HL 35: Semiconductor laser

Time: Tuesday 11:15–12:45 Location: EW 203

HL 35.1 Tue 11:15 EW 203

InP-based narrow-linewidth widely tunable QD-DFB-lasers — •Annette Becker[1], Marko Bjelica[2], Vitalii Sichkovskyi[1], Anna Rippien[1], Florian Schnabel[1], Philipp Baum[1], Bernd Witzigmann[2], and Johann Peter Reithmaier[1] — [1]Technische Physik, Institute of Nanostructure Technologies and Analytics (INA), CINSaT, University of Kassel — [2]Computational Electronics and Photonics, CINSaT, University of Kassel

For high-capacitance coherent optical communication narrow-linewidth widely tunable DFB lasers as reference lasers are needed.InP based quantum dot (QD) material developed for 1.55 μm enables tailoring of device properties, like gain bandwidth and low linewidth enhancement factor (α-factor) favorable for such an application. Theoretical considerations taking into account the quasi zero-dimensional nature of the active zone, clearly predict a strong reduction of the laser linewidth by appropriate tailoring the QD material design. QD lasers with 2 and 5 QD layers were grown and distributed feedback (DFB) lasers fabricated with integrated micro-heaters. A continuous single-mode thermal tuning range up-to 10 nm and a linewidth considerably below 1 MHz could be obtained with DFB lasers consisting of 5 QD layers. A comparison of the two designs confirms the theoretically predicted trend of reduced linewidth for the high-gain design with 5 QD layers, which can be related to a reduction of the α-factor.

HL 35.2 Tue 11:30 EW 203

High UV-Power by a frequency doubled AlGaInP-VECSEL — •Stefan Baumgärtner, Hermann Kahle, Roman Bek, Thomas Schwarzbäck, Michael Jetter, and Peter Michler — Universität Stuttgart, Institut für Halbleiteroptik und Funktionelle Grenzflächen and Research Center SCoPE, Allmandring 3, 70569 Stuttgart

We present a frequency-doubled, optically pumped vertical-external-cavity surface-emitting laser (VECSEL), exceeding continuous-wave output power of 400 mW in the ultraviolet spectral region at 332 nm which is a huge improvement to earlier publications [1]. The VECSEL structure was grown by metal-organic vapor-phase epitaxy with an inhomogeneous quantum well (QW) distribution optimized due to the absorption of the pump laser [2].

The ultraviolet light was generated in a v-shaped cavity by intra-cavity frequency-doubling using β-Bariumborate as a nonlinear crystal. Using a birefringent filter inside the cavity the emission wavelength can be tuned totally 14.9 nm in the ultraviolet spectral region. Also power transfer measurements were performed with a maximum output power of 429 mW at 332 nm. The intensity of the second harmonic beam can be simulated with the theory of Boyd and Kleinman. Current work is focusing on the usage of other nonlinear crystals, namely Bismuthborate and Lithiumtriborate.

[1] Kahle, Bek, et al. J. of appl. Phys. Ex., 7, 092705, (2014) [2] Baumgärtner, Kahle, et al. J. of Crystal Growth, DOI: 10.1016/j.jcrysgro.2014.10.016

HL 35.3 Tue 11:45 EW 203

Mode-locked QD-VECSEL emitting picosecond pulses at 650 nm — •Roman Bek, Grizelda Kersteen, Stefan Baumgärtner, Fabian Sauter, 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

We present a SESAM mode-locked VECSEL emitting at 650 nm with a FWHM pulse duration in the order of a picosecond. A v-shaped cavity with the semiconductor samples as end mirrors and a highly reflective output coupler as folding mirror was used to tightly focus onto the absorber region. As active material, both the gain chip and the absorber contain InP-QDs embedded in $Al_{0.1}GaInP$ and $Al_{0.55}GaInP$. The semiconductor structures were grown by MOVPE in an anti-resonant design. In order to increase the field enhancement and therefore reduce the saturation fluence, SESAM samples were additionally coated with fused silica layers of different thicknesses. For an overall resonant design, the mode locking operation is found to be more stable, but with an increased pulse duration. Therefore we were able to use an output coupler with a slightly reduced reflectivity (99.7 %), resulting in an average output power of more than 10 mW. Current research is made towards intra-cavity frequency doubling of the mode-locked VECSEL.

HL 35.4 Tue 12:00 EW 203

Impact of nanomechanical resonances on the lasing of electrically pumped quantum dot micropillars — •Thomas Czerniuk[1], Andrey Akimov[2,5], Jan Tepper[1], Sebastian Unsleber[3], Christian Schneider[3], Martin Kamp[3], Sven Höfling[4], Dmitri Yakovlev[1,5], and Manfred Bayer[1,5] — [1]TU Dortmund, Dortmund, Germany — [2]University of Nottingham, Nottingham, United Kingdom — [3]University of Würzburg, Würzburg, Germany — [4]University of St Andrews, St Andrews, United Kingdom — [5]Ioffe Physical-Technical Institute, St. Petersburg, Russia

We use a picosecond acoustics technique to modulate the laser output of electrically pumped GaAs/AlAs micropillar lasers with InGaAs quantum dots. The modulation of the emission wavelength takes place on the frequencies of the nanomechanical extensional and breathing (radial) modes of the micropillars. The amplitude of the modulation for various nanomechanical modes is different for every micropillar which is explained by a various elastic contact between the micropillar walls and polymer environment.

HL 35.5 Tue 12:15 EW 203

Metal grating based Interband Cascade Lasers from 3-6 microns — •Julian Scheuermann[1], Michael von Edlinger[1], Robert Weih[2], Lars Nähle[1], Marc Fischer[1], Johannes Koeth[1], Sven Höfling[2], and Martin Kamp[2] — [1]nanoplus GmbH, Oberer Kirschberg 4, 97218 Gerbrunn, Germany — [2]Technische Physik Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

The wavelength region from 3 to 6 microns is of great interest for gas sensing, since many gases have their strongest absorption features in this range. A common approach for highly accurate detection is the so called tunable laser spectroscopy, using distributed feedback (DFB) lasers. Monomode DFB type interband cascade lasers (ICLs) can address the spectral range of interest with superior performance and show low threshold currents as well as low power consumption, which is essential for the application in modern gas sensing systems.

We will report on the fabrication and characterization of novel ICL DFB lasers with lateral metal grating structure. The performance characteristics of fabricated devices are discussed. The definition of the ridge waveguide structure by dry etching and the metal grating structure by electron beam lithography are particular critical processing steps having a high influence on mono mode performance and tuning behavior. Single mode continuous wave emission at room temperature was obtained for various laser structures emitting in the 3-6 μm region with current tuning range up to 22 nm and (noise limited) side mode suppression ratios in excess of 30 dB. Threshold currents below 10 mA and output powers above 20 mW have been observed.

HL 35.6 Tue 12:30 EW 203

Microscopic model for intersubband gain from electrically pumped quantum-dot structures — •Stephan Michael[1], Weng Wah Chow[2], and Hans Christian Schneider[1] — [1]Department of Physics, University of Kaiserslautern, P.O. Box 3049, 67653 Kaiserslautern, Germany — [2]Sandia National Laboratories, Albuquerque, NM 87185-1086, USA

Quantum cascade lasers (QCLs) based on quantum wells (QWs) has been an exciting topic of research for decades. QCLs can operate up to and above room temperature and can produce a high output power. An alternative would be QCLs consisting of self-assembled quantum dots (QDs). Steps in this direction are midinfrared photodetectors using QDs, which include the demonstration of midinfrared electroluminescence at low and more recently also in room temperature. In this contribution, we investigate theoretically the performance of electrically pumped self-organized QDs as gain material in the mid-IR range at room temperature. Therefore, we analyze a comprehensive model based on an AlGaAs structure composed of dots-in a-well sandwiched between two QWs. We find that steady-state gain requires an efficient extraction process, that prevents an accumulation of electrons in the continuum states of the QDs. However, comparing the modal gain to a standard QW structure as used in QCLs, our calculation predict reduced threshold current densities of the QD structure for comparable modal gain. But this is only possible for an inhomogeneous broadening of a QD ensemble that is close to the lower limit achievable today using self-organized growth.