HL 10: Preparation and characterization

Time: Monday 9:30–10:45 Location: EW 202

HL 10.1 Mon 9:30 EW 202

Defect cores investigated by x-ray scattering close to forbidden reflections in silicon — •Till H. Metzger[1], Marie-Ingrid Richard[2], Vaclav Holy[3], and Kai Nordlund[4] — [1]ESRF, Grenoble, France — [2]ESRF/CEA, Grenoble, France — [3]Charles University, Prague, Czech Republic — [4]University of Helsinki, Finland

Characterizing the structure of point defects and dislocations and understanding their properties are of great importance in semiconductor technology. In silicon implantation, the interaction of defects and impurities play a crucial role in the doping of silicon. The most important extended defects observed in such systems are stacking faults, "311" defects and perfect dislocation loops. A new x-ray scattering method is presented making possible the detection of defects and the investigation of the structure of their cores. The method uses diffuse x-ray scattering measured close to the (200) forbidden diffraction peak, in which the intensity scattered from the distorted crystal lattice around the defects is minimized. As an example of this non-destructive method we demonstrate how the local compression of the extra {111} double planes in extrinsic stacking faults in Si can be probed and quantified using a continuum approach for the simulation of the core displacements. The experimental results are found to be in a very good agreement with atomistic simulations [1]. [1] M.I. Richard, T. H. Metzger, V. Holy and K. Nordlund, accepted for publication in Phys. Rev. Lett. 2007

HL 10.2 Mon 9:45 EW 202

Application of evolutionary strategies to the analysis of defects in semiconductors — •Silvia Schumann[1] and Torsten Hahn[2] — [1]TU Bergakademie Freiberg, Institute for Theoretical Physics, Leipziger Str. 23, 09599 Freiberg, Germany — [2]TU Bergakademie Freiberg, Institute for Experimental Physics, Leipziger Str. 23, 09599 Freiberg, Germany

This work presents an application of evolutionary strategies to the analysis of defects in semiconductors. Experimental Photo-Induced Current Transient Spectroscopy (PICTS) measurements have been simulated at different levels of optical excitation. These simulations give access to various physical properties like e.g. the minority carrier lifetimes. This enables us to compare directly the simulated data to quasi steady state photoconductance and PICTS-measurements at different injection levels. The evolutionary strategy was chosen because of the high dimension of the problem and the unknown landscape of the objective function. The application of the evolutionary algorithm provides the defect configurations, where each defect is characterized by its energy, concentration, and capture cross-section. Suitable configurations in very good agreement with experimental data can be obtained already after a few generations. The evolutionary algorithm avoids trapping in local minima and provides information on the range of possible solutions.

HL 10.3 Mon 10:00 EW 202

Probing the free charge carrier distribution with non-contact and contact AFM — •A.-D. Müller[1], F. Müller[1], S. Jänsch[2], C. Henkel[2], P. Pelzing[3], A. Möller[3], and H. Schmidt[4] — [1]Anfatec Instruments AG, Melanchthonstrasse 28, D-08606 Oelsnitz — [2]Universität Leipzig, Institut für Experimentelle Physik II, D-04103 Leipzig — [3]SGS Institut Fresenius GmbH, D-01109 Dresden — [4]Forschungszentrum Dresden-Rossendorf e.V., D-01314 Dresden

We address the issue of extracting the dopant profile information on the nanoscale by electrostatic force microscopy (EFM) in non-contact and Scanning Capacitance Microscopy (SCM) in contact mode. Cross sections prepared of Si epilayers on Si substrates were investigated with highly-doped conductive tips in complementary SPM techniques with a lateral resolution limited by the Debye length. Frequency and tip-sample distance dependent surface work functions were obtained by Kelvin Probe Force Microscopy (KPFM) with a voltage resolution better than 10 meV. Surface band structures in the frequency range between 10 kHz and 300 kHz are acquired by non-contact capacitance detection in dynamic EFM, while high-frequency tip-sample capacitance-voltage characteristics have been detected by a SCM sensor and enable the determination of dopant concentration. The comparison between these techniques is completed by numerical simulations of voltage dependent tip-sample capacitances to improve the understanding of the contrast. The recorded KPFM and SCM data are complementary with respect to surface and depth resolution, respectively, and together they give a more complete impression of the sample's electronic structure.

HL 10.4 Mon 10:15 EW 202

Preparation and tunneling characteristics of MOS structures for Si-based IR light emitters — •Stephan Suckow[1], Martin Kittler[1,2], Winfried Seifert[1,2], Tzanimir Arguirov[1,2], Manfred Schmidt[3], Bert Stegemann[3], and Heike Angermann[3] — [1]IHP/BTU JointLab, Konrad-Wachsmann-Allee 1, 03046 Cottbus, Germany — [2]IHP, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany — [3]Hahn-Meitner-Institut Berlin, Kekuléstraße 5, 12489 Berlin, Germany

Si based light emitters, such as MOS structures based on dislocation networks, are attractive candidates for the generation of electroluminescence in the IR spectral range to be applied e.g. in optical on-chip interconnects. In the present work the preparation of an appropriate MOS structure that facilitates efficient charge carrier injection is explored and its charge carrier tunneling and recombination characteristics are analyzed. In this respect MOS structures with ultra-thin tunnel oxides fabricated by wet-chemical oxidation of Si wafers and thermally deposited Ti contacts turned out to produce the most efficient and reliable results. Moreover, electroluminescence measurements revealed an anomalous temperature behavior of band-to-band recombination with enhanced intensity at higher temperature (300 K). As photoluminescence intensity inversely increases with decreasing temperature, this effect is clearly correlated to efficient minority charge carrier injection via the MOS contact and points towards an application as room temperature IR light emitter.

HL 10.5 Mon 10:30 EW 202

Photoelectrochemical Formation and Shaping of Silicon Nanostructures Controlled by in-situ Brewster-Angle Reflectometry — •Michael Lublow and Hans-Joachim Lewerenz — Hahn-Meitner-Institut Berlin GmbH, Glienicker Str. 100, 14109 Berlin

Silicon nanostructures were produced and manipulated in ammonium fluoride containing solutions at small potentials positive from the open-circuit potential (OCP). In diluted solutions, either divalent or tetravalent electrochemical reactions can be induced by light intensity variations which consequently alter the OCP and therefore the resulting overpotential. During photon flux variation, formation and selective oxidation of the structures were monitored in real-time by the surface sensitive signal of Brewster-angle reflectometry. After subsequent oxide removal, varied aspect ratios and densities of the nanostructures were obtained. Structure alignment effects were analyzed by Atomic Force Microscopy and could be related to the wafer-miscut dependent topographies of the initially H-terminated surfaces. Results for varying miscut angles from 0° to 4° will be presented. The influence of solution concentration and different surface orientations towards (111), (100) and (113) direction will be discussed.