HL 4: Semiconductor Laser I

Time: Monday 10:45–13:00 Location: H13

HL 4.1 Mon 10:45 H13

High-temperature measurements and reliability of red 660 nm AlGaInP-VCSEL — •Marcus Eichfelder[1], Robert Rossbach[1], Michael Jetter[1], Heinz Schweizer[2], and Peter Michler[1] — [1]Institut für Strahlenphysik, Allmandring 3, 70569 Stuttgart, Germany — [2]4. Physikalisches Institut, Pfaffenwaldring 57, 70569 Stuttgart, Germany

In this paper we discuss the potential and the possible limitations of the AlGaInP material system and its consequences for the application as vertical-cavity surface-emitting lasers (VCSEL). Epitaxial and technological solutions were presented to overcome some parts of the inherent problems. Measurements of internal heating of oxide-confined 660 nm AlGaInP-VCSEL are compared with calculated data by a cylindrical heat dissipation model to improve the heat removal out of the device. Pulsed lasing operation of a 660 nm VCSEL at +140°C heatsink temperature is demonstrated, where we exceeded more than 0.5 mW and at 170°C more than 0.1 mW output power was achieved. Continuous-wave measurements of our 660 nm devices show laser emission at 60°C with an optical output power over 0.1 mW and operating times of more than 3700 hours without spontaneous failure.

HL 4.2 Mon 11:00 H13

Micro-Raman investigation of facet temperatures during catastrophic optical damage in AlGaInP laser diodes — •Marwan Bou Sanayeh[1], Peter Brick[1], Bernt Mayer[1], Martin Müller[1], Martin Reufer[1], Wolfgang Schmid[1], Klaus Streubel[1], Sandy Schwirzke-Schaaf[2], and Jens Tomm[2] — [1]OSRAM Opto Semiconductors GmbH, Leibnizstr. 4, 93055 Regensburg — [2]Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Max-Born-Str. 2A, 12489 Berlin

Red-emitting AlGaInP lasers have found commercial applications in optical discs, barcode readers, and color printers. Moreover, high-power AlGaInP broad-area lasers are being developed for laser displays, as direct pump sources for Cr:LiSAF fs-lasers, and for the medical field, e.g. in photodynamic therapy. However, high-power applications are still limited by major degradation effects, especially catastrophic optical damage (COD). Facet temperature changes during COD of high-power red-emitting broad-area AlGaInP lasers are analysed by means of micro-Raman spectroscopy. Although no visible damage at the coated output facet can be observed, extreme temperature increase in the immediate vicinity of the COD starting point is detected. Moreover, differences between fresh and >1000h aged lasers are analyzed.

HL 4.3 Mon 11:15 H13

Measurement of the linewidth enhancement factor of semiconductor lasers — •Wolfgang Rick[1], Jens von Staden[1], Tobias Gensty[1], Guido Giuliani[2], and Wolfgang Elsässer[1] — [1]Institut für Angewandte Physik, Technische Universität Darmstadt, Schloßgartenstraße 7, D-64289 Darmstadt — [2]Dipartimento di Elettronica, Università di Pavia, Via Ferrata 1, I-27100 Italy

We present measurements of the linewidth enhancement factor of different semiconductor laser structures using the interferometric self-mixing technique [1]. In our experiments the laser is simultaniously used as emitter and detector, i.e. the self-mixing signal can be obtained by measuring the voltage variations across the laserchip. An alternative possibility is to measure the selfmixing-waveform with a classical setup using a monitor photodiode. In this work both methods are compared with respect to their potential to measure the alpha-factor. We find the electrical signal to be the first choice because of its better signal-to-noise-ratio. Also we present a statistical analysis of the alpha-measurement that allows to determine alpha and its FWHM and gives an overview of its temporal development. Finally we report on our results measuring the alpha-factor of a Quantum Dot laser.
[1] Y. Yu, G. Giuliani and S. Donati, IEEE Photon. Technol. Lett., vol. 16, pp. 990-992, April 2004.

HL 4.4 Mon 11:30 H13

Measurements of the Linewidth Enhancement Factor of Distributed Feedback Quantum Cascade Lasers by the Self-Mixing Technique — •Jens von Staden[1], Tobias Gensty[1], Wolfgang Elsässer[1], Guido Giuliani[2], and Christian Mann[3] — [1]Institut für Angewandte Physik, Technische Universität Darmstadt, Schloßgartenstraße 7, 64289 Darmstadt, Germany — [2]Dipartimento di Elettronica, Laboratorio Elettroottica, Università di Pavia, Via Ferrata 1, Pavia I-27100, Italy — [3]Fraunhofer-Institut für Angewandte Festkörperphysik (IAF), Tullastrasse 72, 79108 Freiburg, Germany

We present measurements of the linewidth enhancement (α) factor of a distributed feedback (DFB) quantum cascade laser (QCL), using the interferometric self-mixing technique. The vality of this method has been shown for interband semiconductor lasers and is now transferred to the mid infrared wavelength range. In our experiments we use the QCL also to detect the self-mixing waveform by measuring the voltage drop variations across the device. The obtained self-mixing signal can then be used to evaluate both, the linewidth as well as the α-factor. Theoretical considerations predict the linewidth of QCLs to be extremly small. Limited by the resolution of the improved experimental setup, a reduced upper limit for the linewidth can be given. Our investigations of the α-factor have revealed a strong dependence on the injection current. Therefore the underlying mechanisms are further investigated. Thus we present measurements of the influence of the temperature dependent misalignment of the DFB grating on the value of the α-factor.

HL 4.5 Mon 11:45 H13

Tunable two color semiconductor lasers — •Carsten Brenner, Claus-Stefan Friedrich, Michael Breede, Stefan Hoffmann, and Martin Hofmann — AG Optoelectronic devices and materials, Ruhr-University Bochum, IC 2/133, Universitätsstr. 150, 44780 Bochum, Germany

We present different concepts for tunable two color and multimode emission by semiconductor lasers. These systems are particularly interesting for terahertz generation, telecommunications and spectroscopy. Simultaneous lasing on different frequencies is achieved using three different external cavity setups:

The first design is based on a structured end mirror in an external cavity. The emitted frequencies are selected by the geometry of the mirror. For the second configuration the end mirror of the external cavity is replaced by a digital micromirror device, hence the tuning can be achieved all electrically without any moving mechanical parts. To improve the spectral purity of the two colors we introduce a final setup incorporating a prism to achieve a double Littman geometry. In this layout both frequencies can be tuned separately.

HL 4.6 Mon 12:00 H13

Low threshold 1260nm (GaIn)(NAs) semiconductor disk laser — •Wolfgang Diehl[1,2], Bernadette Kunert[2], Stefan Reinhard[2], Peter Brick[1], and Wolfgang Stolz[2] — [1]OSRAM Opto Semiconductors, Leibnizstr. 4, D-93055 Regensburg, Germany — [2]Philipps-University Marburg, Hans Meerwein Str., D-35032 Marburg, Germany

We demonstrate low threshold lasing in semiconductor disk lasers emitting at 1260nm. Threshold densities as low as 1,1kW/cm^2 and slope efficiencies of 12,9% were achieved at 20°C while barrier pumping in pulsed operation. No intracavity heatsink was used so in cw-operation the bottomemitter reached 75°C while emitting more than 120mW. Thermal resistance of our chips was determined to be 50K/W. Nevertheless threshold densities in cw-operation were around 1,3kW/cm^2 with slope efficiencies of 11,4%. The performance of barrier pumping compared to direct well pumping showed only little difference in pulsed mode, reaching 1,4kW/cm^2 with slope efficiencies of 10,7%.

HL 4.7 Mon 12:15 H13

Tuneable Turnkey THz Sources Based on Diode Lasers — •Sebastian Berning, Icksoon Park, Tobias Gensty, and Wolfgang Elsässer — Institut für Angewandte Physik, Technische Universität Darmstadt, Schloßgartenstraße 7, D-64289 Darmstadt

The continuous-wave generation of Terahertz (THz) radiation by means of diode laser devices has experienced extensive research in the past decade. A promising approach in this field of research is based on laser diodes in an external double-cavity setup simultaneously operating at two wavelengths (2λ-ECDL) to drive non-linear photomixers emitting cw radiation at the difference frequency in the THz regime. In the present work, we address the long-term stability of the laser

setup combined with fast, repeatable scanning throughout the entire frequency range, as desirable for spectroscopic applications. For this purpose, we realize a two-colour ECDL device with a new low-loss cavity design allowing simple control of all relevant beam parameters, as the total and relative intensities, the beat frequency and the absolute wavelengths of the two laser modes. Furthermore, we present how modern microprocessor control is introduced to the miniaturized setup in order to enable active stabilization of the above discussed beam properties, allowing for extensive parameter studies and systematic optimizations for this class of THz sources.

HL 4.8 Mon 12:30 H13

Amplified hybrid-mode-locked semiconductor laser in an external cavity with intracavity dispersion control — •Tobias Schlauch[1], Tuyen Le[1], Stefan Hoffmann[1], Martin Hofmann[1], Andreas Klehr[2], and Götz Erbert[2] — [1]AG Optoelektrische Bauelemente und Werstoffe, Ruhr Universität Bochum, D-44780 — [2]Ferdinand Braun Institut für Höchstfrequenztechnik, D-12489 Berlin, Germany

Laser diodes are attractive sources for short pulse generation. Due to their compactness and cost effectiveness, they could be a very promising alternative to the conventional complex and expensive optically pumped short pulse lasers. However, though the gain bandwidth of laser diodes is sufficient for the generation of sub – 100fs pulses, pulses below 1ps are rather difficult to achieve in practice. Critical for shorter pulses is the significant chirp caused by the strong coupling of real and imaginary part of the susceptibility in the semiconductor. While optically pumped solid state femtosecond lasers contain elements for intracavity dispersion control, this concept is rarely used in short pulse diode lasers. We present an approach of an amplified hybrid-mode-locked two-section laser diode in an external cavity. The cavity contains elements which enable spatial separation of the spectral components. A spatial light modulator is used to control phases and amplitudes of the individual spectral components.

HL 4.9 Mon 12:45 H13

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