O 5: Nanostructures at surfaces: Wires, tubes

Time: Monday 11:15–13:00 Location: SCH A215

O 5.1 Mon 11:15 SCH A215

Playing pinball with atoms — •Amirmehdi Saedi, Arie van Houslet, Raoul van Gastel, Bene Poelsema, and Harold Zandvliet — University of Twente, Enschede Netherlands

The feasibility of controlling an atomic scale mechanical device by an external electrical signal has been demonstrated [1]. On a Pt modified Ge(001) surface, a switching motion of pairs of dimers is induced by electrons that are directly injected into the atoms with a scanning tunneling microscope tip. By precisely controlling the tip current and distance we make two atom pairs behave like the flippers of an atomic-sized pinball machine. This atomic scale mechanical device can reside in six different configurations which enables the system to exhibit up to five distinct flipping modes.

[1]. A. Saedi, A. van Houselt, R. van Gastel, B. Poelsema and H.J.W. Zandvliet, accepted for publication in Nano Lett.

O 5.2 Mon 11:30 SCH A215

High temperature growth of Ag-nanowires on bare Si(001) — •Simon Sindermann, Dirk Wall, Michael Horn-von Hoegen, and Frank-Joachim Meyer zu Heringdorf — Department of Physics and Center for Nanointegration Duisburg-Essen

Self-organized Ag-islands on bare Si(001) grow in various shapes. Amongst others, quasi 1-dimensional nanowires can be observed with a fixed width of a few hundred nanometers while their length can expand up to tens of micrometers. To specify the conditions and processes leading to nanowire-formation, the growth was examined at elevated temperatures (800K - 1000K) by Photo-Emission Electron Microscopy (PEEM). From the experimental data we determined the ratio of the number of nanowires over the number of all other islands and observed that this ratio increases exponentially with an activation energy of about 1.4eV [1]. Another important parameter to nanowire-growth is the vicinality of the surface. On 4° vicinal samples all nanowires are aligned along the step edges in $[1\bar{1}0]$ direction, whereas we find nanowire in two directions ([110] and $[1\bar{1}0]$) on flat Si(001). Due to previous experimental results, this observation can be explained by the anisotropy of diffusion which increases quickly from 0° to reach the maximum at 4° [2].

[1] D. Wall, S. Sindermann, M. Horn-von Hoegen, and F.-J. Meyer zu Heringdorf; J. P.:Cond. Matt. (submitted)

[2] D. Wall, K. R. Roos, M. Horn-von Hoegen, and F.-J. Meyer zu Heringdorf; Mater. Res. Soc. Symp. Proc. 1088E; 1088-W05-04 (2008)

O 5.3 Mon 11:45 SCH A215

Self-Organized Atomic Gold Nanowires on Ge(001) Revealed by Scanning Tunneling Microscopy — •Christian Blumenstein, Sebastian Meyer, Jörg Schäfer, and Ralph Claessen — Physikal. Institut, Universität Würzburg, 97074 Würzburg

Atomic nanowires have become objects of intense research, as they host a wealth of physical phenomena not encountered in three-dimensional solids. They are synthesized by self-organization of metal adatoms on suitable semiconducting substrates that guide chain formation. Thus far, examples for quasi one-dimensional (1D) systems have been found where the Fermi surface hosts a charge density wave (CDW). This can be observed below room temperature in systems on Si(111) or high-index variants thereof. However, the ease of CDW condensation points at still significant coupling to the second dimension. In the search for better defined 1D systems, we have identified self-organized Au-induced chains on Ge(001) which grow in a long-range $c(8 \times 2)$ phase and exhibit metallic behavior. In using scanning tunneling microscopy, we find that the wires are spaced by several Ge lattice constants, while their electron density is strictly confined laterally [1]. In turn, the metallic charge cloud is spread out very evenly in chain direction, as seen for a large range of bias values. Such exceptional degree of confinement may open a pathway to study non-Fermi liquid physics. The talk will review the various structural ingredients of this exceptional 1D electron system.

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

O 5.4 Mon 12:00 SCH A215

Magnetism versus formation of transition-metal chains in break junctions — •Alexander Thiess[1,2], Yuriy Mokrousov[1,2], Stefan Heinze[2], and Stefan Blügel[1] — [1]Institut für Festkörperforschung and Institute for Advanced Simulation, Forschungszentrum Jülich, 52545 Jülich, Germany — [2]Institute of Applied Physics, University of Hamburg, 20355 Hamburg, Germany

One of the pressing issues in break junction (BJ) experiments is the experimental search for evidence of magnetism in suspended monoatomic transition-metal (TM) chains [1]. Our strategy to tackle this question is a theoretical analysis of the most fundamental and transparent quantity of these systems: the probability for successful chain creation itself. On the basis of *ab initio* calculations both including and excluding spin-polarization of 3*d*, 4*d* and 5*d* TM chains we developed a model describing chain formation in BJs [2]. Contrasting the different probabilities of forming non-magnetic or magnetic chains, we find that emerging magnetism suppresses the tendency to chain formation. Comparing our results to existing experiments may serve as a proof that even 5*d* chains in BJs are magnetic.

[1] C. Untiedt, D.M.T Dekker, D. Djukic, J.M. van Ruitenbeek, Phys. Rev. B **69**, 081401 (2004)

[2] A. Thiess, Y. Mokrousov, S. Blügel, S. Heinze, Nano Letters **8**, 2144 (2008)

O 5.5 Mon 12:15 SCH A215

Dysprosium silicide nanowires on Si(557) — •Martin Franz[1], Martina Wanke[1], Matthias Vetterlein[1], Gerd Pruskil[1], Christopher Prohl[1], Britta Höpfner[1], Florian Genz[1], Petar Stojanov[2], Eric Huwald[2], John Riley[2], and Mario Dähne[1] — [1]Institut für Festkörperphysik, Technische Universität Berlin, D-10623 Berlin, Deutschland — [2]School of Physics, La Trobe University, Bundoora, VIC 3086, Australia

The structural and electronic properties of self-assembled nanowires on the Si(557) surface have been studied using scanning tunneling microscopy (STM) and angle-resolved photoemission spectroscopy (ARPES) using a toroidal electron analyser. The Si(557) surface is a vicinal Si(111) surface with a miscut angle of 9.5° that facets into (111) and (112) terraces. Different types of nanowires are grown depending on the Dy coverage. At submonolayer coverages, thin semimetallic nanowires with one-dimensional band structure are grown. In contrast, the nanostructures forming at monolayer and multilayer dysprosium coverages exhibit a very different behavior. At these preparation conditions broad nanowires are grown on the Si(111) facets of the Si(557) surface, consisting of $DySi_2$ in the monolayer case and Dy_3Si_5 in the multilayer case. A two-dimensional metallic band structure is observed which is similar to the corresponding ones of the dysprosium silicides on Si(111). This project was supported by the DFG, project number Da 408/11.

O 5.6 Mon 12:30 SCH A215

Silicon overgrowth of rare earth silicide nanowires on Si(001) — •Matthias Vetterlein, Martina Wanke, Martin Franz, and Mario Dähne — Institut für Festkörperphysik, Technische Universität Berlin, D-10623 Berlin, Deutschland

The overgrowth of rare earth silicide nanowires on the Si(001) surface by silicon has been investigated by STM. Free standing broad silicide nanowires present interesting properties such as a one-dimensional metallicity along the wires. Due to this metallicity the self assembled nanowires may be used e.g. as nano-interconnects in advanced chipdesigns. To prevent oxidation and destruction of the nanowires under ambient conditions a suitable capping is required. For this purpose, silicon is an ideal capping material because of its perfect lattice match with the substrate. To the best of our knowledge we present for the first time silicon capping experiment of rare earth silicide nanowires. Our STM results show that capping with small amounts of silicon does not destroy the wires. After further annealing the wires are still present under the silicon cap layer. This indicates the feasibility of nanowire capping by silicon. This project was supported by the DFG, project number Da 408/11.

O 5.7 Mon 12:45 SCH A215

Periodic LDOS modulations in self-organized bi-atomic chains — •Matthias Menzel, Kirsten von Bergmann, André Kubetzka, and Roland Wiesendanger — Institut für Angewandte

Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

The (5×1)-reconstructed Ir(001) surface is an ideal template for the self-organized formation of one-dimensional nanostructures [1]. In this reconstruction, which exists in two rotational domains, the topmost layer forms trenches along the ⟨110⟩-directions of the surface. We used this property of the surface to grow bi-atomic Fe chains at room temperature which we investigated by means of low temperature scanning tunneling microscopy (STM) and spectroscopy (STS).

In maps of the differential conductance ($\mathrm{d}I/\mathrm{d}U$), which is proportional to the local density of states (LDOS), the Fe chains exhibit various different periodic modulations of the LDOS along the chain axis. Those oscillations are commensurate with respect to the atomic distance in the Fe chains and we observe modulations of two, three and four times the atomic distance. The modulations are found to be non-dispersive in energy and they do not depend on the chain length.

[1] L. Hammer *et al.*, Phys. Rev. B, **67**, 125422 (2003)