O 76: Nanostructures at surfaces: Wires, tubes

Time: Thursday 15:00–17:15 Location: H38

O 76.1 Thu 15:00 H38

Tuning Ag nanowire growth on Cu(110) based templates — •Thorsten Wagner, Thomas Brandstetter, and Peter Zeppenfeld — Johannes Kepler University Linz, Institute of Experimental Physics, Austria

The Cu(110) surface can be readily structured by adsorbing oxygen: If the coverage of oxygen is less than required to form a complete (2×1) overlayer, CuO stripes are formed which are separated by bare copper areas. These stripes are regularly arranged and parallel to the [001] direction. On such an oxygen pre-covered surface silver was adsorbed at 660 K. As revealed by scanning tunneling microscopy, submonolayer silver coverages lead to a phase separation between CuO and a Ag/Cu alloy [1]. The original Cu-CuO stripe phase is destroyed and larger CuO areas ('ponds') are formed. The ponds are separated by Ag rich stripes which are again parallel to the [001] direction. These template surfaces can be used to manipulate the further growth of Ag nanowires at 300 K. Since on our template, the nanowires grow only on the Ag rich stripes, their extension along the $[1\bar{1}0]$ direction is limited by the width of these stripes. By carefully choosing the parameters for the preparation of the template, one can even produce Ag nanowires which are aligned along [001] direction, which is perpendicular to the natural extension of Ag nanowires on pure Cu(110).

[1] Brandstetter *et al.*, Surf. Sci. **603**, 3410-3413 (2009)

O 76.2 Thu 15:15 H38

Morphology and electronic properties of Co nanorods on Cu(110)-p(2x3)N — •Sebastian Wedekind[1], Fabio Donati[1,2], Hirofumi Oka[1], Guillemin Rodary[1], Dirk Sander[1], and Jürgen Kirschner[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany — [2]NEMAS, Politecnico di Milano, Milano, Italy

Copper nitride systems are of high current interest in nanoscience as they offer a venue towards decoupling the electronic properties of nanostructures or adatoms from those of the substrate. We have prepared a Cu(110)-p(2x3) (Cu_3N) substrate by N-ion bombardment (600 eV, 30 min, 550 K) of clean Cu(110) [1]. Deposition of Co leads to the formation of several ten nm long Co wires, extending along [1-10]. Our scanning tunneling microscopy and spectroscopy studies at 8 K reveal the positions of all atoms within the rectangular surface unit cell, where we measure unit vectors of 1.094 and 0.502 nm for the Cu_3N structure. Surprisingly, spectroscopy on clean Cu_3N and on Co nanowires on Cu_3N shows very similar results. No special spectroscopic features are identified near the Fermi energy, but peaks at +1.8 and +3.5 eV of presently unknown electronic character of the unoccupied sample states are observed for both Cu_3N and Co/Cu_3N. This suggests a rather strong electronic coupling between substrate and nanowire, questioning the electronic decoupling between this copper nitride system and nanostructures deposited on top. [1] X. Ma, D. Bazhanov, O. Fruchart, F. Yildiz, T. Yokoyama, M. Przybylski, V. Stepanyuk, J. Kirschner, Phys. Rev. Lett. **102** (2009) 205503.

O 76.3 Thu 15:30 H38

Potentiometry measurements of Pb wires on vicinal Si(557) produced by electron-beam stimulated thermal desorption of oxygen — •Jan Rönspies and Herbert Pfnür — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstr. 2, 30167 Hannover, Germany

We explored the structural limits of unconventional electron beam lithography by directly writing with an electron beam into ultra-thin SiO_2 films. These bare silicon window structures are suitable for growing contiguous metallic nanowires with a thickness of a few monolayers. The Auger excitation process necessary for electron-beam stimulated thermal desorption of oxygen (EBSTD) allows generation of single wire structures between two macroscopic metallic contact pads. The prepared line was filled with Pb and by subsequent processing steps a wetting layer remains inside the wire structure. Applying this combination of processes to a regularly stepped $Si(557)$ sample which consists of a periodic array of small (111) and (112) oriented mini-facets with an average periodicity of $5.7nm$ normal to the steps, line widths close to the resolution of the electron microscope of $5nm$ were obtained. Using a STM tip and the macroscopic pads in a potentiometric geometry we were able to identify the quantized nature of ultrasmall structures and their conductance behavior over a range of a few micrometers. These uncovered structures with lateral dimensions down to $10nm$ were analyzed further by potentiometry using scanning tunneling microscopy. We found a significant potential drop in the order of $200\mu V/nm$ at step sites which are probably related to contact resistance.

O 76.4 Thu 15:45 H38

STM induced electroluminescence from individual CdSe nanowires — •Theresa Lutz[1], Alexander Kabakchiev[1], Thomas Dufaux[1], Christian Wolpert[1], Marko Burghard[1], Klaus Kuhnke[1], and Klaus Kern[1,2] — [1]Max Planck Institute for Solid State Research, Stuttgart — [2]Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Scanning tunneling microscopy (STM) not only provides the ultimate tool to obtain atomic scale information in both topographic and spectroscopic measurements at surfaces, but can also be employed to stimulate local photon emission. Here we show STM induced luminescence on individual semiconducting CdSe nanowires in combination with topographic and tunneling spectroscopic measurements at liquid He temperature. We investigate individual CdSe nanowires[1] with average diameters of 8 nm to 22 nm deposited onto a gold surface. The generated luminescence is ascribed to electron-hole recombination in the wire and requires hole injection from the STM-tip in excess of several hundred meV above the luminescence energy. The luminescence spectra are similar to the ones obtained in photoluminescence. Interestingly, the STM-induced luminescence is found even in the absence of tip-induced plasmonic emission, which stands in contrast to studies on similar systems in which light emission and plasmon observation seem to be coupled. We find that the energy of the emission line depends on the diameter of the wire as expected for quantum confinement of the charge carriers to one dimension.

[1] Z. Li et al., Small 4, 1698-1702 (2008)

O 76.5 Thu 16:00 H38

Ab-initio studies of Au-induced atomic wires on Ge(001) — •Simeon Sauer[1,2], Frank Fuchs[1], Friedhelm Bechstedt[1], Christian Blumenstein[3], and Jörg Schäfer[3] — [1]Institut für Festkörpertheorie und -optik, Universität Jena, D-07743 Jena — [2]Physikalisches Institut, Universität Freiburg, D-79104 Freiburg — [3]Physikalisches Institut, Universität Würzburg, D-97074 Würzburg

Au-induced atomic wires on Ge(001) are a promising model system to study the physics of one-dimensional electron liquids [1]. However, the results of scanning tunneling microscopy (STM) experiments do not permit to unambiguously determine the arrangement of surface atoms. Several questions remain unresolved: Are the observed protrusions formed by Au atoms only or do they incorporate Ge as well? What is their absolute height?

Therefore, we theoretically investigate possible atomic geometries of the surface in the framework of density functional theory. For each model, features like surface energy, STM images, and band structure are calculated. The computed properties are compared to experimental data and used to evaluate the different models. Due to the large variety of possible geometries no final statement about the atomic structure of the surface can be made. However, the calculations give good indications towards the correct geometry, e.g. ruling out models proposed in literature or identifying stabilizing building blocks [2].

[1] J. Schäfer et al., Phys. Rev. Lett. 101, 236802 (2008).

[2] S. Sauer, F. Fuchs, F. Bechstedt, C. Blumenstein, and J. Schäfer, submitted for publication.

O 76.6 Thu 16:15 H38

Is Au/Ge(001) a model system for a 1D Electron Liquid? — Arie van Houselt, Daan Kockmann, Tijs Mocking, Bene Poelsema, and •Harold Zandvliet — MESA+ instute for Nanotechnology and University of Twente, Enschede, The Netherlands

Recently it has been claimed that the Au induced nanowires on Ge(001) represent an outstanding case for a one-dimensional electron liquid [1]. Here we show, based on the data of the authors of ref. [1], that the differential conductivity of the Au induced nanowires and the troughs between the nanowires are comparable in magnitude [2]. Therefore, this system cannot be considered as a model system for a one-dimensional electron liquid [2-4].

[1]. J. Schäfer et al. Phys. Rev. Lett. 101, 236802 (2008). [2].

A. van Houselt et al. Phys. Rev. Lett. 103, 209701 (2009). [3]. D. Kockmann, A. van Houselt, T.F. Mocking, B. Poelsema and H.J.W. Zandvliet, Journal of Physical Chemistry C 113, 17156 (2009). [4]. K. Nakatsuij, R. Niikura, Y. Shibata, M. Yamada, T. Iimori and F. Komori, Phys. Rev. B 80, 0814069R (2009).

O 76.7 Thu 16:30 H38

Temperature-dependent Study on the Superstructure of Atomic Gold Nanowires on Ge(001) — •Christian Blumenstein[1], Jörg Schäfer[1], Sebastain Meyer[1], Ralph Claessen[1], Sbeastian Mietke[2], and Rene Matzdorf[2] — [1]Experimentelle Physik 4, Universität Würzburg, 97074 Würzburg, Germany — [2]Fachbereich Naturwissenschaften, Universität Kassel, 34132 Kassel, Germany

Self-organized atomic nanowires on semiconductor surfaces form ideal model systems for the study of physics in low dimensions. A lot of research has been conducted on the Au induced reconstructions on Si(111) and its vicinal surfaces. These wires have been discussed in terms of a Peierls-distorted state at low temperature. A relatively high transition temperature for this charge density wave (CDW) points at a significant coupling between the chains. The recently discovered Au/Ge(001) nanowires can serve as an alternative system to question the origin of the low-temperature structure. They grow in a regular c(8x2) reconstruction and cover the whole sample surface. Their lateral confinement reaches the atomic limit, while the separation between the wires is several Ge lattice constants. Therefore these exceptionally narrow chains represent a new playground for 1D physics. The talk will address the structural elements of the Au/Ge(001) chains, which have been investigated by Low Energy Electron Diffraction and Scanning Tunneling Microscopy over a wide temperature range. Special attention will be paid to superstructure periodicities and their relation to a possible CDW.

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Structural and electronic properties of the Bi:Si(001) Haiku reconstruction. — •Sigrun A. Köster[1], James H. G. Owen[1], François Bianco[1], Daniel Mazur[1], David R. Bowler[2], and Christoph Renner[1] — [1]Université de Genève, Section Physique/DPMC, Quai Ernest-Ansermet 24, 1211 Genève 4, CH — [2]London Centre for Nanotechnology (LCN), University College London, UCL 17-19 Gordon Street, WC1H 0AH, London, UK

There is substantial interest in probing the physical properties of low dimensional systems motivated by the interest in fundamental physics of these systems but also for the development of increasingly small technological devices. Self-assembled bismuth nanolines appear when Bi is deposited onto the Si(001) surface and subsequently annealed [1]. They can reach one micrometer in length and their width is fixed at 1.54 nm owing to the complex underlying Si reconstruction known as the Haiku structure [2]. Exposing the Bi-nanolines to atomic H, we were able to strip off the Bi from the nanoline and expose for the first time the Haiku structure. We present a detailed spectroscopic and structural characterization of the Bi-nanoline and the Haiku using scanning tunneling microscopy and spectroscopy. These results are in excellent agreement with theoretical modelling of the nanowire.

[1] J. H. G. Owen, K. Miki, and D. R. Bowler, J. Mater. Sci. 41, 4568 (2006) [2] J.H.G.Owen, K.Miki, H.Koh, H.W.Yeom and D.R.Bowler, Phys. Rev. Lett. 88, 226104 (2002)

O 76.9 Thu 17:00 H38

Production and electrical properties of nanostructures on graphite surfaces — •Lukas Patryarcha[1], Stefan Balk[1], Karl Bauer[1], Axel Rudzinski[2], Lars Bruchhaus[2], and Heinz Hövel[1] — [1]TU Dortmund, Experimentelle Physik I — [2]Raith GmbH, Dortmund

A Focused Ion Beam (FIB) of Ga^+ ions with 25 keV kinetic energy was used to produce defects in a graphite (HOPG) crystal up to a depth of about 50 nm. Subsequently carbon atoms at the defect positions were oxidized in an Ar/O_2 atmosphere and released from the bulk. Using the ionLiNE FIB instrument (Raith GmbH) bars with different width, length and artificial breaks at different positions were isolated from the surrounding crystal and investigated with STM and AFM. The current distribution in the conductive bars was simulated by an array of discrete resistors. The results of the simulations are planned to be compared to a four tip nanoprobe experiment. Nanostructures with specific electrical properties can be designed on HOPG surfaces if the current distribution is localized sufficiently to the bars.