O 4 Nanostructures I

Time: Monday 11:15–13:00 Room: PHY C213

O 4.1 Mon 11:15 PHY C213

Self-Organized Titanium Oxide Nanotube-Layers:Formation and Applications — •Jan Macak and Patrik Schmuki — University of Erlangen Nuremberg, Dept. of Materials Science, LKO, Martensstr. 7, 91058 Erlangen, Germany

The presentation shows approaches to achieve electrochemical fabrication of self-organized high aspect ratio titanium oxide nanotubes. Key to obtain highly defined tubes is an optimized and controlled anodization of Ti in fluoride containing solutions. In general, the morphology of the tubular layers is affected strongly by the electrochemical parameters such as solution pH and anodization voltage. By optimizing the local electrochemical conditions within the tubes layers consisting of highly ordered TiO2 nanotubes with a length of several micrometers can be grown on Ti surfaces. The diameters that can be obtained range from 20 nm to 200nm * typical wall thicknesses are in the range of 10-20 nm. Except for the formation of the tubes also (potential) applications will be discussed. Titanium oxide is a highly functional material that has numerous interesting properties, for example, in solar energy conversion, catalysis of decomposition of organic compounds (self-cleaning), wettability and biocompatibility. Therefore this simple approach to produce this highly defined nanoscopic form of TiO2 bears a high potential for technological exploitation.

O 4.2 Mon 11:30 PHY C213

Metallic Multilayer $TiSi_2$ Nanocontacts — •Svend Vagt[1], Jan Rönspies[1], Tammo Block[1], Volkmar Zielasek[2], and Herbert Pfnür[1] — [1]Institut für Festkörperphysik, Universität Hannover — [2]Institut für Angewandte und Physikalische Chemie, Universität Bremen

For electrical investigations of nanosized structures, macroscopic contacts pads have to fullfil several prerequisites like low resitivity, chemical purity and inertness, a defect free substrate, and well defined boundaries. By MBE in an UHV-chamber, we produced a stack of alternating Si, Ti, and Si layers on a structured Si sample. After transport through air, an annealing step up to 750°C in UHV forms the highly conducting C54 crystal structure. The Si capping layer efficiently protects the underlying Ti layer against oxidation. Only low temperature annealing is then required afterwards for cleaning and oxide removal. Generation of a deep trench at the boundary of $TiSi_2$ and Si at the surface was avoided by a Si starting layer. Lateral diffusion of Ti into silicon, as shown by [1] for simple thin Ti pads on Si, is vital for the understanding of the contacting of nanostructures to the contactpads. We will compare our results of SAM, STM, and STS measurements of the pad boundaries of the multilayer silicide pads with [1], and discuss the requirements for contacting a one-dimensional electrically conducting system, and show as an example the contacting of Ag and Pb nanowires.

[1] Palermo et. al., Appl. Phys. Lett., Vol. 81, No.19, 2002

O 4.3 Mon 11:45 PHY C213

Atomic structure and electronic properties of self-assembled dysprosium-silicide nanowires on Si(001) — •Martina Wanke[1], Christian Preinesberger[1], Sylvia Hagedorn[1], Gerd Pruskil[1], Mario Dähne[1], Denis Vyalikh[2], Friedrich Schiller[2], Sergeij Molodtsov[2], and Clemens Laubschat[2] — [1]Institut für Festkörperphysik, Technische Universität Berlin, D-10623 Berlin — [2]Institut für Festkörperphysik, Technische Universität Dresden, D-01219 Dresden

We report on high-resolution scanning tunneling microscopy of the self assembly of dysprosium-silicide nanowires on planar and vicinal Si(001) surfaces. These nanowires have widths of 15 to 100 Å and lengths exceeding several 1000 Å. They are found to grow in two domains with different nanowire directions on different substrate terraces, which is related to the geometry of the dangling bonds at the Si(001)2x1 surface. This two-domain growth can be suppressed when the nanowires are prepared on vicinal Si(001) substrates with an angle of 4° in [110] direction.

Two types of such nanowires are formed depending on the preparation conditions. Using high-resolution scanning tunneling microscopy, the atomic structure of both nanowire types is derived. It is shown that anisotropic strain in combination with the Si(001) surface anisotropy is the driving force for nanowire formation.

Angle-resolved photoelectron spectroscopy on vicinal substrates shows an anisotropic metallicity of the nanowires. Thus these nanowires are an interesting model system für one-dimensional metallicity. This project was supported by DFG, project number DA 408/11.

O 4.4 Mon 12:00 PHY C213

Direct Growth of Mesoscopic Copper Wires by Electrodeposition — •Sheng Zhong[1,2], Thomas Koch[1,2], Harald Roesner[2], Horst Hahn[2], Eberhard Nold[3], Torsten Scherer[2], Mu Wang[4], Stefan Walheim[2], and Thomas Schimmel[1,2] — [1]Institute of Applied Physics, University Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institute of Nanotechnology (INT), Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany — [3]Institute for Materials Research I (IMF I), Forschungszentrum Karlsruhe, D-76021 Karlsruhe, Germany — [4]National Laboratory of Solid-State Microstructures, Nanjing University, Nanjing 21009, China

One-dimensional metallic nanowires have attracted considerable attention in recent years because of their potential use as interconnects in future generations of nanometer-scale electronics. For example, in the field of interconnects in electronics especially copper plays an important role. There are few methods to fabricate nanowires that are long, aligned, free standing and metallic. One of the most successful approaches to prepare metallic nanowires is the deposition of metal guided by appropriate templates. In this paper, a new method is demonstrated to self-assemble long, straight, free-standing and thin copper wires consisting of well-orientated single crystalline domains. The wires are directly reduced from copper sulfate solution in the presence of a direct current electric field without templates, surfactants and additives. We present a detailed study of the structure of these thin copper wires with a diameter down to 120 nm by SEM, FIB, TEM and SAMS.

O 4.5 Mon 12:15 PHY C213

Formation of a contacted nanobridge without micropatterning — •S. Wille[1], S. Wu[1], F. H. Gojny[2], M. H. G. Wichmann[2], B. Fiedler[2], K. Schulte[2], and R. Adelung[1] — [1]Lehrstuhl für Materialverbunde, Technische Fakultät der CAU Kiel, Kaiserstr. 2, 24143 Kiel, Germany — [2]Kunststoffe und Verbundwerkstoffe, Technische Universität Hamburg-Harburg (TUHH), Denickestr. 15, 21073 Hamburg, Germany

There are many applications for carbon nanotubes in research nowadays. In our approach we use double wall carbon nanotubes (DWCNTs) as a substrate. Starting with an epoxy-DWCNT composite, there are only a few steps to get a nanobridge structure, suitable for, e.g. a H_2-sensor. As first step, μm-scale channels were fabricated by etching the composite. These cracks were found to be bridged by the DWCNTs. The bridges themselves can be used as a substrate of a metal-nanostructure (e.g. Au, Pd). By evaporating under a small angle, we make use of the shadowing of the crack walls. This avoids a shortcut and covers simultanously the channels bridged by the DWCNTs with metal. The obtained metal tubes that form around the carbon nanotubes determine the conductivity of the ensemble. The details of the formation process will be discussed as well as possible applications.

O 4.6 Mon 12:30 PHY C213

Direct Observation of Individual Defects on Carbon Nanotubes by Dynamic Force Microscopy — •Makoto Ashino and Roland Wiesendanger — Institute of Applied Physics and Microstructure Research Center, University of Hamburg, Jungiusstr. 11, D-20355 Hamburg

Single-walled carbon nanotubes (SWNTs) have attracted much attention due to their unusual mechanical and unique electronic properties, which can provide great opportunity for fabricating nanoscale devices. Actual implementation of the SWNT devices demands a thorough understanding of the structural and electronic properties not only of perfect SWNTs but also of defective SWNTs because some kinds of defects are naturally included and can cause drastic changes of their properties. Recently, we have successfully achieved atomic resolution for imaging SWNTs by dynamic force microscopy (DFM) in ultrahigh vacuum and at low temperature [1]. The DFM, operated by the frequency modulation technique in non-contact regime, has enabled "true" atomic resolution for imaging non-periodic features and point defects. Here, we present atomic resolution imaging of individual defects in the SWNTs. As in the case of Ref. 1, we observed the SWNTs on a graphite substrate under feedback control to maintain a constant frequency shift of the cantilever oscillation with a constant amplitude operation. The images obtained suggest the existence of localized defects. Through detailed analysis of the image

contrasts, we will topologically characterize those defects.

[1] M. Ashino, *et al.*, Phys. Rev. Lett. **93**, 136101 (2004).

O 4.7 Mon 12:45 PHY C213

Innovative Quantum Devices based on C_{60} -Nanodots — •Oliver S. Senftleben, Tanja Stimpel-Lindner, Hermann Baumgärtner, and Ignaz Eisele — Institut für Physik EIT9.1, Universität der Bundeswehr München, 85577 Neubiberg

Thermal evaporation of pure C_{60} molecules is very suitable for the fabrication of new quantum devices. Observation of quantum effects like Coulomb-Blockade or coherent tunnelling can only be observed at room temperature if capacities are in the range of sub-atto-farad regime to exceed thermal noise. Hence the feasibility of extremely thin oxides as well as the behaviour of C_{60} under high temperatures (400-850°C) and oxygen atmosphere is of very high importance. Experiments have been performed in a UHV chamber to avoid any surface contamination during process and to allow in-situ process control with AES, LEED, STM and STS. Thermal oxidation of Si has been studied under several pressures (10^{-5} to 10^{-3} mbar) and temperatures (RT to 850°C). The experiments have shown that oxide-growth is possible up to a thickness of 2 nm. C_{60} films of different coverage have then been studied under these environmental conditions. C_{60} on pure Si shows no chemical reaction with oxygen up to 800°C und a pressure of 10^{-4} mbar. This has been verified by STM and AES. The behaviour of C_{60} on SiO_2 during annealing has been observed under UHV conditions and oxygen pressures up to 10^{-4} mbar. First experiments indicate a weaker binding of C_{60} to the SiO_2 than to the Si(100)-2x1 surface and therefore a higher desorption rate at elevated temperatures. Finally first STS results of C_{60} on UHV grown oxides are presented.