# Advance Program

## Sunday, 14 September 2008

### SHORT COURSES WILL BE HELD IN NETTUNO I

### Short Courses

**SC1 10.00 - 12.00**

**High Power, High Brightness Laser Diode Technology,** Dr. Berthold Schmidt*, Bookham AG, Switzerland*

**SC2 13.00 - 15.00**

**Photonic Crystal Lasers,** Prof. Yong-Hee Lee, *Korea Advanced Institute of Science & Technology, Korea*

**SC3 15.30 - 17.30**

**Tunable Laser Diodes,** Dr. Jens Buus*, Gayton Photonics, UK*

**19.00 - 20.00** **WELCOME RECEPTION**

## Monday, 15 September 2008

### ALL SESSIONS WILL BE HELD IN SIRENE

**08.45 - 11.45**

**Session MA:** **INVITED REVIEW TALKS**
**Session Chair:** Fumio Koyama, *Tokyo Institute of Technology, Yokohama, Kanagawa,* and Anders Larsson, *Chalmers University of Technology, Göteborg, Sweden*

**08.45 - 09.00** **OPENING REMARKS**

**MA1 09.00 - 09.45 (Invited)**

**Developments of Long Wavelength VCSELs,** E. Kapon*, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland*

ABSTRACT NOT AVAILABLE

**09.45 - 10.15** **COFFEE BREAK**

**MA2 10.15 - 11.00 (Invited)**

**Advances in Quantum Dot Lasers and Single Photon Emitters: From Science to Practical Implementation,** Y. Arakawa*, University of Tokyo, Meguro, Tokyo, Japan*

We review recent advances in quantum dot (QD) lasers including highly temperature stable lasers with p-doping, MOCVD-grown lasers at 1.3 μm and photonic crystal nanocavity lasers. Application of the QD to single photon emitters is also discussed.

**MA3 11.00 - 11.45 (Invited)**

**Monolithic, Multi-Channel DWDM Transmitter Photonic Integrated Circuits,** R. Nagarajan, M. Kato, S. Corzine, P. Evans, C. Joyner, R. Schneider, F. Kish and D. Welch*, Infinera, Sunnyvale, CA, USA*

In this presentation we will review the progress in monolithic integration of multi-channel transmitter photonic integrated circuits on InP. The level of complexity has extended to over 200 discrete functions being integrated on a single substrate, including optical signal amplification, and demonstration of multi channel devices capable of aggregate data rates in excess of 1Tb/s.

**11.45 - 13.30** **LUNCH BREAK**

**13.30 - 15.30**

**Session MB:** HIGH-SPEED LASERS AND DIGITAL MODULATION
**Session Chair:** John E. Bowers, *University of California - Santa Barbara, Santa Barbara, CA, USA* and Shinji Tsuji, *Hitachi, Ltd., Tokyo, Japan*

**MB1 13.30 - 13.45**

**Large Aperture 850 nm VCSEL operating at 28 Gbit/s,** P. Westbergh, J. S. Gustavsson, Å. Haglund and A. Larsson, *Chalmers University of Technology, Göteborg, Sweden*

We report on large aperture, oxide-confined VCSELs at 850 nm with modulation bandwidths in excess of 20 GHz and demonstrate large-signal modulation up to 28 Gbit/s at a bias current density of only 10 kA/cm$^2$.

**MB2 13.45 - 14.00**

**120º C 20 Gbit/s Operation of 980 nm Single Mode VCSEL,** A. Mutig, G. Fiol, P. Moser, F. Hopfer, M. Kuntz, V. A. Shchukin, N. N. Ledentsov, D. Bimberg, *Technical University Berlin, Berlin, Germany*, S. S. Mikhrin, I. L. Krestnikov, D. A. Livshits and A. R. Kovsh, *Innolume GmbH, Dortmund, Germany*

Single mode 980 nm VCSEL show under 20 Gbit/s large signal modulation clearly open eyes without adjustment of the laser current and modulation voltage between 25 and 120°C.

**MB3 14.00 - 14.15**

**1.3 µm InGaAlAs/InP VCSEL for 10G Ethernet,** W. Hofmann, *Technical University of Munich, Munich, Germany*, M. Ortsiefer, E. Roenneberg, C. Neumeyr, *VertiLas GmbH, Garching, Germany*, G. Boehm and M.-C. Amann, *Technical University of Munich, Munich, Germany*

1.3 µm InGaAlAs/InP VCSELs for 10G Ethernet solutions are presented. High modulation bandwidth and error-free data transmission at 10.3 Gb/s up to 75°C over 10 km of SMF is demonstrated.

**MB4 14.15 - 14.30**

**Uncooled 10Gb/s Transmission Over 20 km of Standard Fibre at 1.55µm with Directly Modulated Quantum Dot DFB Laser,** R. Brenot, *Alcatel Thales III-V Lab, Palaiseau, France*

We study modulation properties of state-of-the-art quantum dot lasers and compare them with state-of-the-art quantum well lasers. In particular, we demonstrate uncooled transmission over 20 km at 10 Gbit/s, limited by a large adiabatic chirp.

**MB5 14.30 - 14.45**

**Ultra-High Speed 1.3µm Complex-Coupled DFB Lasers for future uncooled 10Gb/s GPON,** H. Lu, J.-S. Huang and H. Su, *Emcore Corp., Alhambra, CA, USA*

Uncooled 1.3µm InGaAsP/InP BH DFB lasers with complex-coupled design have shown stable single mode operation and high-speed performances, exceeding 10Gb/s from -40°C to 85°C, making devices suitable for future 10Gb/s GPON.

**MB6 14.45 - 15.00**

**10-Gbit/s, 200 km Duobinary SMF Transmission using a Full C-Band Tunable DFB Laser Array Co-Packaged with InP Mach-Zehnder Modulator,** K. Tsuzuki, Y. Shibata, N. Kikuchi, M. Ishikawa, T. Yasui, H. Ishii and H. Yasaka, *NTT Corporation, Atsugi, Kanagawa, Japan*

Full C-band 200 km optical duobinary transmission with a constant modulation voltage is demonstrated by using a wavelength tunable laser co-packaged with an InP Mach-Zehnder modulator. We developed a multi-chip assembly technology for high optical coupling efficiency and achieved an output power of +6.5 dBm.

**MB7 15.00 - 15.15**

**40-Gb/s Direct Modulation of 1.3-µm Semi-Insulating Buried-Heterostructure AlGaInAs MQW DFB Lasers,** K. Otsubo, M. Matsuda, K. Takada, S. Okumura, M. Ekawa and T. Yamamoto, *Fujitsu Laboratories Ltd., Atsugi, Kanagawa, Japan*

High relaxation oscillation frequency of 20.5 GHz and its slope of 3.2 GHz/√mA were obtained by SI-BH 1.3-µm AlGaInAs MQW DFB lasers. Eye-opening up to 50ºC was demonstrated as a result of 40-Gb/s direct modulation.

**MB8 15.15 - 15.30**

**Highly External Optical Feedback Tolerant 1.49-micron Single-Mode Lasers with Partially Corrugated Gratings,** M. Gotoda, T. Nishimura, K. Matsumoto, T. Aoyagi and K. Yoshiara, *Mitsubishi Electric Corporation, Amagasaki, Hyogo, Japan*

An InGaAsP single-mode (SMSR >40dB) laser diode, with high endurance against external optical feedback, was realized utilizing an optimized partially corrugated grating. The relative intensity noise (RIN) was maintained below -120 dB/Hz under external optical feedback as high as -10 dB.

**15.30 - 16.00** **COFFEE BREAK**

**16.00 - 18.00**

**Session MC:** **QUANTUM DOT LASERS**
**Session Chair:** Mario Dagenais, *University of Maryland, College Park, MD, USA* and Peter Blood, *Cardiff University, Cardiff, Wales, UK*

**MC1 16.00 - 16.15**

**High Power, Broad Spectral Width, 1300nm Quantim-Dot Superluminescent Diodes,** M. Krakowski, P. Resneau, M. Calligaro, *Alcatel Thales III-V Lab, Palaiseau, France*, M. Hugues, M. Hopkinson, *University of Sheffield, Sheffield, UK*, M. Gioannini, P. Bardella and I. Montrosset, *Politecnico di Torino, Torino, Italy*

1300nm InAs quantum dot narrow ridge superluminescent diodes have reached a high power of 70mW/facet under CW operation, together with a broad spectral width of 80nm.

**MC2 16.15 - 16.30**

**Single Mode Quantum Dot Tapered Lasers,** P. Weinmann, C. Zimmermann, T. Schlereth, C. Schneider, S. Hoefling, M. Kamp and A. Forchel, *Universität Würzburg, Wuerzburg, Germany*

Single mode emission of tapered lasers was achieved by an on-chip distributed Bragg reflector. The quantum dot based devices show stable single mode emission around 920nm, good beam quality and output powers up to 2W.

**MC3 16.30 - 16.45**

**Regimes of Mode-locking in Tapered Quantum Dot Laser Diodes,** M. G. Thompson, R. V. Penty and I. H. White, *University of Cambridge, Cambridge, UK*

Mode-locking regimes in a tapered quantum-dot laser diode are investigated. A range of distinctly different operating regimes are identified, including ultra-short pulse and dual wavelength mode-locking. Fourier-limited 360fs pulse generation is achieved.

**MC4 16.45 - 17.00**

**Decoupled Electron and Hole Dynamics in the Turn-on Behavior of Quantum-Dot Lasers,** K. Luedge, E. Malic, M. Kuntz, D. Bimberg and E. Schoell, *Technical University Berlin, Berlin, Germany*

The complex turn-on behavior of semiconductor quantum-dot lasers is determined by the nonlinearity of the carrier-carrier scattering rates. Hole- and electron dynamics in the dots decouple leading to small cutoff frequencies of these lasers.

**MC5 17.00 - 17.15**

**InP / AlGaInP Short Wavelength Quantum Dot Lasers,** P. M. Smowton, M. Al-Ghamdi, S. N. Elliott, G. T. Edwards, P. Blood, *Cardiff University, Cardiff, Wales, UK* and A. B. Krysa, *University of Sheffield, Sheffield, UK*

We demonstrate MOVPE grown InP q-dot lasers with low threshold current density (195 $Acm^{-2}$ for 2000μm long uncoated devices at 300K) and extended wavelength-coverage (680-740nm). Modulation p-doping reduces gain saturation in lower confinement structures.

**MC6 17.15 - 17.30**

**Very Low Threshold Current Density Continuous Wave Quantum Dot Laser Diode,** D. G. Deppe, S. Freisem, G. Ozgur, K. Shaviritranuruk and H. Chen, *University of Central Florida, Orlando, FL, USA*

Broad area laser diodes are demonstrated that operate at the wavelength 1.22 μm and deliver a power level > 1 W with threshold current densities < 13 $A/cm^2$.

**MC7 17.30 - 17.45**

**Measurement of Linewidth Enhancement Factor in 1.3μm Quantum Dot and Quantum Well Vertical-Cavity Surface-Emitting Lasers,** P.-C. Peng, *National Chi-nan University, Nantou, Taiwan,* C. E. Yeh, H. C. Kuo, S. H. Yang, G. Lin, S. C. Wang, *National Chiao Tung University, Hsinchu, Taiwan, R.O.C.*, R. Xuan, *Industrial Technology Research Institute, Hsinchu, Taiwan, R.O.C.*, J. Y. Chi, *National Dong Hwa University, Hualien, Taiwan, R.O.C*.

This work for the first time, experimentally investigated the linewidth enhancement factor (a factor) of quantum dot vertical cavity surface emitting laser. a factor values between 0.48 and 0.60 were measured.

**MC8 17.45 - 18.00**

**Dynamic Properties of InAs/InP (311)B Quantum Dot Lasers Emitting at 1.52 μm,** A. Martinez, K. Merghem, *Laboratoire de Photonique et de Nanostructures, Marcoussis, France*, J.-G. Provost, *Alcatel Thales III-V Lab, Marcoussis, France*, S. Bouchoule, *Laboratoire de Photonique et de Nanostructures, Marcoussis, France*, F. Martin, *Alcatel Thales III-V Lab, Marcoussis, France*, G. Moreau, *Laboratoire de Photonique et de Nanostructures, Marcoussis, France*, F. Grillot, R. Piron, *Rennes Scientific and Technical University, Rennes, France*, O. Dehaese, *Lab. d'Etude des Nanostructures a Semiconducteurs, Rennes, France*, K. Tavernier, S. Loualiche, *Rennes Scientific and Technical University, Rennes, France* and A. Ramdane, *Laboratoire de Photonique et de Nanostructures, Marcoussis, France*

Microwave frequency properties of truly 3-dimensional confined quantum dot lasers on InP substrate are thoroughly investigated for the first time. A relaxation frequency of 3.7 GHz and a Henry factor of ~ 7 are measured.

**20.00 - 22.00** **RUMP SESSION I**

**TO DOT OR NOT TO DOT, THAT IS THE QUESTION?**

Dieter Bimberg, *Technical University of Berlin, Germany*

**Room: Nettuno IV**

**Quantum Dot Lasers and Integrated Optoelectronics on a Si Platform,** P. Bhattacharya, *University of Michigan, USA*

**Quantum Dot Semiconductor Optical Amplifiers,** G. Eisenstein, *Technion Haifa, Israel*

**Ultra High Speed Surface Emitting Quantum Dot Lasers,** N. Ledentsov, *Ioffe Institute and VI Systems, Germany*

**Mode-Locked QD Lasers for the 100 G Ethernet,** M. Kuntz, *University of California - Berkeley, USA*

# Tuesday, 16 September 2008

**08.30 - 10.00**

**Session TuA:** **LONG WAVELENGTH LASERS**

**Session Chair:** Joseph H. Abeles, *Sarnoff Corporation, Princeton, NJ, USA* and Johann P. Reithmaier, *University of Kassel, Kassel, Germany*

**TuA1 08.30 - 08.45**

**GaSb-based Electrically Pumped VCSEL with Buried Tunnel Junction Operating Continuous Wave up to 50°C,** A. Bachmann, K. Kashani-Shirazi, and M.-C. Amann, *Technical University of Munich, Garching, Munich, Germany*

2.33 µm electrically pumped GaSb-based VCSELs with low threshold currents, continuous-wave and single-mode operation up to 50°C are presented. The devices are (electro-) thermally tunable over 10nm.

**TuA2 08.45 - 09.00**

**GaSb-based Microcavity EP-VCSEL Emitting Above 2.2 µm in CW Regime at RT,** A. Ducanchez, L. Cerutti, P. Grech and F. Genty, *University of Montpellier 2, Montpellier, France*

Monolithic microcavity GaSb-based VCSELs emitting above 2.2 µm in Continuous Wave Regime at Room Temperature are reported. For 60µm diameter devices, a density threshold of 1.1 kA/cm$^2$ was measured at 290K.

**TuA3 09.00 - 09.15**

**Injectorless Quantum Cascade Lasers with Threshold Current Densities Below 500 A/cm$^2$,** S. Katz, G. Boehm and M.-C. Amann, *Technical University of Munich, Garching, Munich, Germany*

An injectorless quantum cascade laser design, using four material compositions, and back-facet high-reflective coating is presented. The threshold current density at 300 K and the characteristic temperature were measured with 0.45 kA/cm$^2$ and 140 K, respectively.

**TuA4 09.15 - 09.30**

**Deep-Well 4.8µm Emitting Quantum-Cascade Lasers Grown by MOCVD,** M. D'Souza, J. C. Shin, D. Xu, J. Kirch, L. J. Mawst, D. Botez, *University of Wisconsin-Madison, Madison, WI, USA*, I. Vurgaftman and J. R. Meyer, *US Naval Research Laboratory, Washington, DC, USA*

A novel design for a deep-well InP-based QC-laser structure has been realized using MOCVD growth for emission wavelengths of 4.6µm-4.8µm with low threshold current density (1.5KA/cm$^2$) at room temperature (RT) and reduced temperature sensitivity.

**TuA5 09.30 - 09.45**

**Gamma-L Scattering in InAs-based Quantum Cascade Lasers Studied using High Hydrostatic Pressure,** I. P. Marko, A. R. Adams, S. J. Sweeney, *University of Surrey, Guildford, Surrey, UK*, R. Teissier, A. N. Baranov, *University of Montpellier 2, Montpellier, France* and S. Tomic, *Science and Technology Facilities Councl, Daresbury, UK*

We show that by decreasing the lasing wavelength of InAs/AlSb-based quantum cascade lasers below 3µm, carrier leakage into the L-minimum of conduction band is responsible for their temperature sensitivity and limits their maximum operating temperature.

**TuA6 09.45 - 10.00**

**Terahertz Silicon Lasers,** S. Pavlov, H.-W. Hübers, U. Böttger, *German Aerospace Center, Berlin, Germany*, R. K. H. Zhukavin, V. V. Tsyplenkov, K. A. Kovalevsky and V. N. Shastin, *Institute For Phasics Of Microstructures, Nizhny Novgorod, Russia*

Stimulated donor and Raman Stokes emission in the 1 - 7 THz frequency range has been achieved under intracenter excitation and photoionization of shallow donor centers in silicon at low temperatures ( < 30 K).

**10.00 - 10.30** **COFFEE BREAK**

**10.30 - 12.00**

**Session TuB:** **DILUTE-NITRIDE AND METAMORPHIC LASERS**
**Session Chair:** Luke J. Mawst, *University of Wisconsin-Madison, Madison, WI, USA* and Tsuyoshi Yamamoto, *Fujitsu Laboratories Ltd., Kanagawa, Japan*

**TuB1 10.30 - 10.45**
**1240nm GaInNAs High Power Laser Diodes,** D. Bisping, D. Pucicki, S. Hoefling, *Universität Würzburg, Würzburg, Germany*, S. Habermann, D. Ewert, M. O. Fischer, J. Koeth, *nanoplus Nanosytems and Technologies GmbH, Gerbrunn, Germany*, C. Zimmermann, P. Weinmann, M. Kamp and A. Forchel, *Universität Würzburg, Würzburg, Germany*

GaInNAs-based 1240nm laser diodes are realized with internal losses as low as 0.5cm$^{-1}$ allowing maximum output powers of 9W at room temperature under continuous-wave operation. Wavelength stabilized tapered laser diodes show output powers of 1W and $M^2$ down to 1.4 demonstrating potential for pumping applications.

**TuB2 10.45 - 11.00**

**High Power and Low Resistive GaInNAs-VCSELs with Buried Tunnel Junctions,** Y. Onishi, N. Saga, K. Koyama, H. Doi, T. Ishizuka, T. Yamada, K. Fujii, H. Mori, J.-I. Hashimoto, M. Shimazu and T. Katsuyama, *Sumitomo Electric Industries Ltd., Yokohama, Kanagawa, Japan*

GaInNAs-VCSELs with buried tunnel junction structures are proposed and demonstrated. The maximum output powers of 4.2 mW at 25°C and 2.2 mW at 85°C are achieved with a low resistance of 65 ohms.

**TuB3 11.00 - 11.15**

**Direct Observation of Lateral Carrier Diffusion in Ridge Waveguide 1.3 μm GaInNAs-GaAs Lasers Using Scanning Near-Field Optical Microscopy,** G. Adolfsson, S. Wang, M. Sadeghi, J. Bengtsson, A. Larsson, *Chalmers University of Technology, Goteborg, Sweden*, J. J. Lim, *University of Nottingham, Nottingham, UK*, V. Vilokkinen and P. Melanen, *Modulight, Tampere, Finland*

Scanning near-field optical microscopy measurements of the lateral spontaneous emission profile for narrow ridge waveguide 1.3 μm GaInNAs-GaAs lasers reveal significant lateral carrier diffusion, which can explain the high characteristic temperature of the threshold current.

**TuB4 11.15 - 11.30**

**High Temperature Operation of 1.26 μm Ridge Waveguide Laser with InGaAs Metamorphic Buffer on GaAs Substrate,** M. Arai, T. Fujisawa, W. Kobayashi, K. Nakashima, M. Yuda and Y. Kondo, *NTT Corporation, Atsugi, Kanagawa, Japan*

We have successfully developed a 1.26 μm ridge waveguide laser diode with an InGaAs metamorphic buffer on an GaAs substrate grown by metal-organic vapor-phase epitaxy. This laser has achieved the highest operating temperature (188° C) reported for a metamorphic laser.

**TuB5 11.30 - 11.45**

**Experimental Investigation of Temperature Dependence of 1.55μm GaInNAsSb/GaNAs QW Lasers Grown in MBE,** H. P. Bae, T. Sarmiento and J. S. Harris, *Stanford University, Stanford, CA, USA*

We investigated the temperature dependence of 1.55μm GaInNAsSb/GaNAs QW lasers, with 3 different QW structures. $T_0$ improves by reducing Auger recombination or carrier leakage into GaNAs barrier, but significant improvement of $T_0$ remains challenging and will require a new barrier material.

**TuB6 11.45 - 12.00**

**Thermal Properties of Silicon Compatible GaNAsP SQW Lasers,** J. A. Chamings, A. R. Adams, S. J. Sweeney, *University of Surrey, Guildford, Surrey, UK*, B. Kunert, K. Voltz and W. Stolz, *Philipps University, Marburg, Germany*

We report on the temperature dependent properties of GaNAsP/GaP-based SQW lasers. While the radiative component of threshold is relatively temperature stable, the threshold current increases strongly with temperature and is attributed to a leakage process.

**12.00 - 14.00** **LUNCH BREAK**

**14.00 - 15.30**

**Session TuC:** **NONLINEAR SWITCHING & NOVEL DEVICES**
**Session Chair:** Douglas C. Hall, *University of Notre Dame, Notre Dame, IN, USA* and Ian H. White, *University of Cambridge, Cambridge, UK*

**TuC1 14.00 - 14.15**
**Optical Compensation of Fiber Nonlinearity Using Vertical Micro-cavity Saturable Absorber,** S. Suda, F. Koyama, N. Nishiyama, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*, C. Caneau and C.-E. Zah, *Corning, Inc., Corning, NY, USA*

We demonstrate the optical compensation of self-phase modulation in fiber by using the VCSEL-based nonlinear phase shifter. The transient phase shift of 25psec pulses induced by self-phase modulation in a 25km long fiber could be optically compensated.

**TuC2 14.15 - 14.30**

**Controllable Large I-L Kink of Tunnel Injection Quantum Well Lasers,** Y. Higa, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*

A large kink in I-L characteristics was demonstrated by using a tunnel injection quantum well structure. The output power was changed from 13mW to 1.9mW under a small current change of 0.06Ith and voltage change of 0.3V.The peak/valley ratio of output power was high as 6.8.

**TuC3 14.30 - 14.45**

**Miniature Optical Gate with VCSEL-based Slow Light Bragg Reflector Waveguide,** K. Kuroki, A. Fuchida, T. Sakaguchi, A. Matsutani and F. Koyama, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*

We demonstrate the optical gating function of VCSEL-based active Bragg reflector waveguide with slowing light. The insertion loss decreases with injection current, functioning as an optical gate. An on-off ratio of over 10dB was obtained for 30μm long device nearby the cutoff wavelength.

**TuC4 14.45 - 15.00**

**Switching Time and Response to ps Optical Trigger Pulse of All-Optical Flip-Flop Based on a Monolithic Semiconductor Ring Laser,** A. Trita, *University of Pavia, Pavia, Italy*, G. Mezosi, *University of Glasgow, Glasgow, UK*, F. Bragheri, J. Yu, *University of Pavia, Pavia, Italy*, S. Furst, *University of Glasgow, Glasgow, Scotland, UK*, I. Cristiani, *University of Pavia, Pavia, Italy*, W. Elsaesser, *Technical University Darmstadt, Darmstadt, Germany*, M. Sorel, *University of Glasgow, Glasgow, Scotland, UK* and G. Giuliani, *University of Pavia, Pavia, Italy*

A bistable monolithic semiconductor ring laser (SRL) is demonstrated to operate as an all-optical Flip-Flop that is triggered by optical pulses of 400 ps and 5 ps duration, showing a response time of 130 ps.

**TuC5 15.00 - 15.15**

**Directional Bi-Stability in Micro-Ring and Micro-Disk Lasers,** G. Mezosi, M. J. Strain, M. Sorel, S. Furst, *University of Glasgow, Glasgow, Scotland, UK*, S. Yu, *University of Bristol, Bristol, Avon, UK* and Z. Wang, *University of Glasgow, Glasgow, Scotland, UK*

We fabricated micro-sized semiconductor ring and disk lasers. Devices operate continuous wave down to a radius of 7μm, with robust directional switching exhibited to a radius of 30μm. Additionally, polarisation rotation is reported.

**TuC6 15.15 - 15.30**

**638nm Single Lateral Mode Laser Diode for Micro-Projector Application,** M. Yukawa, N. Shimada, K. Shibata, K.-I. Ono and T. Yagi, *Mitsubishi Electric Corporation, Itami, Hyogo, Japan*

The high-power operation of the lateral single mode 638 nm AlGaInP laser diode was demonstrated. The stable operation up to 220 mW at 55° C was realized. The LD is suitable for Micro Projector.

**15.30 - 16.00**

**TuPP: Poster Preview**

**16.00 - 16.30** **COFFEE BREAK**

**16.30 - 18.00**

**Session P: POSTER SESSION**

**P1 Simulation of Hole Intersubband Scattering, Transport, and Luminescence in p-GaAs/AlGaAs Quantum Cascade Structures,** Z. Ikonic, P. Harrison, *University of Leeds, Leeds, UK*, R. Steed, M. Matthews, J. Plumridge, M. Frogley and C. C. Phillips, *Imperial College London, London, UK*

Intersubband relaxation rates of holes, optical absorption andluminescence in p-doped GaAs/AlGaAs cascade structures are calculated and compared to experiment, for purpose of extracting the parameters needed for quantum cascade laser design and modelling.

**P2 Spontaneous Carrier Recombination Lifetime in Quantum Well Lasers with Different Band Offset,** W. Susaki, S. Kakuda, H. Nishimura and A. Tomioka, *Osaka Electro-Communication University, Neyagawa, Japan*

Systematical study of the spontaneous carrier recombination lifetime has been performed in GaAs- and InP-based SCH quantum well lasers with different band offset. The lifetime decreases as the band offset decreases, accompanying the electron overflow.

**P3 Narrow Linewidth Destributed Feedback Laser Diodes at 852nm,** V. Ligeret, *Alcatel Thales III-V Lab, Palaiseau, France*, D. Holleville, S. Perrin, *Observatoire de Paris SYRTE, Paris, France*, S. Bansropun, *Thales Research and Technology, Orsay, France*, M. Lecomte, M. Calligaro, O. Parillaud, M. Krakowski, *Alcatel Thales III-V Lab, Palaiseau, France* and N. Dimarcq, *Observatoire de Paris SYRTE, Paris, France*

We have developed single frequency and single spatial mode laser structures with very narrow linewidth (~850kHz @ 15mW measured with an ECL). We demonstrate also a very good interaction between the DFB laser and Cs atoms.

**P4 Wide Temperature Range Operation of DFB Lasers At 1310 and 1490nm,** T. R. Chen, W. Hsin, B. Chen, P. Chen, *Archcom Technology Inc. USA, Azusa, CA, USA* and H. Erlig, *Jet Propulsion Laboratory, Pasadena, CA, USA*

Single mode operation of DFB Lasers at 1310 and 1490nm over record temperature ranges of 180 and 170 degrees C have been demonstrated. The lasers exhibit excellent performance including, high output power and high modulation bandwidths.

**P5 Thermal Characteristics of 1.3μm GaAsSb/GaAs-based Edge- and Surface-Emitting Lasers,** S. J. Sweeney, K. Hild, I. P. Marko, *University of Surrey, Guildford, Surrey, UK*, S. Yu, S. R. Johnson and Y.-H. Zhang, *Arizona State University, Tempe, AZ, USA*

Under ambient conditions, the temperature sensitivity of 1.3μm GaAsSb lasers is limited by non-radiative current losses. These are shown to be a critical design consideration for producing temperature insensitive VCSEL operation around room temperature.

**P6 Small Signal Dynamics of an Electrically-Pumped Long-Wavelength Tunable VCSEL,** B. Koegel, K. Zogal, S. Jatta, *Technical University Darmstadt, Darmstadt, Germany*, M. Maute, C. Grasse, M.-C. Amann, *Technical University of Munich, Garching, Munich, Germany* and P. Meissner, *Technical University Darmstadt, Darmstadt, Germany*

The intrinsic dynamics of a micromachined tunable surface-emitting laser with buried tunnel junction are derived from amplitude modulation response and relative intensity noise. The dependence of resonance frequency on bias current and wavelength is reported.

**P7 Differences in the Injection Locking Bandwidth in 1550nm-VCSELs Subject to Parallel and Orthogonal Optical Injection,** A. Hurtado, I. D. Henning and M. J. Adams, *University of Essex, Colchester, Essex, UK*

We report the experimental observation of differences in the injection locking bandwidth of two 1550nm-VCSELs subject to parallel and orthogonal polarized optical injection into the two polarizations of the fundamental mode.

**P8 Voltage Controlled Operation of a Transistor Vertical Cavity Surface Emitting Laser,** W. Shi, L. Chrostowski and B. Faraji, *University of British Columbia, Vancouver, BC, Canada*

A transistor VCSEL (TX-VCSEL) is numerically modeled. A new optical saturation effect is observed, which comes from the three-port operation. This enables the voltage control of the TX-VCSEL.

**P9 Hot-Cavity Model for Non-Circular VCSELS,** P. Debernardi, *Consiglio Nazionale delle Ricerche, Torino, Italy*, A. Kroener, F. Rinaldi and R. Michalzik, *Ulm University, Ulm, Germany*

A model is presented which is capable to handle real three-dimensional VCSEL geometries and to simulate above threshold operation even exceeding thermal rollover. Comparisons with experimental data indicate that all relevant effects are properly included.

**P10 Highly Efficient Tunable Blue Light Generation using an External Cavity Enhanced Gain Guided Broad Area Laser Diode,** A. Jechow, A. Heuer and R. Menzel, *University of Potsdam, Potsdam, Germany*

An infrared broad area laser diode, wavelength stabilized in an external cavity, is frequency doubled by the use of a PPLN waveguide crystal in a single-pass setup. More than 130 mW visible light could be generated resulting in an internal conversion efficiency of 46%.

**P11 Multi-Quantum Well Emission from Blue InGaN-Based Laser,** M. Schillgalies, A. Laubsch, M. Sabathil, A. Avramescu, S. Lutgen and U. Strauss, *Osram Opto Semiconductors GmbH, Regensburg, Germany*

Electroluminescence measurements of color coded multi-quantum-well structures were used to improve the charge carrier distribution over three quantum wells with emission in the blue spectral region. Laser performance in the blue spectral region (approx. 450nm) was improved significantly by optimized quantum barrier design.

**P12 GaAs-Based Self-Aligned Laser Incorporating an InGaP Opto-Electronic Confinement Layer,** K. M. Groom, B. J. Stevens, D. Childs, R. R. Alexander, J. S. Roberts, *University of Sheffield, Sheffield, UK*, A. S. Helmy, *University of Toronto, Toronto, ON, Canada* and R. A. Hogg, *University of Sheffield, Sheffield, UK*

We demonstrate a novel fabrication process for GaAs-based self-aligned lasers through regrowth upon an n-doped InGaP layer. Electrical and optical confinement results in high power single lateral mode emission from a ~ 980nm DQW laser.

**P13 Fiber Pump Semiconductor Lasers with Optical Antiguiding Layers for Horizontal Transverse Modes,** N. Shomura and T. Numai, *Ritsumeikan University, Kusatsu, Shiga, Japan*

A semiconductor laser with a novel ridge structure, which has optical antiguiding layers for horizontal transverse modes, is proposed and theoretically analyzed. It is found that kink levels are enhanced and threshold current is decreased.

**P14 Theoretical and Experimental Evaluation of a Wavelength-stabilized Talbot Cavity with a Volume Bragg Grating,** D. Paboeuf, G. Lucas-Leclin, *Charles Fabry Laboratory, Palaiseau, France*, N. Michel, M. Krakowski, *Alcatel Thales III-V Lab, Palaiseau, France* and P. Georges, *Institut d'Optique, Palaiseau, France*

We describe the coherent combining and the wavelength stabilization of 10 tapered lasers in an external Talbot cavity. The use of a volume Bragg grating as feedback element to narrow the spectrum is demonstrated.

**P15 High-Wall Plug Efficiency Broad Area Laser Bar with Strain-Compensated Quantum Well,** N. Michel, M. Lecomte, O. Parillaud, M. Calligaro, M. Krakowski, *Alcatel Thales III-V Lab, Palaiseau, France*, T. Westphalen and M. Traub, *Fraunhofer-Institut, Aachen, Nordrhein-Westfalen, Germany*

Based on an Al-free active region with a strain compensated quantum well, we have obtained improved internal parameters, and a high wall-plug efficiency of 68% on a broad area laser bar.

**P16 High Power, Low Threshold 1060-nm InGaAs/AlGaAs Quantum Dot Lasers,** E.-M. Pavelescu, C. Gilfert, J. P. Reithmaier, *University of Kassel, Kassel, Germany*, A. Martin-Minguez and I. Esquivias, *Universidad Politécnica de Madrid, Madrid, Spain*

1060-nm InGaAs/(Al)GaAs quantum-dot laser material was developed with optimized dot geometry to allow high output powers of more than 4.5 W for a broad area laser in pulsed operation and a low transparency current density of 83 A/cm$^2$.

**P17 Multi-Contact Quantum Dot Superluminescent Diodes for Optical Coherence Tomography,** P. Judson and K. M. Groom, *University of Sheffield, Sheffield, UK*

Multi-contact chirped quantum dot superluminescent diodes are characterized with regard to key parameters for image quality in optical coherence tomography systems. By independently tuning power and spectral shape, their penetration depth and resolution are decoupled.

**P18 Two Section Quantum Dot Devices for Tuning and Modulation,** D. Childs, *University of Sheffield, Sheffield, UK*

Two section lasers enable some novel properties of quantum dots to be realised. Engineering these quantum dots results in two very different behaviours with associated application areas, shown here are optical coherence tomography and datacomms

**P19 1.3-µm Quantum Dot DFB Laser with Half-Etching Mesa and High Density QD,** T. Amano, K. Goshima, T. Sugaya and K. Komori, *National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan*

We have proposed a new DFB laser with Half Etching Mesa (HEM) structure. We have achieved low temperature dependence and mode control operation at a grand state emission of 1.3 µm for the first time.

**P20 Quantum-Dot Fabry-Perot Laser-Diode with a 4-THz Injection-Seeding Bandwidth for 1-µm Optical-Waveband WDM Systems,** N. Yamamoto, *National Institute of Information and Communications Technology, Koganei, Tokyo, Japan*, H. Sotobayashi, *Aoyama Gakuin University, Kanagawa, Japan*, K. Akahane and M. Tsuchiya, *National Institute of Information and Communications Technology, Koganei, Tokyo, Japan*

A 4-THz injection-seeding bandwidth (1042-1057 nm) was successfully demonstrated with a 1-µm optical-waveband quantum-dot (QD) Fabry-Perot laser-diode. An Sb-molecule-sprayed InGaAs/GaAs QD structure in its active-medium was grown by molecular-beam-epitaxy with a GaAs-substrate.

**P21 Highly Stacked Quantum Dot Laser Fabricated using a Strain Compensation Technique,** K. Akahane, N. Yamamoto and M. Tsuchiya, *National Institute of Information and Communications Technology, Koganei, Tokyo, Japan*

We fabricated laser diodes containing highly stacked InAs quantum dots (QDs) using the strain-compensation technique, which showed laser emission at 1.58 µm above the threshold current of 162 mA in pulsed mode.

**P22 The Importance of Recombination via Excited States in InAs/GaAs 1.3µm Quantum Dot Lasers,** M. Crowley, *Tyndall National Institute, Cork, Ireland*, I. P. Marko, N. F. Masse, A. D. Andreev, S. J. Sweeney, *University of Surrey, Guildford, Surrey, UK*, E. P. O'Reilly, *Tyndall National Institute, Cork, Ireland* and A. R. Adams, *University of Surrey, Guildford, Surrey, UK*

The optical matrix element for excited-states is significantly weaker than the ground-state leading to thermally stable radiative recombination. This is not so for non-radiative Auger recombination, causing a sharp increase in threshold current with temperature.

**P23 Cross Talk Free Multi Channel Processing of 10 Gbit/s Data via Four Wave Mixing in a 1550 nm InAs/InP Quantum Dash Amplifier,** A. Capua, V. Mikhelashvili, G. Eisenstein, *Technion, Haifa, Israel*, J. P. Reithmaier, *University of Kassel, Kassel, Germany*, A. Somers and A. Forchel, *Universität Würzburg, Würzburg, Germany*

We demonstrate multi wavelength processing in a broad band 1550 nm quantum dash optical amplifier. Two 10Gbit/s signals, spectrally separated by 30nm are individually wavelength converted via four wave mixing with no cross talk.

**P24 Static and Noise Characteristics of 1.55 µm InP-based Fabry-Prot Quantum Dash Lasers for over 11000 hours of Ageing Tests at High Temperature Operation,** P. Resneau, M. Calligaro, B. Rousseau, F. Lelarge and M. Krakowski, *Alcatel Thales III-V Lab, Palaiseau, France*

Life tests on our quantum dash lasers were carried out at 70 and 90ºC, 10 mW. Highly stable static and noise characteristics prior and after 11200 hours of ageing tests are analysed

**P25 Analysis of InAs/InP Quantum Dash Lasers,** S. Heck, S. W. Osborne, S. Healy, E. P. O'Reilly, *Tyndall National Institute, Cork, Ireland*, F. Lelarge, F. Poingt, F. Pommereau, A. Accard and O. Le Gouezigou, *Alcatel Thales III-V Lab, Palaiseau, France*

Calculations show electrons are not confined in the dashes in 1.5 micron InAs/InGaAsP/InP quantum dash in a well structures. Calculations and photoabsorption measurements show strongly polarised recombination. The threshold current remains dominated by Auger recombination.

**P26 Highly Unidirectional Y-Junction-Coupled S-Section InAs/InGaAs/GaAs Quantum-Dot Ring Lasers,** O. K. Qassim, C.-Y. Li, N. J. Withers, G. A. Smolyakov and M. Osinski, *University of New Mexico, Albuquerque, NM, USA*

Fabrication and characterization of Y-junction-coupled S-section InAs/InGaAs/GaAs quantum-dot ring lasers with low threshold current density and high unidirectionality is reported. The new design suppresses unwanted counterpropagating modes more effectively than in the previous S-section-racetrack devices.

**P27 Dynamic Characterization of Semiconductor Ring Lasers: Frequency Response and Linewidth Enhancement Factor,** M. Zanola, *University of Pavia, Pavia, Italy*, G. Mezosi, S. Furst, M. Sorel, *University of Glasgow, Glasgow, Scotland, UK* and G. Giuliani, *University of Pavia, Pavia, Italy*

The frequency response and alpha-factor of monolithic Semiconductor Ring Lasers (SRLs) with 150 micron radius are measured using an all-optical modulation technique, that is new for alpha-factor measurements. The measured -3dB frequency equals 11 GHz, and the alpha factor is 2.4.

**P28 Modal Structure of Integrated Semiconductor Ring Lasers with Output Waveguides,** A. Prez, *University of Iles Balears, Palma de Mallorca, Spain*, S. Furst, *University of Glasgow, Glasgow, Scotland, UK*, A. Scire, J. Javaloyes, *Institut Mediterrani d'Estudis Avançats, Palma de Mallorca, Baleares, Spain*, S. Balle, *University of the Balearic Islands, Palma de Mallorca, Spain* and M. Sorel, *University of Glasgow, Glasgow, Scotland, UK*

We have analyzed experimentally and theoretically the modal properties of a semiconductor ring laser and the wavelength jumps that occur in connection with directional switching above threshold.

**20.00 - 22.00**

**RUMP SESSION II**

**FUTURE OPPORTUNITIES FOR LASER DIODE APPLICATIONS**

Michael Lebby, *OIDA, USA*

**Room: Nettuno IV**

**TBA,** J. Bowers, *University of California – Santa Barbara, USA*

**TBA,** E. Cornejo, *OpNext, USA*

**TBA,** F. Ejeckam, *Group4 Labs, USA*

**TBA,** B. Ring, *WSR Optical Device Solutions, USA*

**TBA,** S. Dunbar, *Spectra-Physics, USA*

# Wednesday, 17 September 2008

**08.30 - 10.00**

**Session WA:** **HIGH POWER LASERS**
**Session Chair:** John C. Connolly, *Innovative Photonic Solutions, Monmouth Junction, NJ, USA* and Berthold E. Schmidt, *Bookham Technologies, Zurich, Switzerland*

**WA1 08.30 - 08.45**

**High-Power Single-Frequency Operation of a DBR Tapered Laser,** K.-J. J. Paschke, C. Fiebig, D. Feise, J. Fricke, C. Kaspari, G. Blume, H. Wenzel and G. Erbert, *Ferdinand-Braun-Institut für Höchstfrequenztechnik, Berlin, Germany*

A 980nm DBR tapered laser is presented which achieves 12W power in a single longitudinal mode and a nearly diffraction limited beam with a conversion efficiency of 44%. The device has a 6th-order surface grating.

**WA2 08.45 - 09.00**

**5 W Frequency Stabilized 976 nm Tapered Diode Lasers for Modulation,** M. T. Kelemen, P. Friedmann and J. Gilly, *m2k-laser Gmbh, Freiburg, Germany*

Frequency stabilized tapered lasers at 976nm with more than 5W nearly diffraction limited behavior have been developed. A two-sectional operation mode preferable for modulation has been established. Without frequency stabilization more than 12W have been demonstrated.

**WA3 09.00 - 09.15**

**253 mW/Micron Maximum Power Density From 9xx nm Epitaxial Laser Structures with d/gamma Greater Than 1 Micron,** I. Petrescu-Prahova, P. Modak, E. Goutain, D. Bambrick, D. Silan, J. Riordan, T. Moritz, *Intense HPD, North Brunswick, NJ, USA* and J. H. Marsh, *Intense Photonics Ltd., Glasgow, Scotland, UK*

Diode laser power scales with length and d/gamma ratio. Record maximum power of 25.3 W was obtained from a 940 nm laser, 5 mm long, with 100 microns wide aperture and 1.15 microns d/gamma ratio.

**WA4 09.15 - 09.30**

**Higher Catastrophic Optical Mirror Damage Power Density Level at Facet from Quantum Dot Material,** S. N. Elliott, P. M. Smowton, G. T. Edwards, *Cardiff University, Cardiff, Wales, UK*, A. B. Krysa, *University of Sheffield, Sheffield, UK* and G. M. Berry, *IQE (Europe) Ltd, Cardiff, UK*

We measured different types of damage and 24 (±4) MW/cm$^2$ optical-power-density (pulsed) thresholds for catastrophic optical mirror damage in quantum dot lasers compared with 12 (±2) MW/cm$^2$ for quantum wells, in a comparable structure.

**WA5 09.30 - 09.45**

**Design of Highly-Efficient High-Power Optically-Pumped Semiconductor Disk Lasers,** F. Demaria, *Ulm University, Ulm, Germany*, S. Lorch, *European Aeronautic Defence and Space Company NV, Ulm, Germany*, S. Menzel, F. Rinaldi, *Ulm University, Ulm, Germany*, M. C. Riedl, *ULM-Photonics, Ulm, Germany*, R. Roesch and P. Unger, *Ulm University, Ulm, Germany*

We present a carefully elaborated layer design for semiconductor disk lasers. Experimental results of devices mounted on simple copper heat spreaders reveal record conversion efficiencies at 13.2 W for 970 nm wavelength laser emission.

**WA6 09.45 - 10.00**

**High-Power Long-Wavelength VCSEL Arrays,** W. Hofmann, M. Goerblich, *Technical University of Munich, Garching, Germany*, M. Ortsiefer, *VertiLas GmbH, Garching, Germany*, G. Boehm and M.-C. Amann, *Technical University of Munich, Garching, Munich, Germany*

Two-dimensional arrays of 1.55 µm vertical-cavity surface-emitting lasers (VCSEL) with continuous wave output powers in the Watt regime at room temperature are presented. Device characteristics are presented in detail and discussed on a theoretical basis.

**10.00 - 10.30** **COFFEE BREAK**

**10.30 - 12.30**

**Session WB:** **TUNABLE WDM SOURCES**
**Session Chair:** Thomas L. Koch, *Lehigh University, Bethlehem, PA, USA* and Hiromi Oohashi, *NTT Corporation, Atsugi, Kanagawa, Japan*

**WB1 10.30 - 10.45**

**110-channel Operation with a 50-GHz Grid in Mode-hop-free Tunable Distributed Amplification (TDA-) DFB Laser Array,** N. Nunoya, H. Ishii, Y. Kawaguchi, R. Iga, T. Sato, Y. Kondo and H. Oohashi, *NTT Corporation, Atsugi, Kanagawa, Japan*

The mode-hop-free tuning range of a TDA-DFB laser with asymmetric units was successfully extended by employing strong optical confinement in the tuning layers. We achieved 110-channel operation with a 50-GHz grid for a 6-TDA-DFB laser array.

**WB2 10.45 - 11.00**

**40 Gb/s Widely Tunable Wavelength Converter with a Photocurrent-Driven High-Impedance TW-EAM and SGDBR Laser,** M. Dummer, *University of California - Santa Barbara, Santa Barbara, CA, USA*

We demonstrate a monolithic transceiver which integrates pre-amplified QW-pin receiver with a tunable SGDBR laser and high-impedance EAM. This device performs wavelength conversion at 40 Gb/s over 22 nm of optical bandwidth.

**WB3 11.00 - 11.15**

**Extending the Tuning Range of DS-DBR Lasers,** A. Ward, N. Whitbread, P. J. Williams, A. Wood and M. Wale, *Bookham Technologies, Towcester, Northamptonshire, UK*

We report on modified DS-DBR designs with an increased number of supermodes which achieved 61nm of continuous tuning. Additionally, a modified manufacturing process gave rise to a significantly flattened gain band shape.

**WB4 11.15 - 11.30**

**Experimental Study of Nanosecond-Order Wavelength Switching in Short-Cavity DBR Lasers,** H. Arimoto, *Hitachi, Ltd., Kokubunji, Tokyo, Japan*

We experimentally investigated fast wavelength switching in short-cavity active DBR (ADBR) lasers. Our fabricated 4-ch laser array continuously covered a 12-nm range in the condition that the switching time is expected to be less than 10 nanoseconds.

**WB5 11.30 - 11.45**

**Reduced Spectral Linewidth (< 0.6 MHz) in L-band Wavelength Tunable DFB Laser Array,** H. Ishii, K. Kasaya and H. Oohashi, *NTT Corporation, Atsugi, Kanagawa, Japan*

A wavelength tunable DFB laser array is fabricated with a new design for spectral linewidth reduction. A narrow linewidth of <0.6 MHz is obtained over the entire tuning range (~40 nm) with a high fiber output power of 20 mW.

**WB6 11.45 - 12.00**

**A Compact Widely Wavelength-Tunable Laser Diode Monolithically Integrated with a Ring/MZI Loop-Filter,** T. Okamoto, S. Sudo, K. Tsuruoka, M. L. Nielson, K. Mizutani, K. Sato and K. Kudo, *NEC Corporation, Otsu, Shiga, Japan*

A monolithically integrated wavelength-tunable laser diode based on a novel loop-filter that consists of two ring resonators and an asymmetric Mach-Zehnder Interferometer (AMZI) is demonstrated with 39-nm tuning range over 30-dB SMSR.

**WB7 12.00 - 12.15**

**Integrated Filtered Feedback Tunable Laser using Double-Ring-Resonator-Coupled Filter,** S. Matsuo, T. Segawa, T. Kakitsuka, T. Sato, R. Takahashi, H. Suzuki, *NTT Corporation, Atsugi, Kanagawa, Japan*, B. Docter, F. Karouta and M. K. Smit, *Eindhoven University of Technology, Eindhoven, The Netherlands*

A novel integrated filtered feedback tunable laser consisting of a Fabry-Perot laser and integrated filtered feedback section is proposed and demonstrated. The device exhibited a 24-nm tuning range and 1-GHz thermal frequency drift.

**WB8 12.15 - 12.30**

**Wavelength Tunability of an Integrated Semiconductor Ring Laser with sub-ns Switching Time,** S. Furst, *University of Glasgow, Glasgow, Scotland, UK*, S. Yu, *University of Bristol, Bristol, Avon, UK* and M. Sorel, *University of Glasgow, Glasgow, Scotland, UK*

We report on the monolithical integration of a semiconductor ring laser and a Bragg reflector to achieve very fast wavelength tunability. Stable and digital wavelength switching with a speed below 1 ns is demonstrated.

**12.30 - 19.00** **POMPEII TOUR**

(CLICK HERE FOR MORE INFORMATION)

**19.00 - 22.00** **CONFERENCE BANQUET**

# Thursday, 18 September 2008

**08.30 - 10.00**

**Session ThA: VCSELs**
**Session Chair:** Kent D. Choquette, *University of Illinois at Urbana-Champaign, Urbana, IL, USA* and Jorn M. Hvam, *Technical University of Denmark, Kgs. Lyngby, Denmark*

**ThA1 08.30 - 08.45**

**Optimization of VCSEL Structure for High-Speed Operation,** Y.-C. Chang and L. A. Coldren, *University of California - Santa Barbara, Santa Barbara, CA, USA*

The optimization of our tapered-oxide-apertured VCSEL structure for high-speed operation is presented. Using a new aperture design and p-doping recipe in the top mirror, bandwidths > 20 GHz and 35 Gb/s error-free operation has been demonstrated.

**ThA2 08.45 - 09.00**

**NEMO Tunable VCSEL using Ultra Compact High Contrast Grating for High Speed Tuning,** C. Chase, Y. Zhou, M. C.-Y. Huang and C. J. Chang-Hasnain, *University of California - Berkeley, Berkeley, CA, USA*

We report a nano-electromechanical optoelectronic (NEMO) tunable VCSEL with a record compact (140 nm x 3 μm x 3 μm) TE-polarized high contrast grating (HCG). A record high tuning speed of ~60 ns is experimentally demonstrated with single mode operation (SMSR ~ 40 dB).

**ThA3 09.00 - 09.15**

**Wavelength Modulation over 500 kHz of Micromechanically Tunable InP-Based VCSELs with Si-MEMS Technology,** T. Yano, H. Saito, N. Kanbara, R. Noda, S.-I. Tezuka, N. Fujimura, M. Ooyama, T. Watanabe, T. Hirata, *Yokogawa Electric Corporation, Tokyo, Japan* and N. Nishiyama, *Tokyo Institute of Technology, Tokyo, Japan*

The wavelength modulation over 500 kHz of a micromechanically tunable VCSEL that consists of a InP-based half VCSEL chip and a micromachined SOI chip with a concave movable mirror has been demonstrated for the first time.

**ThA4 09.15 - 09.30**

**One and Two-dimensional Long-Wavelength VCSEL arrays for WDM Applications and Optical Interconnects,** W. Hofmann, *Technical University of Munich, Garching, Germany*, E. Wong, *University of Melbourne, Melbourne, VIC, Australia*, M. Ortsiefer, *VertiLas GmbH, Garching, Germany*, M. Goerblich, G. Boehm and M.-C. Amann, *Technical University of Munich, Garching, Munich, Germany*

We present monolithically integrated, individually addressable long-wavelength VCSEL arrays in one and two-dimensional configuration. 10 GHz modulation bandwidth and low bit-error-rates (BER), enable parallel optical interconnects and WDM applications with channels addressed by current tuning.

**ThA5 09.30 - 09.45**

**Extended Near-Infrared Wavelength VCSELs for Optical Sensing,** M. Ortsiefer, *VertiLas GmbH, Garching, Germany*, M.-C. Amann, W. Hofmann, *Technical University of Munich, Garching, Munich, Germany*, R. Strzoda, A. Hangauer, J. Chen, *Siemens AG, Munich, Germany*, G. Boehm, *Technical University of Munich, Munich, Germany*, J. Rosskopf, R. Shau and E. Roenneberg, *VertiLas GmbH, Garching, Germany*

We present InP-based VCSELs with buried tunnel junction and extended emission wavelengths >> 1.55 μm for optical sensing. Excellent device performance is demonstrated for 1.87 μm and 2.36 μm wavelength lasers. The latter ones are successfully deployed for CO detection.

**ThA6 09.45 - 10.00**

**High Power Tunable Yellow Laser using InGaAs/GaAs Vertical External-Cavity Surface-Emitting Lasers,** M. Fallahi, C. Hessenius, L. Fan, J. Hader, H. Li, J. V. Moloney, *University of Arizona, Tucson, AZ, USA*, W. Stolz, *Philipps University, Marburg, Germany* and S. W. Koch, *University of Marburg, Marburg, Germany*

We present the development of a tunable, optically pumped VECSEL with multi-Watts output in the wavelength range of 1150 nm to 1190 nm. We report 5W of yellow emission by intra-cavity frequency doubling of the VECSEL.

**10.00 - 10.30** **COFFEE BREAK**

**10.30 - 12.00**

**Session ThB: Mode-locking and Bandwidth Enhanced Lasers**
**Session Chair:** Yoshiaki Nakano, *University of Tokyo, Tokyo, Japan* and Jens Buus, *Gayton Photonics Ltd., Gayton, Northants, UK*

**ThB1 10.30 - 10.45**

**80-GHz Intrinsic 3-dB Bandwidth of Directly Modulated Semiconductor Lasers under Optical Injection Locking,** E. K. Lau, X. Zhao, C. J. Chang-Hasnain and M. C. Wu, *University of California - Berkeley, Berkeley, CA, USA*

We identify key parameters that control the low-frequency damping commonly observed in optical injection-locked lasers. We demonstrate, experimentally and theoretically, that by biasing the slave laser at higher current, the impact of this damping can be eliminated. A record-high 80-GHz intrinsic 3-dB frequency is achieved.

**ThB2 10.45 - 11.00**

**Modulation Response in Isolator-Free MOPA and Injection-Locked Laser Configurations,** W. W. Chow, G. Vawter and E. J. Skogen, *Sandia National Laboratories, Albuquerque, NM, USA*

Modulation response in injection-locked lasers is investigated with optical isolation between master and slave lasers removed. A strong-coupling theory shows that recently demonstrated modulation response enhancement can be maintained in a significantly more compact device.

**ThB3 11.00 - 11.15**

**Mode Locked Silicon Evanescent Laser as a Multiple Wavelength Source for WDM,** B. R. Koch, *Intel Corporation, Santa Barbara, CA, USA*, A. W. Fang, *University of California - Santa Barbara, Santa Barbara, CA, USA*, O. Cohen, *Intel Corporation, Jerusalem, Israel*, M. Paniccia, *Intel Corporation, Santa Clara, CA, USA*, D. J. Blumenthal and J. E. Bowers, *University of California - Santa Barbara, Santa Barbara, CA, USA*

A 10-GHz hybrid mode-locked silicon evanescent laser is used to generate 100 separate wavelengths within a 10-dB spectral width. Linewidth and OSNR measurements are performed with and without optical injection locking.

**ThB4 11.15 - 11.30**

**24GHz Mode-Locking of VCSEL with External Concave Mirror,** T. Kato, A. Matsutani, T. Sakaguchi and K. Kobayashi, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*

By optimizing reflectivities of VCSEL and external mirror of composite resonator using a VCSEL and an external concave mirror, high speed mode-locking with a repetition rate of 24GHz and a low threshold of 0.7mA was simultaneously realized.

**ThB5 11.30 - 11.45**

**Tunable Optical Equalizer Based on 1.55 μm VCSEL for Modulation Bandwidth Enhancement,** S. Suda, *Tokyo Institute of Technology, Yokohama, Kanagawa, Japan*, X. Zhao, *University of California - Berkeley, Berkeley, CA, USA*, F. Koyama, *Tokyo Institute of Technology, Yokohama, Kanagawa,* , C. J. Chang-Hasnain, *University of California - Berkeley, Berkeley, CA, USA*, N. Nishiyama, *Tokyo Institute of Technology, Tokyo, Japan*, C. Caneau and C.-E. Zah, *Corning, Inc., Corning, NY, USA*

We propose and demonstrate the tunable optical equalization function using a 1.55μm VCSEL biased below threshold. Bandwidth enhancement can be tuned by bias current. A modulation bandwidth beyond 70 GHz was obtained on $LiNbO_3$ modulators.

**ThB6 11.45 - 12.00**

**Small-Signal Modulation Bandwidth of Purcell-Enhanced Nanocavity Light Emitters,** R. S. Tucker, *University of Melbourne, Victoria, VIC, Australia*, E. K. Lau and M. C. Wu, *University of California - Berkeley, Berkeley, CA, USA*

We present a new analysis of the modulation bandwidth of nanocavity light emitters. The modulation bandwidth is enhanced by the Purcell effect, but only if the device is operated below threshold. The maximum Purcell-enhanced 3-dB bandwidth scales inversely with the modal volume.

**12.00 - 14.00** **LUNCH BREAK**

**14.00 - 15.30**

**Session ThC:** **Photonic Crystal Lasers and Advanced Materials**
**Session Chair:** Yong-Hee Lee, *Korea Advanced Institute of Science and Technology, Daejon, Korea* and Markus-Christian Amann, *Technical University of Munich, Garching, Munich, Germany*

**ThC1 14.00 - 14.15**

**Proposal of BeZnSeTe/MgZnCdSe II-VI Compound Semiconductors on InP Substrates for Green Laser Diodes,** I. Nomura, K. Kishino, *Sophia University, Tokyo, Japan*, T. Ebisawa, S. Kushida, J. Uota, K. Tasai, H. Nakamura, T. Asatsuma and H. Nakajima, *Sophia University, Chiyoda-ku, Tokyo, Japan*

Long life operations (more than 4800h) of BeZnSeTe green light emitting devices and photo-pumped green lasing of BeZnSeTe DH structures were obtained, which shows possibility of BeZnSeTe/MgZnCdSe II-VI compound semiconductors on InP substrates for green LDs.

**ThC2 14.15 - 14.30**

**High-efficiency GaN-based Laser Diodes for Solid-state Lighting,** S. Saito, Y. Hattori, M. Sugai, Y. Harada, J. Hwang and S. Nunoue, *Toshiba Corporation, Kawasaki, Japan*

GaN-based laser diodes (LDs) with a slope efficiency of 2.6 W/A are presented. The white light source was fabricated by using 405nm LDs and phosphors. The luminous flux was estimated to be 200 lm.

**ThC3 14.30 - 14.45**

**Fabrication and Performance of GaN-based Two Dimensional Photonic Crystal Surface Emitting Lasers,** T.-C. Lu, T.-T. Kao, S.-W. Chen, T.-W. Liu, P. Yu, H.-C. Kuo, S.-C. Wang, *National Chiao Tung University, Hsinchu, Taiwan,* and S. Fan, *Stanford University, Stanford, CA, USA*

We demonstrated GaN-based two-dimensional photonic crystal surface emitting lasers with a low threshold pumping energy density of about $2.7mJ/cm^2$ and a large spontaneous coupling factor of $5x10^{-3}$, and lasing actions from three different band-edges.

**ThC4 14.45 - 15.00**

**Loss Reduction in Single Mode Photonic Crystal Vertical Cavity Surface Emitting Lasers,** M. P. Tan, K. D. Choquette, D. F. Siriani and A. M. Kasten, *University of Illinois at Urbana-Champaign, Urbana, IL, USA*

The reduction of optical loss in single mode photonic crystal vertical cavity surface emitting lasers is demonstrated. Optical loss and threshold current decrease with increasing etch depth while mode discrimination is maintained.

**ThC5 15.00 - 15.15**

**Single Mode Photonic Crystal Heterostructure Cavity Lasers,** A. V. Giannopoulos, Y. J. Li, C. Long, J. M. Jin and K. D. Choquette, *University of Illinois at Urbana-Champaign, Urbana, IL, USA*

We demonstrate the single mode lasing characteristics of a photonic crystal heterostructure cavity formed from an inner kagome lattice surrounded by a hexagonal lattice. Finite element domain decomposition analysis is used to justify the observed modal selectivity.

**ThC6 15.15 - 15.30**

**High Brightness and Ultra-Narrow Beam 850 nm GaAs/AlGaAs Photonic Band Crystal Lasers and First Uncoupled PBC Single-Mode Arrays,** T. Kettler, K. Posilovic, *Institut für Festkorperphysik, Berlin, Germany*, J. Fricke, P. Ressel, A. Ginolas, *Ferdinand-Braun-Institut für Höchstfrequenztechnik, Berlin, Germany*, U. W. Pohl, V. A. Shchukin, N. N. Ledentsov, D. Bimberg, *Technical University Berlin, Berlin, Germany*, J. Joensson, M. Weyers, *Three-five Epitaxial Services AG, Berlin, Germany*, G. Erbert and G. Traenkle, *Ferdinand-Braun-Institut für Höchstfrequenztechnik, Berlin, Germany*

850 nm broad area lasers based on longitudinal photonic band crystal demonstrate ultra-narrow vertical beam divergence of 7° and ultra-high brightness. First arrays of uncoupled single-mode PBC-lasers are demonstrated.

**15.30 - 16.00** **COFFEE BREAK**

**16.00 - 17.00** **POST DEADLINE SESSION**

**17.00** **CLOSING REMARKS**