O 5: Nanostructures at Surfaces I (Wires, Tubes)

Time: Monday 11:15–12:45 Location: H36

O 5.1 Mon 11:15 H36

TiO_2 nanotubes, formation and properties — •Ghicov Andrei, Schmuki Patrik, Macak Jan, and Kunze Julia — WW4- LKO, University of Erlangen-Nuremberg, Martensstr.7, D-91058 Erlange

Electrochemically grown TiO_2 nanotubes represent a combination between a structure with a high effective surface area with numerous functional properties. The material has an adjustable crystalline structure (amorphous /anatase /rutile) which makes the ordered nanotube layers a candidate for even wider applications in different fields. The presentation will show how TiO_2 nanotubes can be grown on titanium substrates and how their geometry can be adjusted in desired ways by anodization parameters. The surface structure and - area are a key factors for wetting [1], biomedical [2], catalytic [3] and electronic [4] applications - some specific examples will be discussed.

References:

[1]. E. Balaur, J. M. Macak, L. Taveira, P. Schmuki, Electrochem. Commun, 7 (2005) 1066

[2]. H. Tsuchiya, M. Macak Jan, L. Muller, J. Kunze, F. Muller, P. Greil, S. Virtanen, P. Schmuki, J. Biomed. Mater. Res., Part A 77 (2006) 534

[3]. J. M. Macak, H. Tsuchiya, A. Ghicov, P. Schmuki, Electrochem. Commun, 7 (2005) 1133

[4]. R. Beranek, H. Tsuchiya, T. Sugishima, J. M. Macak, L. Taveira, S. Fujimoto, H. Kisch, P. Schmuki, Appl. Phys. Lett., 87 (2005) 243114

O 5.2 Mon 11:30 H36

Atomic-force microscopy investigations of semiconductor nanorods — Y. Hou[1], •C. Teichert[1], G. Brauer[2], A. Djurisic[3], V. Sivakov[4], R. Scholz[4], G. Andrä[5], and S. H. Christiansen[6] — [1]Institute of Physics, University of Leoben, Austria — [2]Institut f. Ionenstrahlphysik und Materialforschung, Forschungszentrum Rossendorf, Germany — [3]Department of Physics, University of Hong Kong, PR China — [4]Max Planck Institute of Microstructure Physics, Halle, Germany — [5]Institute of Physical High Technology (IPHT), Jena, Germany — [6]Physics Department, Martin-Luther-University Halle-Wittenberg, Germany

One-dimensional nanostructures, such as nanorods or nanotubes, exhibit technological potential for many device applications like electronic, photonic or sensing devices. However, achieving control on the growth of such nanostructures leading to proper dimensional confinement (nanorods diameter, length, density and orientation) is still a challenging task. So far, scanning electron microscopy and transmission electron microscopy are the methods of choice to characterize arrays of free standing semiconductor nanowires. Atomic force microscopy - at a first glance - might not be suited for such a task. Analyzing arrays of vertical ZnO nanorods grown on Si and ITO substrates and individual Si nanowhiskers grown by electron beam evaporation on Si(111), we demonstrate the capabilities of atomic-force microscopy to yield integral information for example on the height variation of the nanorod arrays as well as detailed information on the facet structure of the nanowhiskers.

O 5.3 Mon 11:45 H36

Topography and valencebandstructure of dysprosium-silicide on Si(557) — •Karolin Löser, Martina Wanke, Gerd Pruskil, and Mario Dähne — Institut für Festkörperphysik, Technische Universität Berlin, D-10623 Berlin

Rare Earth silicide structures on silicon are of special interest because of their extremely low Schottky barrier on Si(111) and the formation of nanowires on Si(001). Here we report on the self-assembled formation of dysprosium-silicide nanostructures on Si(557), which we investigated by high-resolution scanning tunneling microscopy and angle-resolved photoelectron spectroscopy. The formation of the different structures depends mainly on the dysprosium coverage less on the annealing temperature in the range of 600-750°C. Looking at the atomic structure we found three different types of nanostructures. Nanowires similar to those on Si(001) form for a coverage of 0.5 Å. At a coverage of 1,0 Å there is a 5×2-chain structure like that of Gd on vicinal Si(557). At higher coverages more than 3000 Å long and 50-100 Å wide structures form. These consist of $DySi_2$ with a 1×1 reconstruction for coverages around 2,0 Å, while they consist of $\sqrt{3} \times \sqrt{3}$ reconstructed $DySi_{1.7}$ for higher coverages. Both structures are known from the Si(111) surface. Our investigations by angle-resolved photoelectron spectroscopy verified these findings. The $DySi_2$ and $DySi_{1.7}$ structures are characterized by a two-dimensional electronic structure. In contrast, an anisotropic metallicity was found at low coverages for the nanowires and the 5×2-chain structure. This project was supported by DFG, project number DA 408/11.

O 5.4 Mon 12:00 H36

Plasmon dispersion in dysprosium silicide nanowires — •Eddy Patrick Rugeramigabo[1], Volkmar Zielasek[2], and Herbert Pfnür[1] — [1]Institut für Festkörperphysik, Leibniz-Universität Hannover — [2]Institut für Angewandte und Physikalische Chemie, Universität Bremen

By depositing Dy at around half monolayer coverage on single domain Si(001) surfaces miscut by 4° towards [110], we have grown $DySi_2$ nanowires in the submonolayer regime. Their plasmon spectrum has been studied by a combination of high resolution EELS and spot profile analysis of LEED in one instrument (ELS-LEED) which enables us to measure characteristic losses with high momentum resolution. Ultraclean conditions ($P \leq 1 \times 10^{-10}$ mbar during Dy deposition) allowed growth of high quality structures with minimal oxidation of Dy. Deposition of Dy at 500 °C results in the formation of single $DySi_2$ nanowires on each terrace, leaving the periodicity of the clean Si surface unchanged. In contrast, deposition at room temperature and subsequent annealing to 500°C reduces the average terrace width by up to 20%. Clearest results in EELS were obtained for a silicide layer with 0.4 ML of Dy deposited at 500°C. Broad loss features in the range between 0 and 1 eV with typical dipole characteristics were detected, their position being strongly dependent on momentum transfer. As expected these characteristic losses have no dispersion normal to the wires, while parallel to the wires the dispersion is non-linear and goes to zero at zero momentum transfer. Thus the typical behavior of one-dimensional surface plasmons is found.

O 5.5 Mon 12:15 H36

Two-dimensional Routing of Surface Plasmon Polaritons — •Liviu Chelaru and Frank Meyer zu Heringdorf — Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg

We investigated the excitation and propagation of Surface Plasmon Polaritons (SPPs) in single-crystalline Ag nanostructures of arbitrary shapes and sizes by photoelectron emission microscopy (PEEM). Here the photoelectrons are generated by femtosecond laser pulses through a nonlinear two-photon photoemission (2PPE) process. Under these conditions the SPP wave is visualized as a result of interference (beat pattern) between the primary laser pulse and the traveling SPP at the sample surface. We will show that the propagation length of the SPP wave depends on the size of the Ag nanostructures, and that it can extend for several micrometers along the surface. By comparing nanostructures of different geometry, we describe the guiding of the SPP wave, and the coupling of the light into and out of the nanostructures. Depending on the incidence angle of the propagating SPP wave on the nanostructure*s boundary, we observe either trapping of the SPP wave inside the metallic nanostructure or a photoemission yield enhancement in the vicinity of the nanostructure caused by the electric field of the SPP wave.

O 5.6 Mon 12:30 H36

In-situ preparation of contacts for metal nanostructures — •Svend Vagt, Tammo Block, Jan Rönspies, and Herbert Pfnür — Institut für Festkörperphysik, Leibniz Universität Hannover

For direct transport measurements on single ultrasmall structures leads are needed. We present different techniques for this purpose.

In a first attempt contact pads are prepared ex-situ via e-beam lithography and titanium evaporation, followed by annealing to about 1000K. This results in TiSi pads, that exhibit a good electrical conductance. However, to clean the Si areas between the pads, a flash temperature of 1400K is necessary, at which deep trenches are formed at the edges of the pad due to stress induced diffusion of Si into the TiSi pad. We present mulitilayer stacks of Ti and Si, that can be used to improve the situation.

Here we describe another method that completly avoids such step

bunches by flashing the silicon prior to the evaporation of Ti. This whole process has to take place completely in UHV. A few microns thin tungsten wire acts as a simple "shadow mask"and is removed after metal deposition. This leads to ultrathin, but still well conducting TiSi pads, that are stable up to 1000K. The penumbra of the wire also forms a ramp-like shape at the border of the pad and avoids the formation of deeper trenches. Between such contact pads metallic nanostructures are prepared by electron-beam stimulated thermal desorption of oxygen (EBSTD) from a ultrathin SiO_2 layer on the remaining Si(111) area. Subsequent metal deposition and annealing leads to metallic structures in electric contact with the pads.