HL 70: Devices II

Time: Wednesday 17:15–19:00 Location: EW 015

HL 70.1 Wed 17:15 EW 015

(Al,In)GaN laser diodes — •Thomas Weig, Katarzyna Holc, Wilfried Pletschen, Klaus Köhler, Joachim Wagner, and Ulrich Schwarz — Fraunhofer Institute for Applied Solid State Physics IAF, Tullastraße 72, 79108 Freiburg, Germany, www.iaf.fraunhofer.de

We develop violet-blue (Al,In)GaN double heterostructure laser diodes (LD). The single section, ridge waveguide LDs show threshold currents around 60 mW and slope efficiencies greater than 1 W/A in continuous wave (cw) operation. The internal losses are estimated by Hakki-Paoli gain measurements to be smaller than $25\,\mathrm{cm}^{-1}$. Laser dynamics and charge carrier lifetime are investigated with the help of a Streak-camera.

For picosecond pulse generation we also design multi-section InGaN LDs. The absorber section is placed at the end or in the center of the LD structure along the ridge, and is negatively biased. We observe self-pulsation in the GHz frequency range. The physical mechanism of this self-pulsation is in our case a stabilization of the relaxation oscillations which were observed in the single section LDs. By tuning the length of the driving current pulse we achieve optical pulses in the picosecond regime with arbitrary repetition rates from single shots to GHz by gain switching.

HL 70.2 Wed 17:30 EW 015

Tunnel Junctions on GaAs for cost-effective long-wavelength VCSELs — •Hui Li[1], Shu-Han Chen[2], Werner Hofmann[1], and Dieter Bimberg[1] — [1]Institute of Solid State Physics & Center of Nanophotonics, Technische Universität Berlin — [2]Research Center for Applied Sciences, Academia Sinica, Taiwan

Long-wavelength vertical-cavity surface-emitting lasers (VCSELs) are desired for low-cost broadband access. Cost-effective solutions which are compatible to the widely utilized GaAs technology are desired. High-Speed long-wavelength VCSELs, however, require tunnel-junctions (TJs) for low-loss high-speed performance [1, 2]. TJs, on the other hand, are harder to realize on GaAs due to higher bandgaps. Here we report our recent work on highly efficient tunnel junctions grown on GaAs substrates using the InGaAlAsSb material system. We present a detailed analysis both in theory and experiment on several good candidates of low-resistance TJs that may significantly improve the performance of VCSELs and the realization of high performance of long-wavelength VCSELs on GaAs seems feasible.

[1] W. Hofmann, "Evolution of high-speed long-wavelength vertical-cavity surface-emitting lasers," Semicond. Sci. Technol, 26, pp. 014011, 2011. [2] M. Ortsiefer, et al.: "Low-resistance InGa(Al)As Tunnel Junctions for Long Wavelength Vertical-cavity Surface-emitting Lasers," Jap. J. Appl. Phys., 39, pp. 1727, 2000.

HL 70.3 Wed 17:45 EW 015

Marker process for high overlay accuracy e-beam lithography — •Jürgen Moers[1,3], Stefan Trellenkamp[2,3], and Bert Rienks[4] — [1]Peter Grünberg Institute - 9, Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Peter Grünberg Institute - 8-PT, Forschungszentrum Jülich, 52425 Jülich, Germany — [3]JARA - Fundamentals of Future Information Technology — [4]Vistec Lithography B.V., Technical Support Centre, 5684 PS Best, The Netherlands

High level overlay accuracy for e-beam defined patterns in nanoscaled devices is of crucial importance for industrial high performance devices as well as for devices probing new physical effects. Thw quality of overly depends on the quality of the marker itself and the quality of the positioning of the whole marker set. In this work the influence of the positioning algorithm for e-beam defined markers on the overlay accuracy is investigated for two different marker systems: simple square holes in silicon substrates and squares of metal. Both systems were processed with standard methods of semiconductor technology. While in former work the overlay displacement was (18 ± 8) nm, in this work it is shown, that with an optimized marker positioning algorithm overlay displacement of (1.6 ± 2.1) nm can be achieved.

HL 70.4 Wed 18:00 EW 015

Electrical characterization of C60 molecules embedded in a MOS diode — •Daniel Beckmeier and Hermann Baumgärtner — Universität der Bundeswehr München

Fullerene (C60) molecules were embedded in a SiO2 layer. Around this layer a MOS diode structure was defined to study the charge and discharge of the electronic states caused by the molecules. This structure was formed by evaporating a submonolayer of C60 molecules onto a clean silicon wafer followed by an in situ overgrowth of the molecules with amorphous silicon inside the same UHV system. These samples were then oxidized in a wet atmosphere to achieve a complete encapsulation of the C60 molecules by the thermal oxide without destroying the molecules. Aluminum contacts were defined on these layers to perform capacitance voltage (CV), current voltage (IV) and electrical stress measurements on the diodes. CV measurements showed a shift of the flatband voltage caused by the injected charge carriers. This shift was reversible for small voltages of opposite signs. The IV measurements showed a Fowler-Nordheim tunneling current for diodes without and with C60. For samples with C60 the electron current injected from the silicon into the oxide started at smaller fields and had a smaller slope compared to the metal electrode-injected current. We propose a model including trap assisted current injection to explain this behavior.

HL 70.5 Wed 18:15 EW 015

Spectroscopic characterization of silicon photomultipliers on wafer level — •Thomas Ganka[1], Christoph Dietzinger[1], Peter Iskra[2], Florian Wiest[2], and Walter Hansch[1] — [1]Universität der Bundeswehr München, Fakultät für Elektrotechnik und Informationstechnik — [2]KETEK GmbH, München

Silicon photomultipliers (SiPMs) are state-of-the-art sensors, which facilitate measurement of ultra low level light down to single photon resolution. SiPMs are based on an array of avalanche photodiodes operating above the breakdown voltage. In this operation mode single photons can trigger an avalanche and generate a measurable signal. As small technological changes can strongly affect the spectroscopic characteristics of these devices, a setup was built to study the effects already on wafer level. This enables cost-effective and fast development of high-end SiPMs. The developed setup enables fully automatic low-noise measurement of the photon detection efficiency, spectral sensitivity, dark noise, crosstalk and afterpulsing. The results measured on wafer level will be compared with results measured with packaged devices.

HL 70.6 Wed 18:30 EW 015

Embedding submicrometer sized GaN stripes with semipolar quantum wells for application in light emitting diodes — •Robert A. R. Leute[1], Dominik Heinz[1,2], Frank Lipski[1], Tobias Meisch[1], Kamran Forghani[1], Junjun Wang[1], Klaus Thonke[2], and Ferdinand Scholz[1] — [1]Institut für Optoelektronik, Universität Ulm — [2]Institut für Quantenmaterie / Gruppe Halbleiterphysik, Universität Ulm

Laser interference lithography is used to create stripe patterns with 240 nm period on silicon doped c-oriented gallium nitride layers grown on 2-inch sapphire substrates. The pattern which was aligned parallel to the a-direction of gallium nitride is transfered to a mask enabling subsequent selective epitaxy. The resulting stripes exhibit triangular cross-section with semipolar $\{10\bar{1}1\}$ side facets. After epitaxy of InGaN quantum wells on these stripes, Mg doped GaN is grown in a two-step process to planarize the samples which results in a planar c-oriented surface. We present morphological characterization of the final devices as well as electroluminescence results obtained by on-wafer-testing with evaporated contacts.

HL 70.7 Wed 18:45 EW 015

Quenching Resistors for Silicon Photomultipliers — •Christoph Dietzinger[1], Thomas Ganka[1], Peter Iskra[2], Florian Wiest[2], and Walter Hansch[1] — [1]Universität der Bundeswehr München, Fakultät für Elektrotechnik- und Informationstechnik — [2]KETEK GmbH, München

The silicon photomultiplier (SiPM) is a novel photon detector for detecting low levels of lights for medical and analytical applications. The SiPM consists of an array of many single avalanche photodiodes, which operate above the breakdown voltage in reverse direction, the so called Geiger mode. The triggering of one cell by an incoming photon, leads to a voltage drop over the quenching resistor, allowing the regeneration of this cell. Typical values of these resistors are about 0.2 MΩ up to 2

MΩ.

In the first part of this talk, a typical application and the functioning of the SiPM will be presented. The next section describes the process flow and the parameters of the test devices, e.g. the geometry of the resistors and the ion implantation dose. Finally the resistance values will be discussed.