# DS 29: Nanoengineered Thin Films

Time: Thursday 18:00–19:30 Location: H 2013

DS 29.1 Thu 18:00 H 2013

**Glancing angle deposited Si nanostructures on differently patterned substrates** — •Christian Patzig[1], Bernd Rauschenbach[1], and Bodo Fuhrmann[2] — [1]Leibniz Institute of Surface Modification, Permoserstraße 15, 04318 Leipzig, Germany — [2]Martin-Luther-Universät Halle, Heinrich-Damerow-Straße 4, 06120 Halle, Germany

The glancing angle deposition (GLAD) process is a sophisticated vacuum deposition method that allows for the growth of arbitrarily shaped, 3D structures on the nm scale. When the substrate is tilted during deposition in a way that the incoming particle flux strikes it under an highly oblique angle $\beta$ (typically $\beta > 80°$ as measured to the substrate normal), self-shadowing conditions on the substrate surface lead to the growth of non-closed films, that consist of needles which are slanted towards the incoming flux of sputtered particles. In addition with an appropriate substrate rotation mechanism, different structures such as zigzags, vertical posts, spirals or screws can be sculpted. Here, the growth of Si nanostructures on bare Si substrates as well as on differently patterned substrates (electron beam lithography prepatterned, nano sphere lithography pre-patterned) will be shown, and the influence of the periodicity and form of the used pattern on the growth of the structures will be discussed.

DS 29.2 Thu 18:15 H 2013

**Nano pinhole lithography for the fabrication of complex lateral structure arrays** — •Nadine Geyer, Huang Cheng, Bodo Fuhrmann, Frank Syrowatka, and Hartmut S. Leipner — Interdisziplinäres Zentrum für Materialwissenschaften, Martin-Luther-Universität, 06099 Halle (Saale), Germany

This work demonstrates the function of nano pinhole lithography. In this novel technique the image written by an atom-emitting arbitrary shaped macro-sized evaporation source is projected to the nm scale using the principle of a pinhole camera. For this purpose, regular arrays of pinholes are fabricated by modification of hexagonally closed packed monolayers of monodisperse polystyrene spheres. Thermal treatment of the layers yields nearly circular shaped voids between these spheres having uniform diameter and distance to the target substrate. Imaging is realized in a high vacuum thermal evaporation system, where the substrate with the pinhole mask is placed opposite to atom-emitting objects, which were in our approach bend tungsten wires of different shapes and electroplated with nickel. By using polystyrene spheres of different radii, the projection scale could be varied. Scales up to 1:100 000 and images with minimum line widths of $< 50$ nm could be obtained.

DS 29.3 Thu 18:30 H 2013

**Self-assembled Fe nanowires on (2x3)N-induced Cu(110) surface** — •Xiaodong Ma[1], Dmitri Bazhanov[1], Fikret Yildiz[1], Marek Przybylski[1], Valeriy Stepanyuk[1], Toshihiko Yokoyama[2], and Jürgen Kirschner[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Institute for Molecular Science, Okazaki, 444-8585 Aichi, Japan

Nanometer-scale structures are of a great interest due to their potential applications in electronics. They can be grown on reconstructed (110) surfaces. A single layer of a copper nitride template was prepared on a single-crystalline Cu(110) surface by bombardment of nitrogen at elevated temperature. Room temperature scanning tunneling microscopy (STM) images with atomic resolution have clearly revealed a surface reconstruction showing a regular (2x3) periodicity, which was also confirmed by the low energy electron diffraction (LEED) pattern. After depositing Fe by molecular beam epitaxy (MBE) on the (2x3)N/Cu(110) template Fe nanowires were formed. STM images of the nanowires show their orientation along the [1-10] direction with a uniform width of 1.08 nm (which corresponds to three atomic distances along the [100] direction) and of monolayer height. The minimum separation distance between the nanowires is found to be exactly twice the periodicity of the template along [100]. When the coverage increases to a value above 0.5 ML double layer nanowires start form. *Ab initio* calculations were performed in order to understand the template reconstruction and the principles of the nanowire growth behaviour.

DS 29.4 Thu 18:45 H 2013

**Metal nanostructure matrices through laser-patterning of thin films using phase mask projection** — •Marisa Mäder[1], Jürgen Gerlach[1], Thomas Höche[1], Michael Lorenz[2], Marius Grundmann[2], and Bernd Rauschenbach[1] — [1]Leibniz Institute of Surface Modification, Permoserstraße 15, 04318 Leipzig, Germany — [2]Universität Leipzig, Institut für Experimentelle Physik II, Abteilung Halbleiterphysik, Linnéstraße 5, 04103 Leipzig, Germany

Metallic nanostructures feature a wide range of possible applications. Especially within the area of nanowire growth, well ordered matrices of substrate-bound metallic structures are qualified as catalysts. Furthermore, applications as biosensors, for surface enhanced Raman effect-driven phenomena, and for optical data transfer are conceivable. This paper presents very well ordered metal nanostructure matrices that are made by an interference technique called diffraction mask projection laser ablation. A thin metal film (Au, Ni, Ti, and others) is illuminated by a laterally varying laser intensity pattern. The pattern is created by phase mask projection and four-beamlet interference of an Excimer laser (KrF, 248 nm, 30 ns). The pattern is demagnified to nanoscales by passing a Schwarzschild objective. The film is removed from the substrate at positions of high laser intensities. The remaining film material melts and forms structures of minimized surface energy at the positions of the heat sinks. It is shown that nanodots-matrices (Au, Ni) as well as nano-gratings (Ti) form under different conditions. Additional, results of 3D-nanostructure growth using templates prepared by this technique are presented.

DS 29.5 Thu 19:00 H 2013

**Physico-chemical Properties of Metal-Polymer Nanocomposite Films near the Percolation Threshold** — •Vladimir Zaporojtchenko, Haile Takele, Christian Hanisch, Amit Kulkarni, Thomas Strunskus, and Franz Faupel — Chair for Multicomponent Materials, Technical Faculty of the CAU Kiel, Kaiserstrasse 2, D-24143 Kiel, Germany

The present talk reviews properties of metal-polymer nanocomposite films (MPNF) with high volume fractions of metal nanoparticles close to the percolation threshold. In this regime, the DC electrical conductivity and the permittivity are extremely sensitive to the nanoparticle concentration and separation. The morphology of the nanocomposites (particle size and distribution) prepared by PVD methods depends on the properties of the selected polymer and metal as well as on the preparation parameters, i.e. deposition rate and substrate temperature. As a consequence, a percolation threshold in the conductivity was observed at different critical metal concentrations ranging from 15 to 40 vol. %. It is demonstrated also that the optical, electrical and chemical properties may be varied widely close to percolation. Thus the index of refraction can be tuned over a wide range and surface plasmons, occurring for noble metals in the visible range, can be shifted to the infrared region. MPNF chemical sensors are based on the swelling of the polymer matix in the presence of organic vapors. Moreover, new polymer-metal composites with photochromic properties will be presented.

DS 29.6 Thu 19:15 H 2013

**Electrical characterization of conducting ion tracks in insulating tetrahedral amorphous carbon** — •Hans-Gregor Gehrke[1], Anne-Katrin Nix[1], Johann Krauser[2], Christina Trautmann[3], and Hans Hofsäss[1] — [1]II. Physikalisches Institut Göttingen, Germany — [2]Hochschule Harz, Wernigerode, Germany — [3]Gesellschaft für Schwerionenforschung, Darmstadt, Germany

We investigated the formation and the electrical characteristics of quasi one-dimensional conducting tracks in tetrahedral amorphous carbon (ta-C) produced by swift heavy ion irradiation. The ta-C films with thicknesses of about 100 nm were created with mass-separated ion beam deposition (MSIBD) on highly conducting silicon substrates with a deposition energy of 100 eV yielding into a $sp^3$ bond fraction of approximately 80%. The films were irradiated afterwards with 1 GeV $^{238}U$ ions with fluences between $10^8$ and $10^{11}$ ions/cm$^2$. The high electronic energy loss of about 30 keV/nm of the swift heavy ions graphitizes the film locally along the ion trajectory. Thus, conducting nanowires embedded in an insulating matrix were achieved. The presence of the tracks could be confirmed with atomic force microscopy (AFM) using a conducting cantilever and applying a bias voltage. The conductance of the tracks is several orders of magnitude higher than that of the surrounding matrix. Temperature depended electrical characterization (300 K - 15 K) were performed on track ensembles with special focus on improving the contact pads.