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CONFERENCE 10514

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High-Power Diode Laser Technology XVI

Conference Chair: **Mark S. Zediker**, NUBURU, Inc. (USA)

Program Committee: **Friedrich G. Bachmann**, FriBa LaserNet (Germany); **Stefan W. Heinemann**, TRUMPF Photonics (USA); **Volker Krause**, Laserline GmbH (Germany); **Robert Martinsen**, nLIGHT Corp. (USA); **Erik P. Zucker**, Lumentum (USA)

MONDAY 29 JANUARY

SESSION 1 MON 8:20 AM TO 11:30 AM

New High Power Wavelengths

Session Chair: **Erik Zucker**, Lumentum (USA)

Blue 450-nm high power semiconductor continuous wave laser bars exceeding rollover output power of 80 W (*Invited Paper*), Harald König, Alfred Lell, Muhammad Ali, Bernhard Stojetz, Christoph Eichler, Matthias Peter, Andreas Löffler, Uwe Strauss, OSRAM Opto Semiconductors GmbH (Germany); Markus Baumann, Anne Balck, Jörg Malchus, Volker Krause, Laserline GmbH (Germany) [10514-1]

500-W blue fiber-coupled diode-laser emitting at 450 nm, Anne Balck, Markus Baumann, Jörg Malchus, Rony V. Chacko, Sören Marfels, Ulrich Witte, Deepak Dinakaran, Sörn Ocylok, Matthias Weinbach, Charley Bachert, Arnd Kösters, Volker Krause, Laserline GmbH (Germany); Harald König, Alfred Lell, Bernhard Stojetz, Andreas Löffler, Uwe Strauss, OSRAM Opto Semiconductors GmbH (Germany) [10514-2]

Recent progress of 638-nm high-power broad area laser diodes in Mitsubishi Electric, Kyosuke Kuramoto, Shinji Abe, Motoharu Miyashita, Takehiro Nishida, Tetsuya Yagi, Mitsubishi Electric Corp. (Japan) . . . [10514-3]

Next generation DIRCM for 2.1-2.3 micron wavelength based on direct-diode GaSb technology, Edgaras Dvinelis, Greta Naujokaite, Mindaugas Greibus, Augustinas Trinkunas, Kristijonas Vizbaras, Augustinas Vizbaras, Brolis Semiconductors UAB (Lithuania) [10514-4]

Development of high intensity blue diode laser system for materials processing (*Invited Paper*), Masahiro Tsukamoto, Shinichiro Masuno, Yuji Sato, Ritsuko Higashino, Osaka Univ. (Japan); Koji Tojo, Shonan Shimadzu Co., Ltd. (Japan); Keita Asuka, Nichia Corp. (Japan)..... [10514-5]

Blue laser diode (450 nm) system for welding copper, Matthew J. Silva Sa, Mathew Finuf, Robert Fritz, James Tucker, Jean Michel Pelaprat, Mark S. Zediker, NUBURU, Inc. (USA)..... [10514-6]

Visible high power fiber coupled diode lasers, Bernd Köhler, Simon Drows, Michael Stoiber, Sascha Dürsch, Heiko Kissel, Tobias Könnig, Jens Biesenbach, DILAS Diodenlaser GmbH (Germany); Harald König, Alfred Lell, Bernhard Stojetz, Andreas Löffler, Uwe Strauss, OSRAM Opto Semiconductors GmbH (Germany) [10514-7]

Lunch Break Mon 11:30 am to 1:00 pm

SESSION 2 MON 1:00 PM TO 3:00 PM

High Power Diode Laser Technology I

Session Chair: **Stefan W. Heinemann**, TRUMPF Photonics (USA)

Forward development of high power diode lasers, Stephan G. Strohmaier, Götz Erbert, Arne Meissner-Schenk, Matthias Lommel, Christian Carstens, TRUMPF Laser GmbH (Germany); Berthold Schmidt, Hagen Zimer, TRUMPF Photonics (USA); Matthias Karow, Martin Wilkens, Thorben Kaul, Paul Crump, Ferdinand-Braun-Institut (Germany) [10514-8]

Extreme triple asymmetric (ETAS) epitaxial designs for increased efficiency at high powers in 9xx-nm diode lasers, Thorben Kaul, Leibniz Institut für Höchstfrequenztechnik (Germany); Götz Erbert, André Maassdorf, Dominik Martin, Paul Crump, Ferdinand-Braun-Institut (Germany) [10514-9]

High polarization purity operation of 99% in 9xx-nm broad stripe laser diodes, Rintaro Morohashi, Fujikura Ltd. (Japan); Yuji Yamagata, OPTOENERGY Inc. (Japan); Yoshikazu Kaifuchi, Fujikura Ltd. (Japan); Katsuhisa Tada, OPTOENERGY Inc. (Japan); Ryozauro Nogawa, Fujikura Ltd. (Japan); Yumi Yamada, OPTOENERGY Inc. (Japan); Masayuki Yamaguchi, Fujikura Ltd. (Japan) [10514-10]

Simulation of high-power laser diode with improved heat sinking structure using epitaxial liftoff technique, Younghyun Kim, Yunsu Sung, Jung-Tack Yang, Woo-Young Choi, Yonsei Univ. (Korea, Republic of) [10514-11]

Development of highly efficient laser bars emitting around 1060 nm for pulsed applications, Agnieszka Pietrzak, JENOPTIK Diode Lab GmbH (Germany); Jens Meusel, JENOPTIK Optical Systems GmbH (Germany); Martin Zorn, Ralf Huelsewede, Juergen Sebastian, JENOPTIK Diode Lab GmbH (Germany) [10514-12]

970-nm ridge waveguide diode laser bars for high power DWBC systems, Martin Wilkens, Hans Wenzel, Andrea Knigge, Paul Crump, André Maassdorf, Jörg Fricke, Peter Ressel, Ferdinand-Braun-Institut (Germany); Stephan G. Strohmaier, Berthold Schmidt, TRUMPF GmbH & Co. KG (Germany) [10514-13]

SESSION 3 MON 3:30 PM TO 4:50 PM

High Power Diode Laser Technology II

Session Chair: **Robert Martinsen**, nLIGHT Corp. (USA)

Diode lasers optimized in brightness for fiber laser pumping, Marc T. Kelemen, Jürgen Gilly, DILAS Semiconductor Business Unit (Germany); Patrick Friedmann, DILAS Diodenlaser GmbH (Germany); Sascha Hilzensauer, DILAS Semiconductor Business Unit (Germany); Lukas Ogradowski, DILAS Diodenlaser GmbH (Germany)..... [10514-14]

Next generation diode lasers with enhanced brightness, Alexander Killi, Simon Rauch, Lukas Irmiler, Julian Rikels, Steffen Ried, TRUMPF Laser GmbH (Germany); Hagen Zimer, TRUMPF Photonics (USA); Evangelos Papastathopoulos, TRUMPF Laser GmbH (Germany) . . . [10514-15]

Advancements of ultra-high peak power laser diode arrays, John Goings, Prabhu Thiagarajan, Devin Crawford, Steve Smith, Brian Caliva, Lasertel, Inc. (USA)..... [10514-16]

Advances in infrared high power lasers for long term operation, Martin Müller, Sebastian Hein, Fabian Eigenmann, Christian Lauer, Harald König, Uwe Strauss, OSRAM Opto Semiconductors GmbH (Germany) [10514-17]

Simulation of high-power laser diode with improved heat sinking structure using epitaxial liftoff technique

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ABSTRACT

The characteristics of high-power broad-area laser diodes with the improved heat sinking structure are numerically analyzed by a technology computer-aided design based self-consistent electro-thermal-optical simulation. The high-power laser diodes consist of a separate confinement heterostructure of a compressively strained InGaAsP quantum well and GaInP optical cavity layers, and a 100- μm -wide rib and a 2000- μm long cavity. In order to overcome the performance deteriorations of high-power laser diodes caused by self-heating such as thermal rollover and thermal blooming, we propose the fabrication method and its structure with the improved heat sink, without a bulk substrate between an active region and a bottom heat sink. It is possible to obtain by removing a 400- μm -thick GaAs substrate with an AlAs sacrificial layer utilizing well-known epitaxial liftoff techniques. For the accurate simulation results, we first carefully verify our simulation result using the experiment results with given parameters by the paper (SPIE vol. 5739 doi: 10.1117/12.588730) and also fitting parameters of carrier lifetime of 4 ns and Auger coefficient of $1 \times 10^{-29} \text{ cm}^6/\text{s}$ inside the quantum well region. We present the performance improvement of the high-power laser diode with the heat-sinking structure by suppressing thermal effects. The maximum temperature is expected to be reduced by $\sim 390 \text{ K}$ at the operating current of 8 A, which is $\sim 480 \text{ K}$ for the normal structure. As a result, we predict that the characteristics of the laser diode are highly improved, including optical power and beam quality etc.

Keywords: High-power laser diode, self-heating, epitaxial liftoff technique