HL 55 Quantenpunkte und -drähte: Herstellung und Charakterisierung II

Zeit: Dienstag 15:00–16:30 Raum: TU P-N201

HL 55.1 Di 15:00 TU P-N201

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-Doppelstapel, 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)

HL 55.2 Di 15:15 TU P-N201

Aligned InAs quantum dots grown on an epitaxially patterned (110) GaAs surface — •Jochen Bauer, Dieter Schuh, Emanuelle Uccelli, Robert Schulz, Max Bichler, Jonathan Finley, and Gerhard Abstreiter — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, D-85748 Garching

The control of the position of quantum dots is an important demand for the use of quantum dots in future devices and can e.g. be achieved by lithographic methods. A new approach is to self-align InAs quantum dots on defined positions on a (110) GaAs surface as recently demonstrated [1]. Here the template to determine the position of the quantum dots is fabricated using the cleaved edge overgrowth technique (CEO): In a 1st growth step, a series of AlAs layers is grown with molecular beam epitaxy (MBE) on (001) GaAs. By *in situ* cleaving this substrate, a smooth (110) GaAs surface with alternating GaAs and AlAs stripes is obtained. The subsequent deposition of InAs on this surface leads to the formation of InAs quantum dots on top of the AlAs stripes. Due to the high precision of MBE, an atomically precise positioning of these quantum dot chains is possible. Futhermore the size of the quantum dots is correlated with the thickness of the AlAs-stripes, and, hence, can be adjusted in the first MBE growth step. Therefore also the emission energy of these dots is adjustable and μ-PL investigations demonstrate the good optical qualities of these quantum dots.

[1] J. Bauer et al., Appl. Phys. Lett. 85, 4750(2004)

HL 55.3 Di 15:30 TU P-N201

Optical investigation of nanoelectromechanical actuations — •Christine Meyer, Heribert Lorenz, and Khaled Karrai — Center for NanoScience and Physics Department, LMU München

Due to their small sizes and their even smaller actuation ranges nanoelectromechanical systems (NEMS) are not easy to characterize. Electron microscopy seems to be well suited for their investigation but the electrical interaction with the nanostructures can be highly destructive. Here, we present an all-optical method to non-destructively detect NEMS deflections and thus test the functionality of nanomechanical actuators.

The optical investigation was performed on silicon-based cantilevered nanobeams defined by electron-beam lithography. The free-standing cantilevers were either located 400 nm above a silicon substrate or the substrate right beneath the cantilevers was removed. Electrostatic actuation of the nanostructures was achieved by applying a voltage drop between two cantilevers.

Images of the NEMS were taken by confocal scanning optical microscopy while the cantilevers were electrostatically actuated under a low frequency voltage. By demodulation at the actuation frequency displacements of less than 0.5 nm were resolved.

HL 55.4 Di 15:45 TU P-N201

Structure and morphology of InGaN nano-islands on GaN studied by STM — •Subhashis Gangopadhyay, Thomas Schmidt, Sven Einfeldt, Tomohiro Yamaguchi, Detlef Hommel, and Jens Falta — Institute of Solid State Physics, University of Bremen, P. O. Box 330440, Bremen 28334, Germany

Scanning tunneling microscopy (STM) has been used to study the structure and morphology of InGaN nano-islands on GaN/Sapphire. InGaN islands were grown by metal organic vapor pressure epitaxy (MOVPE) for different choices of growth temperature, InGaN deposit, growth rate and III:V flux ratio. After growth, the samples were transferred to the UHV-STM analysis chamber under nitrogen ambient to suppress surface oxidation. Depending on the various growth parameters, three different types of InGaN islands are observed. The lateral size (diameter) of the islands was ranging from 15 nm to 100 nm whereas the height of the islands varied from 1 nm to 8 nm. The top of the larger islands (650°C growth temperature), appears very flat and a spiral disc-like growth with monolayer step-height was observed. Excess In was found in droplets preferentially on the top of the InGaN islands. For smaller islands (600°C growth temperature), homogeneously distributed island with high density were observed.

HL 55.5 Di 16:00 TU P-N201

One-Dimensional Electronic States on Si(111)-2×1: Observation of a Coulomb Gap at low T — •J. K. Garleff[1], M. Wenderoth[1], R. G. Ulbrich[1], C. Sürgers[2], and H. v. Löhneysen[2] — [1]IV. Physikalisches Institut, Universität Göttingen, D-37077 Göttingen — [2]Physikalisches Institut and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76128 Karlsruhe

Scanning tunneling microscopy and -spectroscopy was performed on Si-(111)-2×1 at 8 K with a spectral resolution of ∼10 mV. A disorder induced tail of the surface conduction band is observed in the surface band gap *below* the Fermi energy E_F. At $E = E_F$ a Coulomb gap of width W of up to 150 mV opens. W scales inversely with the undisturbed length L^{-1} of the π-bonded chain between two monatomic steps on the cleaved surface ($10nm \leq L \leq 100nm$). In the case of π-bonded chains that contain a substitutional Phosphorus (P) atom, W increases according to the shortened length of the chain. The enlarged gap is found only on the individual chain interrupted by the P atom. This experimental observation excludes any coupling between neighboring π-bonded chains. Within a factor 2, the measured $W(L^{-1})$ fits quantitatively to the Coulomb gap calculated from the capacitance [1] of the one dimensional (1D) segments of the π-bonded chains with finite length. The scaling $W \propto L^{-1}$ and the absence of coupling between the chains is interpreted as experimental evidence for a 1D electronic system in the π-bonded chains at low temperature $T = 8K$.

[1] D. V. Averin and K. K. Likharev, J. Low Temp. Phys. 62, 345 (1986)

HL 55.6 Di 16:15 TU P-N201

Einfluss der Verspannung auf die Bildung von GaInAs/GaAs Quantenpunkten — •A. Löffler[1], J.-P. Reithmaier[1], A. Forchel[1], A. Sauerwald[2], T. Kümmell[2] und G. Bacher[2] — [1]Technische Physik, Universität Würzburg — [2]Werkstoffe der Elektrotechnik, Universität Duisburg-Essen

Selbstorganisierte Quantenpunktstrukturen im GaInAs/GaAs-Materialsystem werden üblicherweise im sogenannten "Stranski-Krastanov"-Wachstumsmodus hergestellt. Hierbei ist die Verspannung die treibende Kraft für die Bildung der Quantenpunkte, die sich ab einer gewissen kritischen Schichtdicke bilden. Dabei wird die Dichte und Größe der Quantenpunkte im Wesentlichen durch die abgeschiedene Materialmenge bzw. deren Zusammensetzung beeinflusst.

Um insbesondere große Quantenpunktstrukturen mit geringer Dichte für Grundlagenuntersuchungen herzustellen, wurde der Einfluss der Verspannung auf die Quantenpunktbildung untersucht, wobei der Indiumgehalt sukzessive von 60 % über 45 % auf 30 % reduziert wurde. Die Quantenpunktstrukturen wurden in einer Feststoffquellen-MBE gewachsen, mit Tieftemperatur-Photolumineszenz-Messungen optisch charakterisiert bzw. ihre Morphologie mittels REM- bzw. TEM-Messungen untersucht.