# HL 63: Devices I

Time: Wednesday 15:00–17:00 Location: EW 015

HL 63.1 Wed 15:00 EW 015

**Mapping of reflectivity and excited carriers' transport in metal–insulator–metal heterosystems** — Dominik Differt[1], Walter Pfeiffer[1], and •Detlef Diesing[2] — [1]Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany — [2]Fakultät für Chemie, Universität Duisburg-Essen, D-45117 Essen, Germany

The quality of large area thin film metal heterojunctions with interstitial oxide layers depends on the lateral homogeneity of the metal thicknesses and the interstitial oxide's barrier height. Lateral inhomogeneities on the microscopic scale may lead to changed properties of the macroscopic device. We present a new setup which enables the mapping of surface reflectivity and of photo excited carriers transport as well. For the lateral mapping of the **i**nternal **p**hoto **e**mission (**IPE**) in a Ag-TaO-Ta heterosystem the sample is raster scanned across the focus of a Schwarzschild objective (NA=0.4). The illumination with 400 nm laser radiation results in a focus diameter of 5 $\mu$m limiting the spatial resolution of the IPE microscope. Mapping across the 40 $\mu$m wide edge of the top metal film shows transport effects in the top silver electrode as well as the increasing excitation of carriers in the tantalum backelectrode with decrasing top electrode thickness. The spatial variation of the top electrode thickness at the edge of the electrode gives information about the relaxation dynamics of the photo excited carriers.

HL 63.2 Wed 15:15 EW 015

**A new method for obtaining accurate capacitance-voltage curves in the presence of additional space charges** — •Kay-Michael Günther[1], Hartmut Witte[2], Alois Krost[2], Stefan Kontermann[3], and Wolfgang Schade[1,3] — [1]Clausthal University of Technology, EFZN, Am Stollen 19B, 38640 Goslar, Germany — [2]Otto-von-Guericke University Magdeburg, Institute for Experimental Physics,Universitätsplatz 2, 39106 Magdeburg, Germany — [3]Fraunhofer Heinrich Hertz Institute, Am Stollen 19B, 38640 Goslar, Germany

Evaluating capacitance-voltage (C-V) curves is a powerful tool for obtaining doping concentration profiles. If the sample contains additional space charges like pn-junctions, defects, or Schottky barriers, the commonly used methods often deliver false results. The reason is that the capacitance of the investigated junction cannot be measured directly, but the impedance is interpreted in terms of an equivalent circuit (EC). We show that these commonly used ECs are only valid under special considerations and can easily produce false results. We present a new method which uses a more general approach based on whole impedance spectra instead of single impedances to acquire accurate C-V curves even in the presence of additional space charges. We compare our method with the conventional techniques and discuss its advantages and disadvantages.

HL 63.3 Wed 15:30 EW 015

**Solution-processed *p*-channel tin monoxide thin-film transistors** — •Koshi Okamura[1], Babak Nasr[1,2], Richard A. Brand[1], and Horst Hahn[1,2] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT), 76021 Karlsruhe, Germany — [2]Joint Research Laboratory Nanomaterials, Technische Universität Darmstadt and KIT, Petersenstr. 32, 64287 Darmstadt, Germany

Oxide semiconductor thin-film transistors (TFTs) have been fabricated both in the conventional vacuum processes and in the solution-processes intensively for *n*-channel type zinc oxide (ZnO) and amorphous oxide semiconductors. The material search for the *p*-channel type is, however, still challenging. Tin monoxide (SnO) is so far the most promising *p*-type oxide semiconductor that has been demonstrated for epitaxially grown and sputtered TFTs. In this study, *p*-channel enhancement mode SnO TFTs are fabricated in a solution-process by spin-coating a methanol solution of the precursor tin(II) chloride dihydrate ($SnCl_2.2H_2O$), followed by an exposure to ammonium hydroxide and a postannealing in purified forming gas at a temperature of 450-500 °C. Systematic investigations reveal that the transistor performance is strongly dependent on the crystallinity and thin-film morphology, showing a highest field-effect mobility of 0.13 $cm^2$ $V^{-1}$ $s^{-1}$, threshold voltage of -1.9 V, and on/off drain current ratio of 85.

HL 63.4 Wed 15:45 EW 015

**Chemical surface modifications for altering electrical characteristics of silicon nanowire Schottky-barrier FETs** — •Sebastian Pregl[1,2], Walter Weber[2], Joerg Opitz[3], and Gianaurelio Cuniberti[1] — [1]Institute for Materials Science and Max Bergmann Center of Biomaterials, TU Dresden, 01062 Dresden, Germany — [2]NaMLab GmbH, 01187 Dresden, Germany — [3]Fraunhofer Institute IZFP Dresden, 01109 Dresden, Germany

The interface of semiconductors to metals with a different work function introduces a Schottky barrier. For axially Ni-silicidized silicon nanowires a very sharp interface and thus a very defined and reproducible energetical barrier is created. We use $NiSi_2$-Si-$NiSi_2$ heterostructures as Schottky-barrier field effect transistors (SB-FETs) for sensor applications and nanoelectronic devices. Silicon nanowires can be grown as thin as 5nm with VLS (vapor liquid solid) technique in a CVD furnace. The high surface to volume ratio of such nanostructures makes their electronic properties very sensitive to surface adsorbates and covalently bound molecules. The effect of surface functionalization is investigated in respect of a potential use for biosensor applications and new ways to alter device characteristics of silicon nanowire FETs.

HL 63.5 Wed 16:00 EW 015

**Two-color pump-probe experiments with balanced heterodyne detection on InAs/GaAs quantum dot semiconductor optical amplifiers** — •Yücel I. Kaptan, Nina Owschimikow, and Ulrike Woggon — Technische Universität Berlin, Institut für Optik und Atomare Physik, Berlin, Germany

Degenerate one-color pump-probe measurements combined with a balanced heterodyne detection scheme prevailed in the last decade as a leading experimental tool for the measurement of gain and phase dynamics in QD SOAs. In this talk, we present an improved two-color pump-probe setup in which a mode-locked Ti:Sa laser and an infrared super continuum emitting fiber laser provide independently tunable ultrafast pump and probe pulses. Both laser sources have been synchronized via a phase-locked loop using a proportional-integral-derivative controller driving a piezo crystal. With a synchronization jitter of about 400fs we were able to investigate the carrier transition times between the QD ground and excited state, the 2D carrier reservoir and the waveguide. Separating the recovery within the QD states from the carrier recovery in the reservoir, we identify the carrier dynamics in the reservoir as the main contribution to overall phase dynamics and thus change in refractive index. We additionally show that the presented results of the intradot gain dynamics indicate a novel way for ultrafast switching of amplification and wavelength conversion.

HL 63.6 Wed 16:15 EW 015

**AlInN/GaN FETs auf Si(001)** — •Armin Dadgar, Hartmut Witte, Jürgen Bläsing, Annette Diez und Alois Krost — Institut für Experimentelle Physik, Otto-von Guericke-Universität Magdeburg, Universitätsplatz 2, 39106 Magdeburg

Das Wachstum von FET Strukturen auf Si(001) eröffnet die Möglichkeit der Integration von GaN-basierter Hochleistungselektronik mit der gängigen Si CMOS Technologie. Wir untersuchen das Wachstum von AlInN/GaN-basierten FET Strukturen auf Si Substraten. Dabei ist AlInN ein interessantes Halbleitersystem, das das gitterangepasste Wachstum auf GaN bei gleichzeitig hohen pyroelektrischen Feldern ermöglicht. Dies erlaubt 2-dimensionale Elektronengaskonzentrationen, die deutlich über denen im System AlGaN/GaN mit ca. 1xE13 cm-3 liegen. Hier untersuchen wir die Eigenschaften von solchen Strukturen im Vergleich zu Strukturen auf dem ebenfalls in der CMOS Technologie eingesetzten Si(110) und dem für das GaN Wachstum üblichen Si(111). Hauptunterschied ist dabei die kristalline Qualität der Pufferschichten. Die Auswirkungen dieser Qualitätsunterschiede werden mittels Röntgendiffraktometrie, Hall-Effekt, Atomkraft- und Oberflächenpotentialmikroskopie und Photolumineszenzmessungen untersucht.

HL 63.7 Wed 16:30 EW 015

**Effect of temperature and strain on the optical polarization of ultraviolet light emitting diodes** — •T. Kolbe[1], A. Knauer[2], V. Kueller[2], J. Stellmach[1], C. Chua[3], Z. Yang[3], S. Einfeldt[2], P. Vogt[1], N.M. Johnson[3], M. Weyers[2], and M. Kneissl[1,2] — [1]Institute of Solid State Physics, TU Berlin, Hardenbergstr. 36, 10623

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The temperature and strain dependence of the optical polarization of the in-plane electroluminescence (EL) of (0001) oriented (In)(Al)GaN multiple quantum well (MQW) LEDs has been investigated. The EL measurements show a decrease of the emission intensity for transverse-electric (TE) polarized light relative to the transverse-magnetic (TM) polarization with decreasing emission wavelength. This can be explained by a change of the order of the heavy, light and split-off hole band in the (In)(Al)GaN active region with a changing Al-content. With increasing sample temperature it was found that the TM polarized part of the emission increases for LEDs with a dominant TE polarized emission (and inverted) because the occupation probability of high-energetic bands increases with increasing temperature. We further investigate the influence of the strain in the MQWs on the optical polarization of near UV LEDs. It was observed that the TM polarized part of the emission clearly increases if strain of the MQWs is reduced by a change of the barrier material between the quantum wells.

HL 63.8 Wed 16:45 EW 015

**Efficiency droop in nonpolar InGaN quantum wells** — •Lukas Schade[1,2], Ulrich Schwarz[1,2], Tim Wernicke[3], Jens Rass[3], Simon Ploch[3], Markus Weyers[4], and Michael Kneissl[3,4] — [1]Fraunhofer Institut für Angewandte Festkörperphysik (IAF), Freiburg — [2]Institut für Mikrosystemtechnik (IMTEK), Universität Freiburg — [3]Institut für Festkörperphysik, Technische Universität Berlin — [4]Ferdinand-Braun-Institut (FBH), Berlin

InGaN quantum wells (QWs) exhibit a decline of the internal efficiency at high charge carrier excitation. This has been observed for polar as well as for semipolar and nonpolar oriented QWs. Polar stands for the (0001) growth direction with strong piezoelectric fields. Due to the vanishing fields, the orthogonal growth directions (a or m) are called nonpolar, while all directions between are merged as semipolar orientations. In contrast to the polar and many semipolar QWs, nonpolar InGaN QWs provide a special property: optical polarization of the radiative transitions, which is a result of the anisotropic strain within pseudomorphic grown nonpolar QWs. Using this property, the broadened effective emission can be resolved into two fundamental transitions. They are spectrally separated by a defined energy which corresponds to the energy distance of the valence subbands. We studied nonpolar InGaN/InGaN Multi-QWs grown on low defect density GaN substrates with a setup for confocal microscopy. To reach high excitation densities of charge carriers, we use either a combination of an UV laser and highly focusing objectives or an electric pulse generator. The emission is spectrally analysed and compared to established models.