The papers 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. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers 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 these proceedings:


ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510611993

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 © 2017, 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/17/$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
SPIEDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five 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.
# Contents

<table>
<thead>
<tr>
<th>SESSION 1</th>
<th>ADHESIVES AND MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10371 02</td>
<td>Adhesive bonds for optics: analysis and trade-offs [10371-1]</td>
</tr>
<tr>
<td>10371 03</td>
<td>Advancements in adhesive mounting of optics [10371-2]</td>
</tr>
<tr>
<td>10371 04</td>
<td>ZERODUR - bending strength: review of achievements [10371-4]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 2</th>
<th>ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10371 05</td>
<td>2-μm optical time domain reflectometry measurements from novel Al-, Ge-, CaAlSi-doped and standard single-mode fibers [10371-5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 3</th>
<th>OPTOMECHANICAL ANALYSIS I</th>
</tr>
</thead>
<tbody>
<tr>
<td>10371 06</td>
<td>LLIMAS: revolutionizing integrating modeling and analysis at MIT Lincoln Laboratory [10371-7]</td>
</tr>
<tr>
<td>10371 07</td>
<td>The compound diffraction grating in the Ivory optomechanical modeling tools [10371-8]</td>
</tr>
<tr>
<td>10371 08</td>
<td>Linear analysis using secants for materials with temperature dependent nonlinear elastic modulus and thermal expansion properties [10371-9]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 4</th>
<th>OPTOMECHANICAL SYSTEMS I</th>
</tr>
</thead>
<tbody>
<tr>
<td>10371 09</td>
<td>System engineering of complex optical systems for mission assurance and affordability [10371-10]</td>
</tr>
<tr>
<td>10371 0B</td>
<td>HabEx primary mirror trade studies [10371-12]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 5</th>
<th>STABILITY AND ALIGNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>10371 0C</td>
<td>Design and test of precision vertical and horizontal linear nanopositioning flexure stages with centimeter-level travel range for x-ray instrumentation [10371-13]</td>
</tr>
<tr>
<td>10371 0D</td>
<td>Trajectory error analysis of a flexure pivot type guide for linear nanopositioning [10371-14]</td>
</tr>
</tbody>
</table>
The development of alignment turning system for precision len cells

Lithography lens mounting flexure number design and aberration analysis

Double Arm Linkage precision Linear motion (DALL) Carriage, a simplified, rugged, high performance linear motion stage for the moving mirror of an Fourier Transform Spectrometer or other system requiring precision linear motion

Analysis technique for controlling system wavefront error with active/adaptive optics

Using integrated models to minimize environmentally induced wavefront error in optomechanical design and analysis

Using multi-disciplinary optimization and numerical simulation on the transiting exoplanet survey satellite

Adaptive optics mounting method for higher second harmonic generation efficiency of large aperture KDP crystal

Cryogenic, infrared, optical beamsplitter wavefront error analysis and test

Optomechanical design of TMT NFIRAOS Subsystems at INO

Recent advancements in robotic micro-optical assembly at the Lockheed Martin Optical Payload Center of Excellence

The opto-mechanical design process: from vision to reality

Comparison of lenses' thermal expansion formulation in Zemax versus ANSYS with SigFit post processing

Mirrors design, analysis and manufacturing of the 550mm Korsch telescope experimental model

Optimization of a 16 inches diameter primary mirror assembly of a ground-based telescope
Development of an athermalized optomechanical system of large aperture remote sensing instruments [10371-31]

Removal of diamond turning marks with magneto-rheological finishing [10371-32]

Large area of MCP electronic rinse system design [10371-6]
Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Ahmad, Anees, 09
Alvarez-Chavez, J. A., 05
Alves, J. L., 0R
Andersen, David, 0N
Anton, Jayson, 0C
Arnold, William R., 0B
Atwood, Jenny, 0N
Boucher, Marc-André, 0N
Bury, Mark E., 06
Buteau-Vaillancourt, Louis, 0N
Byrnes, Peter W. G., 0N
Chan, Chia-Yen, 0U
Chang, Keng-Shou, 0E
Chang, Shenq-Tsong, 0F
Chen, Fong-Zhi, 0E
Chen, Jun-Cheng, 0E
Chung, Chien-Kai, 0E
Cottin, Pierre, 0N
Daly, John G., 02
Davis, Jacqueline M., 0B
Desnoyers, Nichola, 0N
Dewa, Paul G., 03
Doyle, Keith B., 06, 0J
Faria, João, 0R
Fitzsimmons, Joeleff, 0N
Genberg, Victor L., 0H, 0I
Grejda, Robert D., 03
Grenier, Martin, 0N
Hartmann, Peter, 04
Hatleway, Alson E., 07
Hawk, Matthew D., 02
Herriot, Glen, 0N
Hill, Alexis, 0N
Ho, Cheng-Fang, 0E
Hopkins, Greg, 0G
Hsu, Ming-Ying, 0F
Hsu, Wei-Yao, 0E
Huang, Chien-Yao, 0E
Huang, Po-Hsuan, 05, 0T
Huang, Ting-Ming, 0F, 0U
Huang, Yi-Kai, 05, 0T
Hwang, David, 0O
Hwang, Po-Wen, 0U
Hyun, Sangwon, 0V
Jacoby, Michael S., 0P
Jeon, Min-Woo, 0V
Jeong, Byeong-Joon, 0V
Johnson, Kendall B., 0G
Kearney, Steven, 0C, 0D
Kim, Geon-Hee, 0V
Kim, I-Jong, 0V
Kuo, Ching-Hsiang, 0E
Kvamme, E. Todd, 0P
Lai, Barry, 0C
Lamontagne, Frédéric, 0N
Lardières, Olivier, 0N
Larson, Thomas M., 0O
Leclerc, Mélanie, 0N
Ling, Jér, 0S
Liu, Wenjun, 0C
Martin, Olivier, 0N
Maser, Jorg, 0C
McMaster, Brian M., 03
Michels, Gregory J., 0H, 0I
Nash, Reston, 0N
Newswander, T., 0M
Nunes-Pereira, Eduardo J., 0R
Pepi, John W., 08
Qiu, Yafeng, 0X
Quan, Xusong, 0K
Rey, Justin J., 06
Rodríguez-Novelo, J. C., 05
Roehrig, Christian, 0C
Rong, Yiming, 0K
Rupp, Tyrel, 0M
Sanchez-Lara, R., 05
Sanchez-Nieves, A. J., 05
Shen, Chien-Wen, 0T
Shu, Deming, 0C, 0D
Sierra-Calderon, A., 05
Smith, W. Scott, 0B
Song, Chengxin, 0X
Stahl, Philip H., 0B
Stoeckel, Gerhard P., 06, 0J
Stubbs, David M., 0P
Tian, Menjia, 0K
Tischler, Jonathan Z., 0C
Véran, Jean-Pierre, 0N
Wang, Hui, 0K
Wang, Jung-Hsing, 0E
Yan, Zhigang, 0X
Zhang, Zheng, 0K
Conference Committee

Program Track Chair

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

Conference Chairs

Alson E. Hatheway, Alson E. Hatheway Inc. (United States)
David M. Stubbs, Lockheed Martin Space Systems Company (United States)

Conference Program Committee

Anees Ahmad, Raytheon Missle Systems (United States)
Patrick A. Bournes, MicroMeasure, Inc. (United States)
James H. Burge, College of Optical Sciences, The University of Arizona (United States)
John M. Casstevens, Dallas Optical Systems, Inc. (United States)
Robert Gifford Chave, RCAP Inc. (United States)
Patrick A. Coronato, Raytheon Missile Systems (United States)
John G. Daly, Vector Engineering (United States)
Keith B. Doyle, MIT Lincoln Laboratory (United States)
Robert C. Guyer, BAE Systems (United States)
Mark J. Hegge, Ball Aerospace & Technologies Corporation (United States)
Tony Hull, University of New Mexico at Albuquerque (United States)
Frank W. Kan, Simpson Gumpertz & Heger Inc. (United States)
William Jeffrey Lees, Johns Hopkins University Applied Physics Laboratory (United States)
John J. Polizotti, BAE Systems (United States)
Santiago Royo Royo, Universitat Politècnica de Catalunya (Spain)
Ann F. Shipley, University of Colorado at Boulder (United States)
Deming Shu, Argonne National Laboratory (United States)
Linda C. Usher, Executive Search Group (United States)
Daniel Vukobratovich, Raytheon Missile Systems (United States)
Carl H. Zweben, Consultant (United States)
## Session Chairs

1. Adhesives and Materials  
   **Alson E. Hatheway**, Alson E. Hatheway Inc. (United States)

2. Elements  
   **Carl H. Zweben**, Consultant (United States)

3. Optomechanical Analysis I  
   **Anees Ahmad**, Raytheon Missile Systems (United States)

4. Optomechanical Systems I  
   **William Jeffrey Lees**, Johns Hopkins University Applied Physics Laboratory (United States)

5. Stability and Alignment  
   **David M. Stubbs**, Lockheed Martin Space Systems Company (United States)

6. Optomechanical Analysis II  
   **Mark J. Hegge**, Ball Aerospace & Technologies Corporation (United States)

7. Mounting  
   **Alson E. Hatheway**, Alson E. Hatheway Inc. (United States)

8. Optomechanical Systems II  
   **Alson E. Hatheway**, Alson E. Hatheway Inc. (United States)