

## HL 42: Interfaces/surfaces

Time: Thursday 9:30–10:45

Location: POT 51

HL 42.1 Thu 9:30 POT 51

**How a hydrogen passivated surface could appear to be metallic: the story of the 3C-SiC (001) 3x2 surface** — ●PETER DEAK, BALINT ARADI, and THOMAS FRAUENHEIM — Bremen Center for Computational Materials Science, University of Bremen, Am Fallturm 1, D-28359 Bremen, Germany

Photo electron and scanning tunneling spectroscopy has revealed partially filled states near the conduction band edge of the silicon rich (3x2)-reconstructed (001) surface of cubic SiC, after exposure to atomic hydrogen. These were attributed to a row of unsaturated singly occupied Si dangling bonds by experimentalists, and to a defect band due to a row of Si-H-Si tri-center bonds by theorists. Here we show that the surface is, in fact, completely passivated by hydrogen (no partially filled defect band) but, in doped samples, the accumulation of conduction band electrons at a polar surface can explain the experimental observations.

HL 42.2 Thu 9:45 POT 51

**Control of Donor Charge States with the Tip of a Scanning Tunneling Microscope** — ●K. TEICHMANN<sup>1</sup>, M. WENDEROTH<sup>1</sup>, S. LOTH<sup>1</sup>, R. G. ULBRICH<sup>1</sup>, J. K. GARLEF<sup>2</sup>, A. P. WIJNHUJMER<sup>2</sup>, and P. M. KOENRAAD<sup>2</sup> — <sup>1</sup>IV. Physikalisches Institut, Georg-August-Universität Göttingen — <sup>2</sup>PSN, Eindhoven University of Technology, the Netherlands

The functionality of nanoscale semiconductor devices crucially depends on details of the electrostatic potential landscape on the atomic scale and its microscopic response to external electric fields. We report here an investigation of charge state switching of buried single Si donors in  $6 \cdot 10^{18} \text{ cm}^{-3}$  n-doped GaAs with scanning tunnelling microscopy (STM) under UHV conditions at 5K. The effect of tip induced band bending (TIBB) through the freshly cleaved (110)-surface was used to change the charge state of individual donors from neutral to positively charged and reverse. Scanning tunnelling spectroscopy (STS) revealed a ring like feature around each donor center. The ring radius depends on tip bias voltage [1]. The charge state of each donor in the random arrangement of dopants was in most cases unambiguously fixed by the extension of the tip-induced space charge cloud, which was located under the tip and controlled by the applied voltage. For certain geometric configurations the system showed bi- (or multi-) stable behaviour, this lead to dynamic flickering of the ionization sequence. This work was supported by DFG SFB 602 and DFG SPP 1285.

[1] PRL 101, 076103 (2008)

HL 42.3 Thu 10:00 POT 51

**Application of catalytic nanoparticles to wide bandgap semiconductor surfaces** — ●SUSANNE SCHAEFER<sup>1</sup>, SONJA WYRZGOL<sup>2</sup>, YIZHEN WANG<sup>1</sup>, JOHANNES LERCHER<sup>2</sup>, and MARTIN STUTZMANN<sup>1</sup> — <sup>1</sup>Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — <sup>2</sup>Technische Chemie 2, Technische Universität München, Lichtenbergstr. 4, 85747 Garching, Germany

Wide bandgap semiconductors are investigated as materials for the electronic control of catalytic reactions via metal nanoparticles. To conduct test reactions like selective hydrogenation, platinum nanoparticles are applied to the semiconductor surface. GaN substrates, which were grown by MOCVD as well as PAMBE, were used as nanoparticle support. The nanoparticles were prepared by two methods: spin-coating with polymer-encapsulated Pt nanoparticles and evaporation of Pt at elevated temperatures. For polyvinyl-pyrrolidone (PVP)-

coated nanoparticles, an average size of 2.4 nm was observed with TEM. The PVP-coated particles were applied to the semiconductor support via spin coating and activated by oxygen plasma. For particles applied by evaporation, Pt layers with a nominal thickness of 0.2-5 nm were deposited, as determined by EDX. Under defined heating and gas flow, the platinum atoms coalesce to particles. Particle sizes and distributions were investigated with AFM. For testing the electronic properties of these semiconductor-metal interfaces, Schottky diodes were processed with standard lithography. UI-characteristics were measured for various particle sizes.

HL 42.4 Thu 10:15 POT 51

**Surface states and origin of the Fermi level pinning on non-polar GaN(1 $\bar{1}00$ ) surfaces** — ●LENA IVANOVA<sup>1</sup>, SVETLANA BORISOVA<sup>2</sup>, HOLGER EISELE<sup>1</sup>, MARIO DÄHNE<sup>1</sup>, ANSGER LAUBSCH<sup>3</sup>, and PHILIPP EBERT<sup>2</sup> — <sup>1</sup>Institut für Festkörperphysik, Technische Universität Berlin, 10623 Berlin, Germany — <sup>2</sup>Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — <sup>3</sup>OSRAM Opto-Semiconductors GmbH, 93055 Regensburg, Germany

Group-III nitrides raised considerable attraction because of their ideal properties for green, blue, and ultraviolet laser and LED devices. One particular challenge of the epitaxial growth is the impurity, dopant, and defect incorporation during growth, which often depends on the position of the Fermi level at the growth surface. For the non-polar GaN surfaces only little is known about the exact positions of the surface states and thus their possible influence on the Fermi energy.

Therefore, we investigated GaN(1 $\bar{1}00$ ) cleavage surfaces by cross-sectional scanning tunneling microscopy and spectroscopy [1]. We identified the energy positions and types of surface states as well as the origin of the Fermi level pinning on GaN(1 $\bar{1}00$ ) cleavage surfaces. It is found that both the N and Ga derived intrinsic dangling bond surface states are outside of the fundamental band gap. The observed Fermi level pinning 1.0 eV below the conduction band edge is attributed to the high step and defect density at the surface but not to intrinsic surface states. [1] L. Ivanova et al., APL 93, 192110 (2008). This work is supported by the DFG.

HL 42.5 Thu 10:30 POT 51

**Initial stages of GaN(0001)-2x2 - oxidation** — ●PIERRE LORENZ<sup>1</sup>, RICHARD GUTT<sup>2</sup>, JUERGEN A. SCHAEFER<sup>1</sup>, and STEFAN KRISCHOK<sup>1</sup> — <sup>1</sup>Institute of Physics and Institute of Micro- und Nanotechnologies, Technical University Ilmenau, P.O. Box 100565, D-98684 Ilmenau, Germany — <sup>2</sup>Fraunhofer Institute for Applied Solid State Physics, Tullastr. 72, 79108 Freiburg, Germany

We studied the initial oxidation stages of 2x2 reconstructed Ga-face GaN(0001) grown in-situ by PAMBE. The oxidation process was characterized using X-ray and ultraviolet photoelectron spectroscopy (XPS, UPS), as well as reflection high energy electron diffraction (RHEED). In particular, the evolution of the valence band structure, the work function and the core levels of gallium and nitrogen as well as the increase of the oxygen O 1s emission were studied in combination with the corresponding RHEED pattern as a function of oxygen exposure. The clean GaN(0001)-2x2 surface exhibits two surface states at 2 eV (S1) and 3.5 eV (S2) below the Fermi level. The exposure to O<sub>2</sub> results in two well pronounced valence band structures at binding energies of about 6 eV and 11 eV, respectively, which are caused by the adsorbed oxygen. The 2x2 reconstruction as well as the S1 state disappear rapidly, revealing an extremely high reactivity of the as grown GaN surface, whereas the S2 state vanishes considerably slower.