic decomposition method to directly synthesize DWNT bundles with high purity, narrow diameter distribution and good alignment. In a first step Raman spectra of DWNT bundles were studied. The results indicate that (1) the radial breathing mode (RBM) and G-band profiles can all be decomposed into two intrinsic independent single-walled carbon nanotube (SWNT) components constituting the DWNT, and (2) D-band and G'-band were composed of four well-resolved peaks, which are considered to originate from the curvature effect related to the tube diameter and relative atom stacking effect of the two constituent tubes.

In a second step, Raman measurements at a single nanotube level were carried out. The correlation between the Raman spectra of the individual nanotubes and their bundles will be discussed. All results indicate that DWNTs possess unique and characteristic Raman spectra different from other sp2 carbon materials.