DS 9: Ion and Electron Beam Induced Processes

Time: Monday 16:15–17:15 Location: H8

DS 9.1 Mon 16:15 H8

Sputtering effects on ion irradiated Au nanoparticles — •Henry Holland-Moritz[1], Christian Borschel[1], Sebastian Scheeler[2], Claudia Pacholski[2], and Carsten Ronning[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena — [2]Max-Planck-Institut für Intelligente Systeme, Heisenbergstrasse 3, 70569 Stuttgart

Today, nanoparticles can easily be fabricated by different physical and chemical processes and can also be arranged in many different patterns and shapes. However, the synthesis is usually restricted to thermally equilibrium conditions. Ion beam irradiation, a non-equilibrium method, is one possible subsequent approach to tune the properties of nanoparticles. An important effect in this case is sputtering, especially when the ion range in the nanoparticles material is in the range of its size. For different purposes, it is important to understand the quantity of the sputtering effects on nanoparticles and how sputtering works on nanoparticles on top of substrates due to enhanced sputtering in nanostructures compared to bulk-like structures or films. Simulations were done by the Monte-Carlo-code iradina and hexagonal arranged gold nanoparticles with diameters of 50 nm on top of silicon substrates with native oxide layer were irradiated by argon ions using energies from 20 keV up to 350 keV and different ion fluencies. The sputtering effects were investigated with SEM and AFM measurements to get information about the energy dependence of the sputteryield and the fluence dependence of the volume decrease of the nanoparticles and the results were compared with the simulation results by iradina.

DS 9.2 Mon 16:30 H8

Bombardment induced ion transport (BIIT) through thin polymer films — •Susanne Schulze, Julia Zakel, Martin Schäfer, Andreas Greiner, and Karl-Michael Weitzel — Philipps-Universität Marburg, FB Chemie, 35032 Marburg

We report on the transport of potassium ions (K^+) through Poly(*para*-xylylene) (PPX) films (thickness 100 nm to 2720 nm) induced by ion bombardment. The films were formed by plasma chemical vapor deposition onto a metal electrode. The experiments were performed in an UHV apparatus where an ion beam is generated by thermionic emission of potassium ions from aluminosilicates. By bombarding the PPX films with an ion beam of low kinetic energy (10 eV to 500 eV) we generate a potential gradient and a concentration gradient inducing transport of the ions through the material. The ion transport is detected as a current on the backside electrode of the film. By measuring this current as a function of the kinetic energy of the impinging ions, we are able to determine the ionic conductivity of the material. In a second experiment PPX is bombarded with an ion beam of constant kinetic energy for several days. This experiment leads to the formation of an electro-diffusion profile of potassium in the film as shown by time-of-flight secondary ion mass spectrometry. The potassium diffusion profiles, which reach through the entire film, can be quantitatively described by theoretical calculations based on the numerical solution of the Nernst-Planck-Poisson equations. From this analysis we conclude that the effective diffusion coefficient of K^+ in PPX decreases with increasing incorporation of the K^+ ions into the film.

DS 9.3 Mon 16:45 H8

The role of defect-types in ion beam induced stress in $LiNbO_3$ — •Emanuel Schmidt, Tobias Steinbach, and Werner Wesch — Institute of Solid State Physics, Friedrich Schiller University Jena

Ion-irradiation of complex crystalline materials, such as Lithium niobate ($LiNbO_3$), can result in the formation of different types of defects. With increasing ion-irradiation these defects accumulate or convert into more extensive defects, until in many materials a continuous amorphous surface layer is formed. This phase-transformation in general involves a density-change, which leads to the formation of mechanical forces. However, only a few quantitative studies on ion beam induced stress phenomena have been made, even though stresses in microstructures cause substrate bending, delamination and cracking as well as anomalous diffusion of dopands. To investigate the ion beam induced formation and relaxation of stress due to the formation and accumulation of defects and amorphous regions a scanning laser reflection technique was established at the FSU Jena. By means of this technique the bending of a freestanding sample away from the irradiated surface is defined by the compensation of forces and moments between the underlying substrate and the irradiated regions. In the case of $LiNbO_3$ these forces are highly anisotropic due to the crystal-structure of the material. The fluence dependent stress-evolution in $LiNbO_3$ shows a different behaviour compared to classical semiconductors, such as Ge and Si. The results are discussed in the framework of a defect-related model. Additional Rutherford-backscattering-measurements support the applied defect-relations in this approach.

DS 9.4 Mon 17:00 H8

Temperature- and orientation-dependent damage-formation due to electronic energy deposition in $LiNbO_3$ — •Matthias Schmidt[1], Jura Rensberg[1], Frank Schrempel[2], and Werner Wesch[1] — [1]Institute of Solid State Physics, Friedrich Schiller University Jena — [2]Institute of Applied Physics, Friedrich Schiller University Jena

Among the methods to realize micro- and nanostructures with high aspect ratio in order to fabricate novel photonic devices in $LiNbO_3$ crystals, ion beam enhanced etching (IBEE) was found one of the most promising techniques. The high ion energies (several MeV) necessary to achieve sufficiently deep structures (several μm) are accompanied by high electronic energy deposition dominating especially close to the sample surface.

It is well known that the ion fluences to produce damage and to amorphize the material in the electronic energy loss regime are at least an order of magnitude lower compared to the fluences necessary to produce the same damage concentration by means of nuclear energy deposition. In this contribution the damage evolution up to complete amorphization in $LiNbO_3$ was investigated using MeV oxygen and silicon ions. The transition to the amorphous phase was studied as a function of irradiation temperature and crystal orientation. The differences in damage formation due to nuclear and electronic processes are discussed.