

PROCEEDINGS OF SPIE

Laser Source Technology for Defense and Security IV

**Mark Dubinskii
Gary L. Wood**
Editors

**17–18 March 2008
Orlando, Florida, USA**

Sponsored and Published by
SPIE

Volume 6952

Proceedings of SPIE, 0277-786X, v. 6952

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Laser Source Technology for Defense and Security IV*, edited by Mark Dubinskii, Gary L. Wood, Proceedings of SPIE Vol. 6952 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 0277-786X

ISBN 9780819471437

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2008, Society of Photo-Optical Instrumentation Engineers

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/08/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a similar font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii *Conference Committee*

SESSION 1 FIBER LASERS

- 6952 02 **Overview of Sandia's fiber laser program (Invited Paper)** [6952-01]
D. A. V. Kliner, R. P. Bambha, B. T. Do, R. L. Farrow, Sandia National Labs. (USA); J.-P. Fève, JDSU (USA); B. P. Fox, Univ. of Arizona (USA); G. R. Hadley, A. Hansen, Sandia National Labs. (USA); H. J. Hoffman, M. Hotoleanu, Liekki Corp. (Finland); A. A. Hoops, W. L. Hsu, J. P. Koplrow, Sandia National Labs. (USA); J. Koponen, Liekki Corp. (Finland); S. W. Moore, R. L. Schmitt, P. E. Schrader, Sandia National Labs. (USA); J. H. Simmons, K. Simmons-Potter, Univ. of Arizona (USA); A. V. Smith, Sandia National Labs. (USA); M. Söderlund, Liekki Corp. (Finland); W. J. Thomes, G. Wien, Sandia National Labs. (USA)
- 6952 04 **Compact high-power eye safe fiber laser for LADAR** [6952-03]
J. Henrie, M. S. Bowers, R. Afzal, B. Jenson, Aculight Corp. (USA); J. E. Grobmyer, U.S. Army Aviation and Missile Research, Redstone Arsenal (USA)
- 6952 05 **Yb-free, SLM EDFA: comparison of 980-, 1470- and 1530-nm excitation for the core- and clad-pumping** [6952-04]
M. Dubinskii, Army Research Lab. (USA); V. Ter-Mikirtychev, NovaWave Technologies, Inc. (USA); J. Zhang, Army Research Lab. (USA); I. Kudryashov, Princeton Lightwave Inc. (USA)
- 6952 06 **Parametric generation in optical fibers in the 900–950nm spectral band** [6952-05]
W. Torruellas, M. Dennis, J. Warren, Johns Hopkins Univ. (USA); J. Hu, C. Menyuk, Univ. of Maryland, Baltimore County (USA)
- 6952 07 **Comparison of spectral beam combining approaches for high power fiber laser systems** [6952-06]
P. Madasamy, T. Loftus, A. Thomas, P. Jones, E. Honea, Aculight Corp. (USA)

SESSION 2 DIODE LASERS

- 6952 08 **Advances in high-brightness semiconductor lasers** [6952-07]
M. L. Osowski, W. Hu, R. M. Lammert, S. W. Oh, P. T. Rudy, T. Stakelon, L. Vaissie, J. E. Ungar, QPC Lasers, Inc. (USA)
- 6952 09 **Diode laser pumping sources for cryogenically cooled solid-state lasers** [6952-08]
M. A. Maiorov, I. E. Trofimov, Vullfort, Inc. (USA)
- 6952 0A **High-brightness laser diode modules for Yb and Er fiber lasers** [6952-09]
M. A. Maiorov, I. E. Trofimov, Vullfort, Inc. (USA); C. Schnitzler, S. Hambücker, Ingeneric GmbH (Germany)
- 6952 0B **High-power very high-brightness fiber-coupled diode laser arrays** [6952-10]
D. M. Grasso, S. D. Roh, Coherent, Inc. (USA)

- 6952 0C **Mode control for high performance laser diode sources** [6952-11]
P. Leisher, K. Price, S. Bashar, L. Bao, H. Huang, J. Wang, D. Wise, S. Zhang, S. Das,
M. DeFranza, A. Hodges, U. Trifan, D. Balsley, W. Dong, M. Grimshaw, M. DeVito, J. Bell,
R. Martinsen, J. Farmer, P. Crump, S. Patterson, nLight Corp. (USA)
- 6952 0D **High power volume Bragg laser bar with 10 GHz spectral bandwidth** [6952-12]
G. Venus, A. Gourevitch, College of Optics and Photonics, Univ. of Central Florida (USA);
V. Smirnov, OptiGrate (USA); L. Glebov, College of Optics and Photonics, Univ. of Central
Florida (USA)

SESSION 3 ADVANCED LASER CONCEPTS

- 6952 0E **A general model of a thermal conductivity for optical materials (Invited Paper)** [6952-13]
T. Taira, Y. Sato, Institute for Molecular Science (Japan)
- 6952 0G **Single-frequency-mode Q-switched Nd:YAG laser controlled by volume Bragg gratings**
[6952-15]
N. Vorobiev, College of Optics and Photonics, Univ. of Central Florida (USA); V. Smirnov,
OptiGrate (USA); L. Glebov, College of Optics and Photonics, Univ. of Central Florida (USA)
- 6952 0H **Design and fabrication of efficient collimation and focusing optics for mid-IR quantum
cascade lasers** [6952-16]
B. E. Bernacki, K. Krishnaswami, N. C. Anheier, Jr., B. D. Cannon, Pacific Northwest National
Lab. (USA)
- 6952 0I **Cohering of multiple polariton lasers for sensing applications** [6952-17]
R. L. Fork, L. A. Burgess, M. L. Davenport, D. M. Ramey, P. J. Reardon, D. B. Pollock,
R. G. Lindquist, D. M. Fork, Univ. of Alabama, Huntsville (USA)

SESSION 4 HIGH POWER SSL

- 6952 0K **Kilowatt class high-power CW Yb:YAG cryogenic laser** [6952-19]
D. C. Brown, J. M. Singley, E. Yager, K. Kowalewski, J. Guelzow, J. W. Kuper, Snake Creek
Lasers, LLC (USA)
- 6952 0L **2.3-kW continuous operation cryogenic Yb:YAG laser** [6952-37]
J. K. Brasseur, A. K. Abeeluck, A. R. Awtry, L. S. Meng, K. E. Shortoff, N. J. Miller,
R. K. Hampton, M. H. Cuchiara, D. K. Neumann, Directed Energy Solutions (USA)
- 6952 0M **Tensile strength and elastic moduli of composite solid state laser media** [6952-21]
H.-C. Lee, H. E. Meissner, Onyx Optics Inc. (USA)

SESSION 5 VISIBLE, EYE-SAFE, AND MID-IR LASERS

- 6952 0O **First laser performance of Er³⁺-doped scandia (Sc₂O₃) ceramic (Invited Paper)** [6952-23]
M. Dubinskii, N. Ter-Gabrielyan, L. D. Merkle, G. A. Newburgh, Army Research Lab. (USA);
A. Ikesue, World Lab. Co., Ltd. (Japan)

- 6952 OP **Thermo-optical model for Er³⁺:YAG gain media** [6952-24]
M. Eichhorn, French-German Research Institute of Saint-Louis (France)
- 6952 OQ **Design of walk-off corrected biaxial crystal composites** [6952-25]
H.-C. Lee, H. E. Meissner, Onyx Optics Inc. (USA)
- 6952 OR **Miniature solid-state lasers for pointing, illumination, and warning devices** [6952-26]
D. C. Brown, J. M. Singley, E. Yager, K. Kowalewski, B. Lotito, J. Guelzow, J. Hildreth,
J. W. Kuper, Snake Creek Lasers, LLC (USA)
- 6952 OS **Thulium fiber laser-pumped mid-IR OPO** [6952-28]
D. Creedon, BAE Systems (USA); M. Jiang, Spectrode, LLC (USA); P. A. Budni,
P. A. Ketteridge, S. D. Setzler, Y. E. Young, J. C. McCarthy, P. G. Schunemann, T. M. Pollak,
BAE Systems (USA); P. Tayebati, Spectrode, LLC (USA); E. P. Chicklis, BAE Systems (USA)

SESSION 6 POSTER SESSION

- 6952 OT **Nonlinear optical device for middle infrared generation** [6952-30]
N. B. Patel, Univ. of Campinas (Brazil)
- 6952 OU **300-kW eye-safe intracavity OPO transmitter** [6952-31]
W. Zendzian, J. K. Jabczynski, J. Kwiatkowski, K. Kopczynski, Military Univ. of Technology
(Poland)
- 6952 OW **High-power diode lasers operating around 1500-nm for eyesafe applications** [6952-35]
S. Patterson, P. Leisher, K. Price, K. Kennedy, W. Dong, M. Grimshaw, S. Zhang, J. Patterson,
S. Das, S. Karlsen, R. Martinsen, J. Bell, nLight Corp. (USA)

Author Index

Conference Committee

Symposium Chair

Larry B. Stotts, Defense Advanced Research Projects Agency (USA)

Symposium Cochair

Ray O. Johnson, Lockheed Martin Corporation (USA)

Program Track Chair

Gary W. Kamerman, FastMetrix, Inc. (USA)

Conference Chairs

Mark Dubinskii, Army Research Laboratory (USA)

Gary L. Wood, Army Research Laboratory (USA)

Program Committee

Steven R. Bowman, Naval Research Laboratory (USA)

Andrew J. W. Brown, Aculight Corporation (USA)

Joseph Mangano, Defense Advanced Research Projects Agency (USA)

Mark W. Neice, High Energy Laser Joint Technology Office (USA)

Stephen G. Post, Missile Defense Agency (USA)

Session Chairs

- 1 Fiber Lasers
Andrew J. W. Brown, Aculight Corporation (USA)
- 2 Diode Lasers
Steven R. Bowman, Naval Research Laboratory (USA)
- 3 Advanced Laser Concepts
Gary L. Wood, Army Research Laboratory (USA)
- 4 High Power SSL
Don D. Seeley, High Energy Laser Joint Technology Office (USA)
- 5 Visible, Eye-Safe, and Mid-IR Lasers
Stephen G. Post, Missile Defense Agency (USA)

