PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 7425

, "Front Matter: Volume 7425," Proc. SPIE 7425, Optical Materials and Structures Technologies IV, 742501 (14 September 2009); doi: 10.1117/12.846290

Event: SPIE Optical Engineering + Applications, 2009, San Diego, California, United States

PROCEEDINGS OF SPIE

Optical Materials and Structures Technologies IV

Joseph L. Robichaud

William A. Goodman

Editors

2–3 August 2009

San Diego, California, United States

Sponsored and Published by

SPIE

Volume 7425

Proceedings of SPIE, 0277-786X, v. 7425

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 *Optical Materials and Structures Technologies IV*, edited by Joseph L. Robichaud, William A. Goodman, Proceedings of SPIE Vol. 7425 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 0277-786X

ISBN 9780819477156

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 © 2009, 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/09/\$18.00.

Printed in the United States of America.

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

SPIE
Digital Library

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 MATERIAL SELECTION AND CHARACTERIZATION

- 7425 02 **Optical system material selection using performance indices in a simultaneous optimization approach** [7425-01]
T. Newswander, B. Crowther, Space Dynamics Lab. (United States)
- 7425 03 **CTE measurements of Cescic®: a low-CTE ceramic composite** [7425-02]
M. R. Krödel, ECM GmbH (Germany); T. Ozaki, Mitsubishi Electric Corp. (Japan)
- 7425 04 **CTE characterization of ZERODUR® for the ELT century** [7425-03]
R. Jedamzik, T. Döhring, T. Johansson, P. Hartmann, T. Westerhoff, SCHOTT AG (Germany)
- 7425 05 **Cryogenic refractometer for high accuracy measurements of the refractive index of materials** [7425-04]
P. Spanò, INAF - Osservatorio Astronomico di Brera (Italy); A. Bianco, INAF - Ist. Astrofisica Spaziale e Fisica Cosmica (Italy); G. Toso, INAF - Osservatorio Astronomico di Brera (Italy); G. Pariani, Politecnico di Milano (Italy) and INAF - Osservatorio Astronomico di Brera (Italy)

SESSION 2 NDE OF SILICON CARBIDE

- 7425 06 **A general overview of some nondestructive evaluation (NDE) techniques for materials characterization (Invited Paper)** [7425-05]
S. Kenderian, O. Esquivel, K. R. Olson, E. C. Johnson, The Aerospace Corp. (United States)
- 7425 07 **NDE methods for determining the materials properties of silicon carbide plates** [7425-06]
S. Kenderian, Y. Kim, E. Johnson, I. A. Palusinski, The Aerospace Corp. (United States)
- 7425 08 **High frequency ultrasound phased array characterization of SiC mirror blanks** [7425-07]
R. A. Haber, A. Portune, Rutgers Univ. (United States)
- 7425 09 **Material testing of silicon carbide mirrors** [7425-08]
D. B. Witkin, I. A. Palusinski, The Aerospace Corp. (United States)

SESSION 3 SI-SiC

- 7425 0A **Proof load testing of lightweight silicon carbide mirror substrates** [7425-09]
M. J. O'Brien, A. De La Cruz, C.-Y. Tang, I. A. Palusinski, The Aerospace Corp. (United States)
- 7425 0B **Recent achievements using chemical vapor composite silicon carbide (CVC SiC)** [7425-10]
W. A. Goodman, C. Tanaka, Trex Advanced Materials (United States)

- 7425 0C **Silicon cladding for mirror substrates** [7425-11]
C. J. Duston, N. Gunda, Entegris, Inc. (United States); J. R. Schwartz, J. L. Robichaud, L-3 Communications SSG-Tinsley (United States)
- 7425 0D **Production of mirrors made of HB-Cesic for an airborne reconnaissance telescope system** [7425-12]
M. R. Krödel, P. Hofbauer, ECM GmbH (Germany); G. Luichtel, J. Katzer, M. Tausendfreund, Carl Zeiss Optronics GmbH (Germany); G. Derst, Dr. Carl Zeiss Jena GmbH (Germany)
- 7425 0E **Why silicon for telescope mirrors and structures?** [7425-13]
R. A. Paquin, D. R. McCarter, McCarter Machine Co., Inc. (United States)
- 7425 0F **SPIRALE: the first all-Cesic® telescopes orbiting earth** [7425-14]
M. R. Krödel, ECM GmbH (Germany); C. Devilliers, Thales Alenia Space (France)

SESSION 4 BERYLLIUM AND BE COMPOSITES

- 7425 0H **An all-beryllium-aluminum optical system for reconnaissance applications** [7425-17]
M. J. Russo, BAE Systems (United States)
- 7425 0J **Cryogenic adhesive testing for the NIRCam optical bench assembly** [7425-19]
M. Jacoby, A. Nordt, Lockheed Martin Space Systems Co. (United States); B. Hurlbut, Rhombus Consultants Group (United States)
- 7425 0K **NIRCam optical bench assembly qualification vibration testing** [7425-20]
M. Jacoby, A. Nordt, Lockheed Martin Space Systems Co. (United States)

SESSION 5 GLASS

- 7425 0L **Heritage of ZERODUR® glass ceramic for space applications** [7425-21]
T. Döhring, P. Hartmann, F.-T. Lentjes, R. Jedamzik, SCHOTT AG (Germany); M. J. Davis, SCHOTT North America, Inc. (United States)
- 7425 0M **ZERODUR® glass ceramics for high stress applications** [7425-22]
P. Hartmann, K. Nattermann, T. Döhring, R. Jedamzik, M. Kuhr, P. Thomas, SCHOTT AG (Germany); G. Kling, S. Lucarelli, EADS Astrium GmbH (Germany)
- 7425 0O **A bonded precision optical assembly using potassium hydroxide** [7425-24]
P. V. Mammini, Lockheed Martin Space Systems Co. (United States)

SESSION 6 OPTICAL MATERIALS, PROVEN AND EMERGING

- 7425 0P **A century of sapphire crystal growth: origin of the EFG method (Keynote Paper)** [7425-25]
D. C. Harris, Naval Air Systems Command (United States)
- 7425 0Q **Silicon nitride for lightweight stiff structures for optical instruments** [7425-26]
K. Berroth, FCT Ingenieurkeramik GmbH (Germany); C. Devilliers, Thales Alenia Space (France); G. Luichtel, Carl Zeiss Optronics GmbH (Germany)

- 7425 OR **Structural design considerations for an 8-m space telescope** [7425-37]
W. R. Arnold, Sr., Jacobs ESTS Group (United States); H. P. Stahl, NASA Marshall Space Flight Ctr. (United States)
- 7425 OS **Replication of lightweight mirrors** [7425-28]
M. Y. Chen, L. E. Matson, Air Force Research Lab. (United States); H. Lee, Air Force Research Lab. (United States) and UES, Inc. (United States); C. Chen, Air Force Research Lab. (United States) and Univ. of Dayton Research Institute (United States)

SESSION 7 THIN FILM COATINGS

- 7425 OT **Space radiation testing of thin film and multilayer optical coatings** [7425-29]
G. E. Thayer, E. L. Blansett, B. E. N. Keeler, Sandia National Labs. (United States)
- 7425 OU **Fabrication and characterization of cerium oxide thin films for ultraviolet sensing applications** [7425-30]
K. Wang, Univ. of Waterloo (Canada) and Thunder Bay Regional Research Institute (Canada); A. Reznik, Thunder Bay Regional Research Institute (Canada); K. S. Karim, Univ. of Waterloo (Canada)
- 7425 OV **Characterization of silver and aluminum custom mirror coatings for the MRO interferometric telescopes** [7425-31]
K. M. McCord, D. A. Klinglesmith III, C. A. Jurgenson, E. J. Bakker, New Mexico Institute of Mining and Technology (United States); R. A. Schmell, R. A. Schmell, D. Gartner, Optical Surface Technologies, LLC (United States); A. Jaramillo, W.M. Keck Observatory (United States); K. Romero, A. Rael, J. Lewis, Optical Surface Technologies, LLC (United States)

POSTER SESSION

- 7425 OY **Synchrotron radiation x-ray absorption fine-structure and raman scattering studies on 6H-SiC materials** [7425-34]
Y.-L. Tu, Z. C. Feng, National Taiwan Univ. (Taiwan); L.-Y. Jang, National Synchrotron Radiation Research Ctr. (Taiwan); W. Lu, Fisk Univ. (United States)
- 7425 OZ **Fabrication of microlens arrays on a glass substrate by roll-to-roll process with PDMS mold** [7425-35]
C.-N. Hu, G.-D. J. Su, National Taiwan Univ. (Taiwan)

Author Index

Conference Committee

Conference Chairs

Joseph L. Robichaud, L-3 Communications SSG-Tinsley (United States)
William A. Goodman, Trex Enterprises Corporation (United States)

Program Track Chair

H. Philip Stahl, NASA Marshall Space Flight Center (United States)

Program Committee

Christopher Carl Alexay, StingRay Optics, LLC (United States)
Scott R. Antonille, NASA Goddard Space Flight Center (United States)
Carol A. Click, SCHOTT North America, Inc. (United States)
David A. Content, NASA Goddard Space Flight Center (United States)
Brett J. de Blonk, Air Force Research Laboratory (United States)
Douglas Deason, U.S. Army Space and Missile Defense Command
(United States)
Richard A. Haber, Rutgers University (United States)
Matthias R. Krödel, ECM GmbH (Germany)
Lawrence E. Matson, Air Force Research Laboratory (United States)
Rob V. Michel, Brush Wellman, Inc. (United States)
Iwona A. Palusinski, The Aerospace Corp. (United States)
Thomas B. Parsonage, Brush Wellman Inc. (United States)
John W. Pepi, L-3 Communications SSG-Tinsley (United States)
Marc Tricard, QED Technologies, Inc. (United States)
David V. Wick, Sandia National Laboratory (United States)

Session Chairs

- 1 Material Selection and Characterization
John W. Pepi, L-3 Communications SSG-Tinsley (United States)
- 2 NDE of Silicon Carbide
Iwona A. Palusinski, The Aerospace Corporation (United States)
- 3 Si-SiC
William A. Goodman, Trex Enterprises Corporation (United States)
Matthias R. Krödel, ECM GmbH (Germany)

- 4 Beryllium and Be Composites
Thomas B. Parsonage, Brush Wellman Inc. (United States)
Rob V. Michel, Brush Wellman, Inc. (United States)
- 5 Glass
John W. Pepi, L-3 Communications SSG-Tinsley (United States)
- 6 Optical Materials, Proven and Emerging
Joseph L. Robichaud, L-3 Communications SSG-Tinsley (United States)
- 7 Thin Film Coatings
Michael J. Ellison, Alpine Research Optics Corporation (United States)