HL 18: Lasers and LEDs I

Time: Monday 15:00–16:30 Location: H16

HL 18.1 Mon 15:00 H16

Interplay of different degradation mechanisms in short wavelength InGaAlP light emitting diodes in model and experiment — •Cynthia Karl, Jens Ebbecke, Claudia Kauss, Thomas Lutz, and Roland Zeisel — OSRAM Opto Semiconductors, 93055 Regensburg, Germany

The interplay of different degradation mechanisms in short wavelength $(Al_xGa_{1-x})_{0.5}In_{0.5}P$ LED structures is investigated by overstress experiments. The experimental data are analyzed with regard to the characteristic dependence of each of the concurring degradation mechanisms on the stress and measurement power density. Therefore a multi component defect evolution approach is used describing simultaneous growth and annealing of defects with different characteristic time constants. In combination to this approach the rate equation model for radiative and non-radiative recombination and leakage losses is applied. In such a way access to a further understanding of the origin of the different occurring aging mechanisms is provided, whose superposition can lead to a quite complex overall LED degradation behavior.

HL 18.2 Mon 15:15 H16

Red quantum dot based semiconductor disk laser — •Thomas Schwarzbäck, Roman Bek, Fabian Hargart, Christian A. Kessler, Hermann Kahle, Elisabeth Koroknay, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen and Research Center SCoPE, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

Since the pioneering work of Kuznetsov et al. in 1997, semiconductor disk lasers also known as vertical external cavity surface-emitting lasers (VECSELs) have excited growing interest in science. These kinds of lasers combine some advantages, which none of the remaining semiconductor laser sources can offer. High continuous-wave (cw) output power and near-diffraction-limited beam quality with a TEM00 Gaussian beam profile are somewhat unique. Meanwhile not only quantum wells but rather quantum dots (QDs) are used as gain material, where theory promises stunning properties like higher and broader gain or temperature insensitive low threshold. This make QD-VECSELs predestinated for lots of applications in various fields such as medicine, life sciences, display or projection applications and in research.

The QD-VECSEL is fabricated via metal-organic vapor-phase epitaxy. The fundamental laser emission around 650 nm is provided by InP QDs embedded in a separate confinement heterostructure. We will present laser characteristics as well as output powers exceeding 1.3 W.

HL 18.3 Mon 15:30 H16

Passively mode-locked red AlGaInP-VECSEL emitting < 50 ps pulses — •Roman Bek, Hermann Kahle, Thomas Schwarzbäck, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen and Research Center SCoPE, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

Since the first introduction of a semiconductor saturable absorber mirror (SESAM) into a vertical external cavity surface-emitting laser (VECSEL) in 2000, there has been substantial progress regarding pulse duration, repetition rate and output power. Despite the numerous advantageous properties of these mode-locked VECSELs like the possibility of bandgap engineering and near-diffraction-limited beam quality, most research has been limited to the infrared spectral range from 830 nm to 1.5 μm. We present SESAM mode locking of a VECSEL producing pulses with a FWHM duration below 50 ps and a repetition rate of 810 MHz at around 665 nm. The metal-organic vapor-phase epitaxy fabricated structures include a Bragg mirror consisting of 55 $\lambda/4$ pairs of AlGaAs/AlAs on a GaAs substrate. The following active region of the VECSEL has a resonant periodic gain structure containing 20 GaInP quantum wells. Two of the same quantum wells serve as absorber layers in the SESAM using fast surface recombination. The SESAM structure has a resonant design with an additional SiO_2 coating for low saturation fluence and a flat group delay dispersion. We use a V-shaped cavity with an overall length of 185 mm to strongly focus onto the SESAM where the folding mirror is used for outcoupling.

HL 18.4 Mon 15:45 H16

Implementation of diffractive optical elements into AlGaInP-based vertical-cavity surface-emitting lasers for beam shaping — •Susanne Weidenfeld[1], Hendrik Niederbracht[1], Thomas Schwarzbäck[1], Frederik Schaal[2], Christoph Pruss[2], Wolfgang Osten[2], Michael Jetter[1], and Peter Michler[1] — [1]Institut für Halbleiteroptik und Funktionelle Grenzflächen, University of Stuttgart, Stuttgart, Germany — [2]Institut für Technische Optik, University of Stuttgart, Stuttgart, Germany

Vertical-cavity surface-emitting lasers (VCSELs) have all kinds of applications, like in the field of optical data transmission, in optical computer mice, laser printing and sensor applications. The idea is now the development of a compact micro optical device for non-pixelated spatial polarization control of an incoming light field. Here, the red-emitting AlGaInP-based VCSEL will act as a lighting module for a photo-addressable layer. With the monolithic integration of an oxide aperture, the transverse beam profile can be defined. The vertical structure of these lasers and thus the on-wafer processing offers also the opportunity to implement beam shaping optics monolithically in the top surface. The aim of these additional features is the manipulation of the laser beam for special device applications. We present first steps towards integrating a diffractive optical element (DOE) directly into the top mirror of the VCSEL. Different measurements will be presented to determine the optical and electrical characteristics of the VCSEL, especially to analyze the effect of the DOE on the beam profile.

HL 18.5 Mon 16:00 H16

Harmonic emission intensity modulation of a microlaser using picosecond acoustics — •Thomas Czerniuk[1], Christian Brüggemann[1], Andrey V. Akimov[2,3], Christian Schneider[4], Sven Höfling[4], Alfred Forchel[4], Dimitri R. Yakovlev[1,2], and Manfred Bayer[1] — [1]Experimentelle Physik 2, TU Dortmund, 44221 Dortmund, DE — [2]A. F. Ioffe Physical Technical Institute, 194021 St Petersburg, RU — [3]School of Physics and Astronomy, University of Nottingham, NG7 2RD, UK — [4]Technische Physik, Universität Würzburg, 97074 Würzburg, DE

We demonstrate a harmonic $\sim$10 GHz modulation of the microcavity laser emission intensity using picosecond strain pulses. The gain medium of the microlaser is an 11 meV broad inhomogenious InGaAs quantum dot ensemble. These QD's are placed inside a resonant optical AlAs/GaAs Bragg reflector microcavity with a linewidth of 1.2 meV. This results in a inefficient coupling for a large fraction of the quantum dot ensemble to the laser mode. An optically excited broadband strain pulse propagates through the cavity and, once hitting the QD's, shifts their transition energies by $\sim$10 meV within picoseconds. This couples more QD's into the laser mode, thereby increasing the emission intensity. Due to the acoustic mismatch of AlAs and GaAs, the Bragg reflectors also work for phonons, increasing the lifetime of 16.6 GHz phonons inside the cavity. The effect is maximal, if the laser is pumped slightly above the lasing threshold, where we observe GHz modulations with a relative amplitude of 1.5 for more than 300 ps, much longer than the duration of the strain pulse.

HL 18.6 Mon 16:15 H16

High Modal Gain 1.55 μm InAs/InP(100) Based Quantum Dot Lasers with High Wavelength Stability — •Vitalii Sichkovskyi, Vitalii Ivanov, and Johann Peter Reithmaier — Institute of Nanostructure Technologies and Analytics, CINSaT, University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel, Germany

Self-organized InAs/InP quantum dot systems are promising candidates for telecommunication applications at 1.55 μm. Based on a novel quantum dot (QD) growth technique, high density dot-like QDs can be grown on (001) InAlGaAs surfaces which results in a strongly improved modal gain per QDs layer. Here we report on the influence of the number of QD layers on static properties of the laser. By reducing the number of QD layers to only three or even two layers, i.e., lowering the modal gain, the wavelength shift with temperature can be reduced. The broad area lasers processed from such laser structure revealed small coefficients of their wavelength variation with temperature, whose values decreased with decreasing the cavity length down to a remarkably low value of 0.07 nm/K, which is 5 times less than for QW lasers. As a proof of high modal gain material, ridge waveguide lasers with only one active InAs QDs layer and cavity lengths of

2025 μm could be operated at room temperature. The threshold current was measured to 130 mA and a total cw output power of 9 mW was obtained. The laser structures with specially optimized design for high-speed telecom applications will be presented and discussed.