

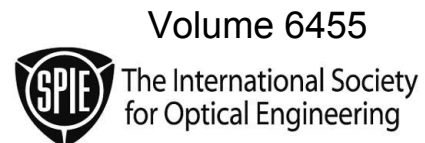
PROCEEDINGS OF SPIE

Nonlinear Frequency Generation and Conversion: Materials, Devices, and Applications VI

Peter E. Powers
Editor

23–24 January 2007
San Jose, California, USA

Sponsored and Published by
SPIE—The International Society for Optical Engineering



Proceedings of SPIE—The International Society for Optical Engineering, 9780819465689, v. 6455

SPIE is an international technical society dedicated to advancing engineering and scientific applications of optical, photonic, imaging, electronic, and optoelectronic technologies.

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 *Nonlinear Frequency Generation and Conversion: Materials, Devices, and Applications VI*, edited by Peter E. Powers, Proceedings of SPIE Vol. 6455 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X
ISBN 9780819465689

Published by

SPIE—The International Society for Optical Engineering

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

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

<http://www.spie.org>

Copyright © 2007, The 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 \$15.00 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 <http://www.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/07/\$15.00.

Printed in the United States of America.

Contents

ix *Conference Committee*

SESSION 1 VISIBLE AND UV NONLINEAR OPTICAL DEVICES

- 645502 **Design and characterization of a rugged and compact setup for widely tunable harmonic generation in the ultraviolet** [6455-01]
B. Jungbluth, M. Vierkoetter, M. Hofer, J. Loehring, D. Oberbeckmann, D. Hoffmann, Fraunhofer Institute for Lasertechnology (Germany)
- 645503 **Generation of more than 300 mW diffraction-limited light at 405 nm by second-harmonic generation of a tapered diode laser with external cavity feedback** [6455-02]
O. B. Jensen, J. Holm, Risø National Lab. (Denmark); B. Sumpf, G. Erbert, Ferdinand-Braun-Institut für Höchstfrequenztechnik (Germany); P. E. Andersen, P. M. Petersen, Risø National Lab. (Denmark)
- 645504 **Novel low-loss 3-element ring resonator for second-harmonic generation of 808nm into 404nm using periodically poled KTP** [6455-03]
J. Holm, Risø National Lab. (Denmark) and Lund Institute of Technology (Sweden); O. B. Jensen, Risø National Lab. (Denmark); B. Sumpf, G. Erbert, Ferdinand-Braun-Institut für Höchstfrequenztechnik (Germany); S. Andersson-Engels, Lund Institute of Technology (Sweden); P. E. Andersen, P. M. Petersen, Risø National Lab. (Denmark)

SESSION 2 NONLINEAR OPTICAL APPLICATIONS

- 645506 **Frequency doubling of ps Ti:sapphire laser with PPMgLN waveguide for spin polarization of ^3He** [6455-05]
K. Kyutoku, H. Kumagai, A. Kobayashi, Osaka City Univ. (Japan)

Pagination: 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.

- 645507 **Integrated ultraviolet and tunable mid-infrared laser source for analyses of proteins** [6455-06]
H. Hazama, Osaka Univ. (Japan); Y. Takatani, Kawasaki Heavy Industries, Ltd. (Japan); K. Awazu, Osaka Univ. (Japan)
- 645508 **Active narrowband multiple fundamental and second-harmonic wavelength filters in aperiodically poled lithium niobates** [6455-07]
Y.-H. Chen, C.-H. Lin, J.-Y. Chang, National Central Univ. (Taiwan)

SESSION 3 NONLINEAR OPTICAL TESTING

- 645509 **Terahertz wave generation in orientation-patterned GaAs using resonantly enhanced schemes (Invited Paper)** [6455-09]
K. L. Vodopyanov, J. E. Schaar, P. S. Kuo, M. M. Fejer, X. Yu, J. S. Harris, Stanford Univ. (USA); V. G. Kozlov, Microtech Instruments, Inc. (USA); D. Bliss, C. Lynch, Hanscom Air Force Research Lab. (USA)
- 64550A **Optical parametric amplification of mid-infrared radiation using multi-layer glass-bonded QPM GaAs crystals** [6455-10]
B. J. Perrett, P. D. Mason, P. A. Webber, S. C. Woods, D. A. Orchard, QinetiQ (United Kingdom)
- 64550B **Optimization of noncollinear optical parametric amplification** [6455-11]
D. N. Schimpf, J. Rothardt, J. Limpert, A. Tünnermann, Friedrich-Schiller-Univ. Jena (Germany)
- 64550C **Optical parametric generation of high-energy femtosecond pulses in the 1-3 μm spectral range using BiB_3O_6** [6455-12]
V. Petrov, Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy (Germany); M. Ghotbi, ICFO The Institute of Photonic Sciences (Spain); P. Tzankov, F. Noack, Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy (Germany); I. Nikolov, I. Buchvarov, Sofia Univ. (Bulgaria); M. Ebrahim-Zadeh, ICFO The Institute of Photonic Sciences (Spain)
- 64550D **Compact sub-mW mid-infrared DFG laser source using direct-bonded QPM-LN ridge waveguide and laser diodes** [6455-13]
O. Tadanaga, Y. Nishida, T. Yanagawa, K. Magari, T. Umeki, M. Asobe, H. Suzuki, NTT Corp. (Japan)
- 64550E **8.6 watt single-frequency CW OPO** [6455-14]
A. Henderson, R. Stafford, Aculight Corp. (USA)

SESSION 4 ULTRAFast NONLINEAR OPTICS

- 64550F **Nonlinear optics for high-order frequency conversion: applied attosecond science (Invited Paper)** [6455-15]
X. Zhang, A. L. Lytle, D. Gaudiosi, T. Popmintchev, H. C. Kapteyn, M. M. Murnane, O. Cohen, Univ. of Colorado, Boulder (USA), National Institute of Standards and Technology (USA), and National Science Foundation (USA)

- 64550G **Coherent detection of multicycle terahertz pulses generated in periodically inverted GaAs structures** [6455-16]
Y.-S. Lee, W. C. Hurlbut, Oregon State Univ. (USA); K. L. Vodopyanov, M. M. Fejer, Stanford Univ. (USA); V. G. Kozlov, Microtech Instruments, Inc. (USA)
- 64550H **Fiber continuum seeded ultrafast parametric amplification** [6455-17]
C. Aguergaray, Univ. Bordeaux I (France); T. V. Andersen, Univ. of Aarhus (Denmark); J. Limpert, Friedrich-Schiller-Univ. Jena (Germany); E. Cormier, Univ. Bordeaux I (France); A. Tünnermann, Friedrich-Schiller-Univ. Jena (Germany)
- 64550J **Arbitrary terahertz pulse shaping via optical rectification in fanned-out periodically poled lithium niobate** [6455-19]
Y.-S. Lee, J. R. Danielson, N. Amer, Oregon State Univ. (USA)
- 64550K **Extending the flat gain bandwidth of combined Raman-parametric fiber amplifiers using highly nonlinear fiber** [6455-20]
M. F. Arend, M. A. Ummy, City College, CUNY (USA); L. Leng, New York City College of Technology, CUNY (USA); R. Dorsinville, City College, CUNY (USA)

SESSION 5 NONLINEAR OPTICAL MODELING AND DEVICES

- 64550L **Two-stage PPLN parametric amplification for higher conversion efficiency** [6455-21]
A. R. Pandey, J. W. Haus, P. E. Powers, Univ. of Dayton (USA)
- 64550M **Four-dimensional treatment of frequency conversion and the effect of smoothing by spectral dispersion** [6455-22]
P. A. Treadwell, Atomic Weapons Establishment (United Kingdom)
- 64550N **Iterative resonator model describing the Stokes and anti-Stokes emission of a continuous-wave silicon-based Raman laser** [6455-30]
N. Vermeulen, C. Debaes, H. Thienpont, Vrije Univ. Brussel (Belgium)
- 64550O **Analysis of a third-order optical parametric oscillator in TiO₂** [6455-24]
C. Wang, M. Sheik-Bahae, The Univ. of New Mexico (USA)
- 64550P **Singly resonant optical parametric oscillators with pump-modulation transfer for frequency modulated spectroscopy in the mid-infrared** [6455-25]
I. D. Lindsay, P. Groß, C. J. Lee, B. Adhimoolam, K.-J. Boller, Univ. of Twente (Netherlands)
- 64550Q **Simultaneous SHG of orthogonally polarized fundamentals in single QPM crystals** [6455-26]
B. F. Johnston, Macquarie Univ. (Australia); S. M. Saltiel, Univ. of Sofia (Bulgaria); M. J. Withford, Macquarie Univ. (Australia); Y. S. Kivshar, Australian National Univ. (Australia)

SESSION 6 NONLINEAR OPTICAL MATERIALS AND CHARACTERIZATION I

- 64550R **Improved NLO crystals for mid-IR laser applications (Invited Paper)** [6455-27]
P. G. Schunemann, BAE Systems, Inc. (USA)
- 64550T **Stimulated Raman scattering in new organic and inorganic crystalline materials** [6455-29]
H. Rhee, Technische Univ. Berlin (Germany); A. A. Kaminskii, Institute of Crystallography (Russia); H. J. Eichler, Technische Univ. Berlin (Germany)

- 64550U **Modeling mid-infrared continuous-wave silicon-based Raman lasers** [6455-23]
N. Vermeulen, C. Debaes, H. Thienpont, Vrije Univ. Brussel (Belgium)

SESSION 7 NONLINEAR OPTICAL MATERIALS AND CHARACTERIZATION II

- 64550W **Theory of second harmonic generation in presence of diffraction, beam walk-off, and pump depletion (Invited Paper)** [6455-32]
S. Guha, L. P. Gonzalez, Air Force Research Lab. (USA)
- 64550Z **Novel high sensitivity thermal managed eclipse Z-scan technique** [6455-36]
A. S. L. Gomes, E. L. Falcão Filho, C. B. de Araújo, D. Rativa, R. E. de Araujo, Federal Univ. of Pernambuco (Brazil)
- 645511 **Comparison between stimulated Raman and Brillouin scattering processes in magnetized doped III-V semiconductors** [6455-38]
N. Kishore, M. Singh, P. Aghamkar, Guru Jambheshwar Univ. of Science and Technology (India)

POSTER SESSION

- 645512 **Parametric oscillation in $B_2B_3O_6$ pumped at $1.0642 \mu\text{m}$** [6455-39]
K. Kato, Chitose Institute of Science and Technology (Japan)
- 645513 **Noncritical phase-matched difference-frequency generation in $\text{AgGa}_{1-x}\text{In}_x\text{S}_2$** [6455-40]
S. Banerjee, K. Kato, Chitose Institute of Science and Technology (Japan)
- 645514 **New experimental results for SHG and DFG in AgGaGeS_4** [6455-41]
K. Miyata, Chitose Institute of Science and Technology (Japan); V. Petrov, Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy (Germany); N. Umemura, K. Kato, Chitose Institute of Science and Technology (Japan); N. Saito, S. Wada, Institute of Physical and Chemical Research RIKEN (Japan)
- 645515 **Hybrid intra-extra cavity OPO using monolithic crystal for improvement in OPO efficiency** [6455-43]
S. K. Verma, D. R. Korhalkar, A. Nautiyal, Bharat Electronics Ltd. (India)
- 645516 **Supercontinuum generation enhanced by conventional Raman amplification at pumping by nanosecond pulses from a directly modulated DFB laser** [6455-44]
R. Rojas-Laguna, Univ. de Guanajuato (Mexico); J. Gutiérrez-Gutiérrez, E. A. Kuzin, B. Ibarra-Escamilla, S. Mendoza-Vázquez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); J. M. Estudillo-Ayala, Univ. de Guanajuato (Mexico); J. W. Haus, Univ. of Dayton (USA)
- 645517 **Resonant doubler with a 2-THz automatic quasi-smooth scan range for widely tunable CW single-frequency lasers** [6455-45]
S. Kobtsev, Novosibirsk State Univ. (Russia) and TEKHNOSCAN Joint-Stock Co. (Russia); V. Lunin, TEKHNOSCAN Joint-Stock Co. (Russia)

- 645518 **Mid-infrared ZGP optical parametric oscillator directly pumped by a lamp-pumped Q-switched Cr,Tm,Ho:YAG laser.** [6455-46]
A. F. Nieuwenhuis, C. J. Lee, P. J. M. van der Slot, P. Groß, K.-J. Boller, Univ. of Twente (Netherlands)
- 645519 **Amplitude and frequency characteristics of a multiphonon light scattering in tellurium dioxide single crystal** [6455-47]
A. S. Shcherbakov, S. E. B. Mata, Y. N. Ledeneva, National Institute for Astrophysics, Optics & Electronics (Mexico); A. A. Lopez, Mixteca Univ. of Technology (Mexico)
- 64551A **Optical parametric generation at extremely low pump irradiance in a long periodically poled lithium niobate** [6455-48]
S. Acco, P. Blau, S. Pearl, Soreq NRC (Israel); A. Arie, Tel Aviv Univ. (Israel)
- 64551D **Fast-acting nonlinear optical limiters and switchers based on fullerenes and fullerene-like nanostructures** [6455-51]
I. M. Belousova, V. P. Belousov, N. G. Mironova, T. D. Murav'eva, A. G. Scobelev, M. S. Yur'ev, D. A. Videnichev, Institute for Laser Physics (Russia)

Author Index

Conference Committee

Symposium Chairs

Henry Helvajian, The Aerospace Corporation (USA)
Friedrich G. Bachmann, Rofin-Sinar Laser GmbH (Germany)

Symposium Cochairs

L. N. Durvasula, DARPA (USA)
Jan J. Dubowski, Université de Sherbrooke (Canada)

Program Track Chair

Peter E. Powers, University of Dayton (USA)

Conference Chair

Peter E. Powers, University of Dayton (USA)

Program Committee

Darrell J. Armstrong, Sandia National Laboratories (USA)
Rajan Bhatia, Consultant (USA)
Mark S. Bowers, Aculight Corporation (USA)
Robert C. Eckardt, Cleveland Crystals Inc. (USA)
Abraham Englander, Soreq Nuclear Research Center (Israel)
Richard Hammond, U.S. Army Research Office (USA)
Yehoshua Y. Kalisky, Nuclear Research Center Negev (Israel)
Thomas J. Kulp, Sandia National Laboratories (USA)
Fredrik Laurell, Kungliga Tekniska Högskolan (Sweden)
Michael W. Millard, ITT Industries, Inc. (USA)
Jeffrey W. Pierce, JP Innovations, LLC (USA)
Kenneth L. Schepler, Air Force Research Laboratory (USA)
Peter G. Schunemann, BAE Systems, Inc. (USA)
Ramesh K. Shori, University of California, Los Angeles (USA)

Session Chairs

- 1 Visible and UV Nonlinear Optical Devices
Peter E. Powers, University of Dayton (USA)
- 2 Nonlinear Optical Applications
Michael W. Millard, ITT Industries, Inc. (USA)

- 3 Nonlinear Optical Testing
Yehoshua Y. Kalisky, Nuclear Research Center Negev (Israel)
- 4 Ultrafast Nonlinear Optics
Thomas J. Kulp, Sandia National Laboratories (USA)
- 5 Nonlinear Optical Modeling and Devices
Robert C. Eckardt, Cleveland Crystals, Inc. (USA)
- 6 Nonlinear Optical Materials and Characterization I
Darrell J. Armstrong, Sandia National Laboratories (USA)
- 7 Nonlinear Optical Materials and Characterization II
Peter E. Powers, University of Dayton (USA)