DS 10: Surface Modification

Time: Tuesday 11:00–12:45 Location: GER 37

DS 10.1 Tue 11:00 GER 37

Interface modification by fluorinated aromatic SAMs — •Christian Schmidt and Gregor Witte — Philipps-Universität Marburg

One of the key issues of organic electronic devices is a precise control of metal-organic heterojunctions. Recently, Gundlach et al. demonstrated that pre-treatment of Au-electrodes with pentafluorobenzenethiol (PFBT) largely improves device characteristics of difTESADT based OTFTs [1] which was attributed to enhanced crystal growth and a lowering of injection barrier. However, our previous works revealed only a poor ordering for benzenethiol-SAMs (BT) [2] which becomes even worse for PFBT. Motivated by this apparent contradiction, we investigated the adsorption of the differently fluorinated aromatic thiol based SAMs (benzenethiol, p-fluoro-BT, p-trifluoromethyl-BT and PFBT) on the model substrate Cu(100) which provides well ordered films. By combining various techniques including LEED, UPS, NEXAFS and TDS the microstructure of the films and their influence on the work function have been thoroughly studied and will be discussed.

[1] D. J. Gundlach et al., nature materials, 7, 216 (2008)

[2] D. Käfer, A. Bashir and G. Witte, JPC C, 111, 10546 (2007)

DS 10.2 Tue 11:15 GER 37

Fundamentals of surfactant sputtering — •Hans Hofsäss and Kun Zhang — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-PLatz 1, 37077 Göttingen, Germany

We introduce a new, versatile sputter technique, utilizing the steady state coverage of a substrate surface with up to 10^{16} cm^{-2} of foreign or self atoms simultaneously during sputter erosion by combined ion irradiation and atom deposition. These surfactant atoms strongly modify the substrate sputter yield on atomic to macroscopic length scales. The sputter yield can be attenuated in a controlled way from the value of the pure substrate down to zero or even to negative values (growth). Depending on the surfactant-substrate combination, the technique allows enhanced smoothing of surfaces, the generation of surface patterns and nanostructures and shaping of surfaces. The new method may be comparable to ion beam assisted deposition operated beyond the resputtering limit. In this contribution we present examples of surface morphology evolution, smoothing and shaping and shaping of surfaces using surfactant sputtering and we describe analytical and numerical approaches to predict the sputter yield attenuation and the steady state surface coverage. Experiments were done with 5 keV Xe ions at variable incidence angle and fluences up to 10^{18} cm^{-2}. Sputter yield attenuation is demonstrated for sputtering of Si, SiO_2, a-C and Fe with different surfactant species. We analyze in detail sputtering of Si under the influence of Au surfactants, leading to a steady state buried Au silicide layer and enhanced surface smoothing.

DS 10.3 Tue 11:30 GER 37

Importance of internal ionbeam parameters on the self-organized pattern formation withlow-energy broad beam ion sources — •Marina Cornejo, Bashkim Ziberi, Michael Tartz, Horst Neumann, Frank Frost, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung (IOM), Permoserstrasse 15, D-04318Leipzig, Germany

Self-organized pattern formation during low energy ion beam erosion of solid surfaces is a simple bottom-up approach for the generation of nanostructures. Using broad beam sources, large-area nanostructured surfaces can be produced in a cost-efficient single-step process. A critical parameter for the patterning with ion beams is the ion beam incidence angle. However, inherent to all broad beam sources, the ion beam exhibits a certain divergence. This generates a spread of the local incidence angle with respect to the geometrically defined beam incidence angle. Recent studies showed that the divergence angle and angular distribution of the ions, here called internal beam parameters, also affect the surface topography. In this contribution we focus on the effect of the internal beam parameters on the surface topography. It was analyzed the effect on the topography on Si surfaces of some experimental parameters that affect the internal beam parameters by changing the ion-optical parameters and the shape of the plasma sheath boundary. Explicitly, the influence of the discharge voltage, the operation time and the distance between the screen and accelerator grid is shown. Additionally, first result of quantitative measurements of divergence and angular distribution within the ion beam will be presented.

DS 10.4 Tue 11:45 GER 37

Influence of the ion distribution on shape and damage in Xe-induced ripple formation on Si — •Andreas Biermanns[1], Ullrich Pietsch[1], Antje Hanisch[2], Jörg Grenzer[2], Stefan Facsko[2], and Hartmut Metzger[3] — [1]Universität Siegen, Germany — [2]Foschungszentrum Dresden-Rossendorf, Germany — [3]ID01 beamline, ESRF, France

In recent years, the creation of surface-nanostructures due to ion-beam sputtering has gained much interest due to the possibility to pattern large surface areas with tunable morphologies in a short time. One kind of those nanostructures are wave-like patterns (ripples) produced by an interplay between a roughening process caused by ion beam erosion (sputtering) of the surface and smoothening processes caused by surface diffusion. For the creation of such ripple patterns with medium energy ions, the ion beam has to be inclined with respect to the surface normal of the target by an angle between 60° and 80°. In this presentation we show that the resulting inhomogeneity within the irradiated sample area is essential for the ripple formation. We report on investigations of the ion distribution on ripple formation on Si (001) surfaces after irradiation with medium-energy Xe^+-ions. We studied the change of average surface morphology and the damage imposed to the crystal by means of grazing-incidence - small angle scattering (GISAXS) and diffraction (GID) using synchrotron-radiation. We show that changing the asymmetry of the ion distribution changes both morphology and degree of damage of the crystalline material.

DS 10.5 Tue 12:00 GER 37

Xe^+ ion beam induced rippled structures on Si miscut wafers — •Antje Hanisch[1], Jörg Grenzer[1], Andreas Biermanns[2], and Ullrich Pietsch[2] — [1]Forschungszentrum Dresden-Rossendorf, Dresden, Germany — [2]Institute of Physics, University of Siegen, Germany

We report on the influence of the initial roughness and crystallography of the substrate on the formation of self-organized ripple structures on semiconductors surfaces by noble gas ion bombardment. The Bradley-Harper theory predicts that an initial roughness is most important for starting the sputtering process which in the ends leads to the evolution of regular patterns. We produced periodic structures with intermediate Xe^+ ion energies (5-70 keV) at different incidence and azimuthal angles which lead to the assumption that also crystallography plays a role at the beginning of ripple evolution. Most of the previous investigations started from the original roughness of a polished silicon wafer. We used (001) silicon wafers with a miscut angle of 1°, 5° and 10° towards [110]. We studied the ripple formation keeping the ion beam parallel to the [111], [-1-11] or [-111] direction, i.e. parallel, antiparallel or perpendicular to the miscut direction [110]. The parallel and antiparallel case implies a variation of the incidence angle with increased roughness over the surface step terraces. The perpendicular orientation means almost no roughness. The results were compared to normal Si(001) and Si(111) wafers.

DS 10.6 Tue 12:15 GER 37

Mechanisms in low-energy ion beam erosion of fused silica surfaces — •Jens Völlner, Bashkim Ziberi, Frank Frost, and Bernd Rauschenbach — Leibniz-Institut ür Oberflächenmodifizierung (IOM), Permoserstrasse 15, D-04318 Leipzig, Germany

In a recent study the topography evolution of fused silica surfaces under low-energy Ar^+ ion beam erosion was studied. It was shown that, for ion incidence angles between 50° and 70° the surface topography of fused silica is dominated by regular ripple structures with an orientation perpendicular to the ion beam direction. In contrast, at incidence angles $< 50°$ stable and very smooth surfaces were observed.

Based on this study two special cases have been examined, where rippled surfaces are used as initial surfaces. First a ripple pre-pattern was formed with a characteristic ripple wave vector parallel to ion beam projection. Afterwards the sample was rotated azimuthal by 90° and irradiated again at an (polar) ion incidence angle of 50°. Consequential, the original ripple structures disappear slowly and, simultaneously, a new superimposed ripple pattern emerges. In a second set of experiments rippled surfaces are irradiated at incidences angles < 50° and at azimuth angles parallel and perpendicular to the original ripple orientation, where in both cases surface smoothing should be dominating. Based on a detailed analysis of the temporal and the angle dependent evolution of the surface topography gradient dependent sputtering has been identified as the dominating mechanisms responsible for surface topography evolution in this system.

DS 10.7 Tue 12:30 GER 37

Development strategy of new liquid metal and alloy ion sources for focussed ion beam technology — •Kirill Trunov, Paul Mazarov, Alexander Melnikov, Rüdiger Schott, and Andreas D. Wieck — Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

Liquid metal ion and alloy sources (LMIS and LAIS) are widely used in focused ion beam (FIB) technology. Since many years our group develops and produces a lot of different LMIS and LAIS for micromachining and surface treatment in the submicron and nano-scales. For very successful approach to high sputter efficiency, Bi and Au ion species are employed, partially with heavy and big clusters. The development of rare-earth element LAISs (Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm) opens new applications in superconductivity, optical and magnetic material research. Silicon is n-type doped with elements from the fifth group of the periodic table (P, As, Sb, Bi) and p-type doped with elements from the third group (B, Al, Ga, In) giving the possibility of a large range of ionization energy for donors and acceptors in Si. For producing these and another LMIS and LAIS, we apply completely new methods for mechanical and chemical treatment of the sources, testing and the use in commercial FIB systems.