PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 6713

, "Front Matter: Volume 6713," Proc. SPIE 6713, Nanophotonics and
Macrophotonics for Space Environments, 671301 (30 October 2007); doi:
10.1117/12.776735

SPIE.

Event: Optical Engineering + Applications, 2007, San Diego, California, United
States

PROCEEDINGS OF SPIE

Nanophotonics and Macrophotonics for Space Environments

Edward W. Taylor
David A. Cardimona
Editors

27–28 August 2007
San Diego, California, USA

Sponsored and Published by
SPIE

Volume 6713

Proceedings of SPIE, 0277-786X, v. 6713

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 *Nanophotonics and Macrophotonics for Space Environments*, edited by Edward W. Taylor, David A. Cardimona, Proceedings of SPIE Vol. 6713 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X

ISBN 9780819468611

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 © 2007, 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/07/\$18.00.

Printed in the United States of America.

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

SPIEDigitalLibrary.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
ix	Introduction

SESSION 1 POLYMER/ORGANIC MATERIALS AND COMPONENTS FOR SPACE ENVIRONMENTS

- 6713 02 **Optical signal processor using electro-optic polymer waveguides** [6713-01]
B.-J. Seo, Jet Propulsion Lab. (USA); S. Kim, H. Fetterman, Univ. of California, Los Angeles (USA); D. Jin, R. Dinu, Lumera Corp. (USA)
- 6713 03 **Record-high intrinsic hyperpolarizabilities for polymeric electro-optic modulators (Invited Paper)** [6713-02]
J. Pérez-Moreno, I. Asselberghs, Y. Zhao, K. Song, Univ. of Leuven (Belgium); H. Nakanishi, S. Okada, K. Nogi, Tohoku Univ. (Japan); O.-K. Kim, Naval Research Lab. (USA); J. Je, Sun Fine Chemicals Co. Ltd. (South Korea); J. Mátrai, M. De Maeyer, Univ. of Leuven (Belgium); M. G. Kuzyk, Washington State Univ. (USA); K. Clays, Univ. of Leuven (Belgium)
- 6713 04 **Shrinking polymer lasers (Invited Paper)** [6713-03]
I. D. W. Samuel, A. E. Vasdekis, G. Tsiminis, G. A. Turnbull, Univ. of St. Andrews (United Kingdom); E. W. Taylor, International Photonics Consultants (USA)

SESSION 2 NANO-POLYMER MATERIALS AND COMPONENTS IN SPACE RADIATION ENVIRONMENTS I

- 6713 07 **Organics, polymers, and nanotechnology for radiation hardening and shielding applications** [6713-06]
E. W. Taylor, International Photonics Consultants, Inc. (USA)
- 6713 08 **Hardening of polymer optical materials with laser cycling and gamma-rays (Invited Paper)** [6713-07]
M. G. Kuzyk, Washington State Univ. (USA); E. W. Taylor, International Photonics Consultants (USA); N. Embaye, Y. Zhu, J. Zhou, Washington State Univ. (USA)

SESSION 3 NANO-POLYMER MATERIALS AND COMPONENTS IN SPACE RADIATION ENVIRONMENTS II

- 6713 0B **Novel hybrid electro-optic modulators with horizontal taper structure** [6713-10]
G. Yu, B. Li, D. Jin, L. Zheng, R. Dinu, Lumera Corp. (USA); A. Chen, Univ. of Washington (USA)
- 6713 0D **In-situ monitoring of slow light structures in dye-doped polymer waveguide materials** [6713-12]
E. M. McKenna, Jr., A. Lin, A. Waskiewicz, A. R. Mickelson, Univ. of Colorado, Boulder (USA)

- 6713 0E **Experimental research on radiation induced changes of polymer optical fiber under gamma-ray irradiation (Invited Paper)** [6713-13]
W. Ge, Xinjiang Univ. (China) and Xi'an Institute of Optics and Precision Mechanics (China); W. Tian, Xi'an Institute of Optics and Precision Mechanics (China); Z. Jia, Xinjiang Univ. (China); Y. Wang, Xi'an Institute of Optics and Precision Mechanics (China)

SESSION 4 PHOTONICS TECHNOLOGY FOR SPACE APPLICATIONS I

- 6713 0F **Space qualification issues in acousto-optic and electro-optic devices (Invited Paper)** [6713-14]
N. S. Prasad, NASA Langley Research Ctr. (USA); E. W. Taylor, International Photonics Consultants (USA); S. Trivedi, S. Kutcher, J. Soos, Brimrose Corp. (USA)
- 6713 0G **Advanced optical technologies for space exploration (Invited Paper)** [6713-15]
N. Clark, NASA Langley Research Ctr. (USA)
- 6713 0H **Sensor and actuator ASICs for space missions** [6713-16]
D. Kerns, Sigenics, Inc. (USA)
- 6713 0I **Tunable optical filters for space exploration** [6713-18]
C. Crandall, High Chiva (USA); N. Clark, P. Davis, NASA Langley Research Ctr. (USA)

SESSION 5 NOVEL PHOTONIC DEVICES AND CONCEPTS FOR SPACE-BASED APPLICATIONS

- 6713 0K **A quantum dot longwave infrared photodetector with integrated optical amplifier** [6713-20]
X. Lu, Univ. of Massachusetts, Lowell (USA)
- 6713 0L **A longwave infrared transparent flexible electronics by printing at room temperature** [6713-21]
X. Lu, Univ. of Massachusetts, Lowell (USA); X. Han, Brewer Science Inc. (USA)
- 6713 0N **A super dark material: randomness and porosity in a nanostructure (Invited Paper)** [6713-23]
Z.-P. Yang, S. Y. Lin, J. A. Bur, L. Ci, P. M. Ajayan, Rensselaer Polytechnic Institute (USA)
- 6713 0O **Improving SNR of fiber Bragg grating sensor by digital signal processing** [6713-24]
J. Ning, Geophysics Institute of China Earthquake Administration (China) and Stevens Institute of Technology (USA); S. Yang, Yantai Univ. (China) and Stevens Institute of Technology (USA); Y. Zhang, H. Cui, Stevens Institute of Technology (USA)
- 6713 0P **Plasmon assisted photonic crystal quantum dot sensors** [6713-25]
R. V. Sheno, D. A. Ramirez, Y. Sharma, R. S. Attaluri, Ctr. for High Technology Materials, Univ. of New Mexico (USA); J. Rosenberg, O. J. Painter, California Institute of Technology (USA); S. Krishna, Ctr. for High Technology Materials, Univ. of New Mexico (USA)

SESSION 6 PHOTONICS TECHNOLOGY FOR SPACE APPLICATIONS II

- 6713 0Q **Requirements validation testing on the 7 optical fiber array connector/cable assemblies for the Lunar Reconnaissance Orbiter (LRO) (Invited Paper)** [6713-26]
M. N. Ott, NASA Goddard Space Flight Ctr. (USA); X. Jin, Perot Systems Government Services (USA); F. V. LaRocca, MEI Technologies (USA); A. Matuszeski, NASA Goddard Space Flight Ctr. (USA); R. F. Chuska, S. L. MacMurphy, MEI Technologies (USA)
- 6713 0R **Investigation of radiation-induced photodarkening in passive erbium-, ytterbium-, and Yb/Er co-doped optical fibers** [6713-27]
B. P. Fox, K. Simmons-Potter, J. H. Simmons, Univ. of Arizona (USA); W. J. Thomes, Jr., R. P. Bambha, D. A. V. Kliner, Sandia National Labs. (USA)
- 6713 0S **Space flight qualification on a novel five-fiber array assembly for the Lunar Orbiter Laser Altimeter (LOLA) at NASA Goddard Space Flight Center** [6713-28]
X. Jin, Perot Systems Government Services (USA); M. N. Ott, NASA Goddard Space Flight Ctr. (USA); F. V. LaRocca, R. F. Chuska, MEI Technologies (USA); S. M. Schmidt, A. J. Matuszeski, NASA Goddard Space Flight Ctr. (USA); S. L. Macmurphy, W. J. Thomes, R. C. Switzer, MEI Technologies (USA)
- 6713 0T **Investigation of hermetically sealed commercial LiNbO₃ optical modulator for use in laser/LIDAR space-flight applications (Invited Paper)** [6713-29]
W. J. Thomes, Jr., F. V. LaRocca, MEI Technologies/NASA Goddard (USA); M. N. Ott, NASA Goddard Space Flight Ctr. (USA); X. L. Jin, Perot Systems Government Services (USA); R. F. Chuska, S. L. MacMurphy, MEI Technologies/NASA Goddard (USA); T. L. Jamison, NASA Goddard Space Flight Ctr. (USA)

SESSION 7 PHOTONICS TECHNOLOGY FOR SPACE APPLICATIONS III

- 6713 0U **Waveguide PPLN second harmonic generator for NASA's Space Interferometry Mission (SIM) (Invited Paper)** [6713-30]
D. H. Chang, I. Y. Poberezhskiy, J. L. Mulder, Jet Propulsion Lab. (USA)
- 6713 0V **Compact electro-optic imaging Fourier transform spectrometer** [6713-31]
T.-H. Chao, Jet Propulsion Lab. (USA)
- 6713 0W **Silicon-on-sapphire fiber optic transceiver technology for space applications** [6713-33]
C. P. Kuznia, J. F. Ahadian, R. J. Pommer, R. Hagan, Ultra Communications, Inc. (USA)

Author Index

Conference Committee

Conference Chairs

Edward W. Taylor, International Photonics Consultants, Inc. (USA)
David A. Cardimona, Air Force Research Laboratory (USA)

Program Committee

Mansoor Alam, Nufern (USA)
Natalie Clark, NASA Langley Research Center (USA)
Richard O. Claus, Virginia Polytechnic Institute and State University (USA)
Douglas M. Craig, Air Force Research Laboratory (USA)
Raluca Dinu, Lumera Corporation (USA)
Alexandre I. Fedoseyev, CFD Research Corporation (USA)
Michael J. Hayduk, Air Force Research Laboratory (USA)
Dan-Hong Huang, Air Force Research Laboratory (USA)
James E. Nichter, Air Force Research Laboratory (USA)
Melanie N. Ott, NASA Goddard Space Flight Center (USA)
Narasimha S. Prasad, NASA Langley Research Center (USA)
Anthony D. Sanchez, Air Force Research Laboratory (USA)
Robert C. Stirbl, Jet Propulsion Laboratory (USA)

Session Chairs

- 1 Polymer/Organic Materials and Components for Space Environments
Raluca Dinu, Lumera Corporation (USA)
- 2 Nano-Polymer Materials and Components in Space Radiation Environments I
Natalie Clark, NASA Langley Research Center (USA)
- 3 Nano-Polymer Materials and Components in Space Radiation Environments II
Alexandre I. Fedoseyev, CFD Research Corporation (USA)
- 4 Photonics Technology for Space Applications I
Narasimha S. Prasad, NASA Langley Research Center (USA)
- 5 Novel Photonic Devices and Concepts for Space-Based Applications
Dan-Hong Huang, Air Force Research Laboratory (USA)

- 6 Photonics Technology for Space Applications II
 Melanie N. Ott, NASA Goddard Space Flight Center (USA)
- 7 Photonics Technology for Space Applications III
 Robert C. Stierbl, Jet Propulsion Laboratory (USA)

Introduction

The inaugural SPIE Nanophotonics and Macrophotonics for Space Environments (NMSE) proved to be a well-attended conference, in part, because it was an outgrowth from the previous SPIE Photonics for Space Environments I-XI conferences. The synergism of nanotechnology and photonics for addressing and advancing space applications was clearly evident and proved to be an excellent choice for this new conference providing a unique and useful forum.

As would be expected, the majority of NMSE Conference papers involved the advancement of polymer and hybrid organic materials for development of photonic-based space applications. The focus of many papers was primarily on the ability of the materials and devices to function in a space radiation environment. A large number of invited papers were presented as well as two excellent Keynote presentations by Dr. D. K. Shenoy of the Defense Advanced Research Projects Agency (DARPA) and Dr. K. C. Reinhardt of the Air Force Office of Scientific Research. The former dealt with DARPA's Supermolecular Photonics Engineering Program, while the latter presentation involved Integrated Multi-Mode Sensing. The Nano-Polymer Materials I and II and the Novel Photonic Devices and Concepts for Space Based Applications sessions drew much interest since these topics were addressed by presentations describing the novel integration and fusion of quantum dots, various nanoparticles and nanostructures for improving sensors, solar cells and detector characteristics.

We look forward to the next convening of the SPIE NMSE Conference and expect that additional advanced nano-, micro- and macrophotonic areas of research and development will be presented and continue to expand and improve the conference objectives.

The Chairs wish to thank the SPIE NMSE program committee, speakers, session chairs, and especially the SPIE staff for their many contributions to making the NMSE conference a success.

Edward W. Taylor
David A. Cardimona