HL 50 Nanodrähte

Zeit: Dienstag 10:45–13:30 Raum: TU P-N201

HL 50.1 Di 10:45 TU P-N201

Template-directed fabrication of periodic ZnO nanowire arrays and the electrical characterizations by SEM nanomanipulator — •Hongjin Fan[1], Frank Fleischer[1], Woo Lee[1], Kornelius Nielsch[1], Margit Zacharias[1], Armin Dadgar[2], and Alois Krost[2] — [1]Max Planck Institute of Microstructure Physics, Halle (Saale) — [2]Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg

We report the successful fabrication of periodical arrays of single-crystalline ZnO nanowire arrays by combining substrate nanopatterning and catalyst-directed epitaxial growth. First, ordered arrays of Au nanodots were obtained by using metal nanohole membranes as shadow mask for Au deposition. This novel type of shadow mask was obtained from an electrochemical duplication process of anodic porous alumina. Subsequent vapor-phase growth resulted in vertically-aligned and hexagonal-arranged ZnO nanowires on GaN/Si substrates. The Au nanodots served as both catalyst and site-specific template for the growth of ZnO nanowires. As the size (30 to 250 nm) of the Au nanodots is tunable by choosing different masks for the Au deposition, the resulting ZnO wires are adjustable in their diameters. For the electrical characterizations, the ZnO nanowires were transferred to an oxide-coated Si substrate. A SEM-based nanomanipulator system, in which two independent sharp needles serve as electrodes, was employed to measure the I-V characteristics of individual ZnO nanowire. Results on this will be shown in detail.

HL 50.2 Di 11:00 TU P-N201

ZnO Nanorods Fabricated by Solution Synthesis and Chemical Vapor Deposition on Patterned Substrates — •Thomas Büsgen, Michael Hilgendorff, Witold Kandulski, Adam Kosiorek, Peter Karageorgiev und Michael Giersig — caesar research center, Ludwig-Erhard-Allee 2, 53175 Bonn, Germany

We will present the current results of preparations and characterizations of ZnO nanorods and -wires. Small ZnO nanorods of 10 nm in diameter and aspect ratios up to 10 have been synthesized in alcoholic solutions by a sol-gel approach using appropiate surfactants.

Larger ZnO wires of several microns in length and 100 nm in diameter were fabricated by chemical vapor deposition. The wire growth has been catalyzed by highly ordered Au islands, pre-patterned on sapphire substrates by nanoshadow lithography.

The as prepared ZnO materials have been characterized by SEM, TEM, NSOM, and optical spectroscopy. Their properties will be discussed in view of future applications.

HL 50.3 Di 11:15 TU P-N201

Catalyst–Nanostructure Interaction in Growth of ZnO and ZnS 1–D Nanostructures — •Christine Borchers, Sven Müller, Daniel Stichtenoth, and Carsten Ronning — II. Physikalisches Institut, Universität Göttingen, 37077 Göttingen

Vapor-liquid-solid is a well established process in catalyst guided growth of 1–D nanostructures, i.e. nanobelts and nanowires. The catalyst particle is generally believed to be in the liquid state during growth, and it is the site for adsorbing incoming molecules. The crystalline structure of the catalyst may not have any influence on the structure of the grown nanostructures. In this presentation, using Au guided growth of ZnO and ZnS nanostructures, we show that the interfaces between the catalyst droplet and the nanostructure grow in well defined mutual crystallographic relationships. The catalyst droplet directs the nanostructure's growth direction and defines its diameter. Possible alloy, intermetallic, or eutectic phase formation during catalysis are elucidated.

HL 50.4 Di 11:30 TU P-N201

Modifikation von ZnS Nanobändern durch Ionenbestrahlung — •Daniel Stichtenoth, Daniel Schwen, Sven Müller, Christine Borchers und Carsten Ronning — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany

ZnS als ein II-VI Halbleiter mit direkter Bandlücke von 3,66 eV in der kubischen und 3,74 eV in der wurzitischen Phase eignet sich aufgrund seiner besonderen optischen Eigenschaften wie einem hohem Brechungsindex zur Fertigung optoelektronischer Bauteile. Halbleiter Nanobänder mit einer Dicke von 20nm - 200nm und einem hohen Aspektverhältnis wurden durch einen einfachen thermischen CVD Prozess sythetisiert. TEM Untersuchungen ergaben, dass die entstandenen Nanobänder sowohl wurzitische als auch kubische Kristallstruktur haben. Geeignete Fremdatome zur Dotierung der Bänder wurden durch Ionenimplantation eingebracht. Defekte wurden durch Anlassen weitesgehend ausgeheilt. An den Proben wurden Photo- und Kathodolumineszenz Untersuchungen in einem Temperaturbereich von 12K - 300K als Funktion der Anlasstemperatur durchgeführt. Zusätzlich werden in diesem Vortrag zeitaufgelöste Messungen an ausgewählten Zuständen diskutiert.

HL 50.5 Di 11:45 TU P-N201

Wachstum und Dotierung von ZnO Nanodrähten — •Sven Müller, Daniel Stichtenoth, Daniel Schwen, Tania Hernan Hakansson, Christine Borchers und Carsten Ronning — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

ZnO Nanodrähte wurden mit einem einfachen CVD Verfahren hergestellt. Dazu wurden hexagonal angeordnete Goldkatalysatorpunkte durch Nanospherelithographie auf geeignete Substrate aufgebracht. Diese Goldpunkte wirken im anschließenden Vapor-Liquid-Solid (VLS) Wachstum der Nanodrähte als Katalysator. Die hergestellten Nanodrähte wurden mit Al+ (als Donator) und N+ (als Akzeptor) Ionen und einer Energie von 25 keV bestrahlt, um einen p- und n-typ-Dotierung zu erhalten. Die anschließenden TEM und Photolumineszenzuntersuchungen für die unterschiedlichen Implantationsdosen wurden direkt nach dem Implantieren und nach dem Ausheizen untersucht. Die Ergebnisse zum Wachstum und zur Implantation werden in diesem Vortrag diskutiert.

HL 50.6 Di 12:00 TU P-N201

Wachstum von Silizium Nanodrähten auf Si-(111)-Substraten mittels Molekularstrahlepitaxie — •Luise Schubert[1], Nikolai D. Zakharov[1], Gerald Gerth[1], Hartmut S. Leipner[2], Peter Werner[1] und Ulrich Gösele[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle (Saale) — [2]Martin-Luther-Universität, Abteilung Physik, Halle (Saale)

Nanodrähte aus Halbleitermaterialien werden zumeist mittels CVD (chemical vapour deposition) hergestellt. Dabei dienen kleine Metalltröpfchen auf der Substratoberfläche als Katalysatoren für den Wachstumsprozeß, welcher als VLS (vapour liquid solid)-Mechanismus in der Literatur beschrieben wird. Erste Arbeiten unserer Arbeitsgruppe zeigen, daß es ebenfalls möglich ist, Silizium-Nanodrähte auf der Basis der Molekularstrahlepitaxie (MBE) wachsen zu lassen. Diese Methode hat den Vorteil, daß diese Nanostrukturen unter sehr sauberen und kontrollierbaren Bedingungen gezüchtet werden können [1]. Das Wachstum der mittels MBE hergestellten Silizium Nanodrähte läßt sich jedoch nicht ausschließlich mit dem klassischen Modell des VLS-Mechanismus beschreiben. Die Experimente zeigen, daß neben thermodynamischen Wachstumsbedingungen zusätzlich Oberflächendiffusionsprozesse einen entscheidenden Einfluß auf die Ausbildung von Nanodrähten haben. Die Herstellung von entsprechenden Si/Ge-Heterostrukturen wird ebenfalls diskutiert.

[1] L. Schubert et al, Appl. Phys. Lett. 84, 4968-70 (2004)

HL 50.7 Di 12:15 TU P-N201

Paramagnetic Defects of Chemically Modified Silicon Nanowires — •A. Baumer[1], M. Loeb[1], M. Stutzmann[1], M.S. Brandt[1], F.C.K. Au[2], and S.T. Lee[2] — [1]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — [2]Center of Super-Diamond and Advanced Films & Department of Physics & Material Science, City University of Hong Kong, Hong Kong SAR, China

The paramagnetic defects of Si nanowires (SiNWs) obtained by oxide-assisted growth were studied by electron spin resonance spectroscopy. For the as-grown nanowires with a typical diameter of $10-15$ nm, three different defects were found: Dangling bonds or P_b-centers with $g = 2.0065$, located at the interface of the crystalline core to the surrounding oxide, E'-centers with $g = 2.0005$ and EX-centers with $g = 2.00252$, located in the oxide. For the EX-centers, the characteristic hyperfine lines separated by 16.4 G were detected. The as-grown Si nanowires showed a spin density of about $10^{11}\mathrm{cm}^{-2}$. H termination of the nanowires via hydrofluoric acid decreases the spin density drastically to $2 \cdot 10^{9}\mathrm{cm}^{-2}$. Further chemical modification of the H-terminated nanowires via hydrosilylation with alkenes provides alkyl-terminated nanowires as verified by Fourier-transform infrared-spectroscopy. The alkyl-terminated nanowires showed a spin density of about $10^{10}cm^{-2}$, which is stable for at least several weeks.

HL 50.8 Di 12:30 TU P-N201

Theoretical study of reaction pathways of the formation and decay of 1D nanostructures — •Karl-Heinz Heinig und Lars Röntzsch — Forschungszentrum Rossendorf, Dresden

Nanowires have fascinating properties. Also the kind and strength of driving forces for their structural evolution differ from macroscopic systems, thus opening new routes for their synthesis. And, with respect to interface energy, nanowires are unstable, during their decay new self-organized 1D structures evolve.

This presentation summarizes reaction pathways of the formation and decay of 1D nanostructures predicted by atomistic computer simulations. It will be shown that nanowire synthesis by phase separation from supersaturated 1D traces relies on different time scales of different processes involved: (i) phase separation is faster than long-range diffusion, thus, initially small nanodroplets form. (ii) Short-range diffusion is fast, thus, lateron the minority phase is concentrated/unified to a wire (ripening, coalescence). (iii) On a long time scale, the wire lowers its surface energy by peristaltic undulations and decays finally into large droplets (Rayleigh instability). Each process can be governed in order to fabricated functional structures. For instance, crosspoints of nanowires accelerates the wire instability locally, which leads to a nanodot separated by nm gaps from the four nanowires. Such a Si structure embedded in SiO_2 might operate as a room temperature single electron transistor.

HL 50.9 Di 12:45 TU P-N201

Switching between one and two dimensions: conductivity of Pb–induced chain structures on Si(557) — •C. Tegenkamp, Z. Kallasy, H.-L. Günter, V. Zielasek, and H. Pfnür — Institut für Festkörperphysik, Abteilung Oberflächen, Appelstr. 2, 30167 Hannover, Germany

The conductivity of epitaxially grown Pb–structures on Si(557) has been measured. Different characteristic transport mechanisms have been found: For coverages above the percolation limit(0.6ML) up to 3ML the electronic transport in the annealed Pb–films is activated. Furthermore, the uniaxial symmetry of the Si(557) surface is reflected directly in a higher conductance in the parallel direction compared to the direction perpendicular to the steps. For coverages higher than 3ML a metallic behavior is found for both directions, i.e. the conductance decreases with increasing temperature. In contrast, already one ML, but annealed to 640K, leads to the formation of atomic wires, as seen by STM, with an extremely high and quasi one–dimensional surface state conductance along the wire direction. At a critical temperature of T_c=78K, the system switches from low to high conductance anisotropy, with a metal–insulator transition in the direction perpendicular to the chain structure, while in the direction along the chains conductance with a (1/T +*const.*) temperature dependence was found. STM has shown further, that the 1D/2D transition is associated with an order–disorder phase transition of a 10-fold superperiodicity along the Pb chains.

HL 50.10 Di 13:00 TU P-N201

Leitende Ionenspuren in diamantartigem Kohlenstoff — •J.-H. Zollondz[1,2], D. Schwen[1], C. Trautmann[3] und H. Hofsäss[1] — [1]II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 — [2]Hahn-Meitner-Institut, Glienickerstr. 100, 14109 Berlin — [3]Gesellschaft für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt

Schwere Ionen (z.B. 1 GeV Uran oder auch 600 MeV Gold) erzeugen in diamantartigen Kohlenstoff-Filmen nanoskopische leitende Ionenspuren. Das Durchdringen des amorphen Materials mit schweren Ionenen führt zu einer strukturellen Änderung. Diese Änderung resultiert in leitenden Drähten mit 8 nm Durchmesser deren Leitfähigkeit um vier Grössenordnungen höher als die des umgebende Materials ist. Ergebnisse mittels Rasterkraft-Mikroskopie in Verbindung mit Stromkartierung und lokalen Strom-Spannungs-Charkeristiken werden vorgestellt, wobei die Variation der Ionenart als auch der Einfluss deren Ladungszustands untersucht wurde.

HL 50.11 Di 13:15 TU P-N201

Electrical Transport in GaN-whiskers — •Raffaella Calarco[1], Ralph Meijers[1], Thomas Richter[1], Ali Irfan Aykanat[1], Toma Stoica[1,2], Michel Marso[1], and Hans Lüth[1] — [1]Institute of Thin Films and Interfaces (ISG1) and CNI - Centre of Nanoelectronic Systems for Information Technology, Research Center Jülich, 52425 Jülich, Germany — [2]INCDFM, Magurele, POB Mg7, Bucharest, Romania

Among different types of nanostructures, semiconductor nanowires and nanotubes are extremely interesting as building blocks for nanoelectronics, due to their suitability for fabricating both nanoscale devices and interconnects. GaN whiskers are reproducibly grown by plasma assisted molecular beam epitaxy on Si(111). The nanocolumns density and diameter are controlled by means of the III/V ratio. The nanocolumns grow parallel to the [111] direction of the Si substrate. The whiskers have been released from the Si(111) substrate and deposited on a Si(100) host substrate covered with a layer of 400nm silicondioxide, finger shaped electrical leads (Ti/Au) are subsequently patterned on it. The electrical behavior of metal semiconductor metal, MSM Schottky barrier photodiode nanostructures is analyzed by means of current voltage measurements with and without UV illumination. The influence of the whisker diameter on the electrical properties has been analysed.