DS 24: Trends in Ion Beam Technology: From the Fundamentals to the Application

Time: Thursday 9:30–11:00 Location: H 2013

Invited Talk DS 24.1 Thu 9:30 H 2013

Nanostructures produced with energetic heavy ion projectiles
— •Christina Trautmann — Gesellschaft für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany

Heavy ions of kinetic energies in the MeV to GeV range offer unique possibilities of modifying materials properties and producing micro and nanostructures. Each projectile creates a cylindrical track with a few nanometers in diameter, consisting of physically and chemically modified material. The small track size in combination with the large ion range (up to 100 μm and more) allows us to overcome limits of planar structuring techniques.

To date, most ion-track applications are based on chemical etching, which dissolves the track material preferentially and creates fine channels of a few nanometers up to several micrometers in diameter. The superior properties of ion track membranes are related to the well-defined number and uniformity of diameter, length, and shape of the pores. Various examples will be presented such as perforated micromoulds, microfluidic systems with integrated nanoporous filter zones, and templates for the growth of nanowires. Polymer foils containing one single conical nanopore are suitable for biosensor applications and exhibit interesting ion-transport properties. Governed by the properties of the internal surface, synthetic nanopores function as a voltage gate, rectify ion currents, and show voltage-dependent fluctuations with kinetics similar to voltage-gated biological ion channels.

Invited Talk DS 24.2 Thu 10:00 H 2013

Low energy maskless implantation with high lateral resolution.
— •Jan Meijer[1], Sebastien Pezzagna[1], Dirk Reuter[2], Ivo W. Rangelow[3], Hartmut Wiggers[4], Fedor Jelezko[5], Inam Mirza[5], Jörg Wrachtrup[5], Ferdinand Schmidt-Kaler[6], Wolfgang Schnitzer[6], and Kilian Singer[6] — [1]RUBION, Ruhr-Universität Bochum — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum — [3]Mikro- und Nanoelektronische Systeme, TU-Ilmenau — [4]Institut für Verbrennung und Gasdynamik, Universität Duisburg-Essen — [5]3. Physikalisches Institut, Universität Stuttgart — [6]Quanteninformationsverarbeitung, Universität Ulm

The fabrication of scalable quantum computers based on solid state materials requires tools to manipulate and implant single atoms, clusters or molecules with nm resolution or below.

The technical requirements to meet this challenge are enormous. In the first approach, we will present a technology able to implant ions through an AFM-tip with a small hole. This technique is already realized in Bochum. It allows a maskless implantation of small structures using different types of ions and energies between 0.5 - 5 keV. In the second step, this method will be combined with an ion trap as a single ion source. This method will be developed at the University of Ulm. Calculations show that this enhancement offers the implantation of countable ions with a lateral resolution below one nm. The paper will give an overview of the status of these methods as well as the first results to apply single ion implantation in the fabrication of NV centres in diamond as a solid state room temperature qubit.

Invited Talk DS 24.3 Thu 10:30 H 2013

Cluster ion-surface interactions: from meV to MeV energies
— •Kai Nordlund, Kristoffer Meinander, Tommi T. Järvi, Jarkko Peltola, and Juha Samela — Accelerator Laboratory, University of Helsinki, Finland

The nature of cluster ion-surface interactions changes dramatically with the kinetic energy of the incoming cluster species. In this talk I will review some of our recent work on the nature of cluster-surface interactions spanning an energy range from a few meV/cluster to about 1 MeV/cluster and cluster sizes in the range of 10 - 1000 atoms/cluster.

In the energy range of a few meV/cluster ion, the kinetic energy of the incoming ion is insignificant compared to the energy gained when the surface potential energy at the cluster-surface interface is released and partly translated into kinetic energy. Even in this energy regime I will show that surprisingly drastic effects can occur. When the energy of the incoming cluster is raised to a few eV/atom, the kinetic energy of the incoming cluster starts to affect the deposition. It will cause the cluster to entirely reform on impact. When the energy is raised to the range of keV's/cluster, the clusters start to penetrate the sample, fairly similar to conventional ion implantation. However, in dense targets the cluster ions may stick close to each other long enough to cause a significant enhancement of the heat spike in the material. Finally, I will show that at kinetic energies around 1 MeV/cluster the cluster enhancement of the heat spike may lead to dramatic surface effects.