PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9983

, "Front Matter: Volume 9983," Proc. SPIE 9983, Pacific Rim Laser Damage 2016: Optical Materials for High-Power Lasers, 998301 (8 September 2016); doi: 10.1117/12.2241075

SPIE.

Event: Pacific Rim Laser Damage 2016: Optical Materials for High Power Lasers, 2016, Yokohama, Japan

PROCEEDINGS OF SPIE

Pacific Rim Laser Damage 2016

Optical Materials for High-Power Lasers

Takahisa Jitsuno
Jianda Shao
Wolfgang Rudolph
Editors

18–20 May 2016
Yokohama, Japan

Sponsored by
SPIE

Organized by
Institute of Laser Engineering, Osaka University (Japan)
SPIE
SIOM—Shanghai Institute of Optics and Fine Mechanics (China)

Cooperating Organizations
Institute for Laser Technology
Laser Society of Japan
Japan Laser Processing Society

Published by
SPIE

Volume 9983

Proceedings of SPIE 0277-786X, V. 9983

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

Pacific Rim Laser Damage 2016: Optical Materials for High-Power Lasers, edited by
Takahisa Jitsuno, Jianda Shao, Wolfgang Rudolph, Proc. of SPIE Vol. 9983, 998301
© 2016 SPIE · CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2241075

Proc. of SPIE Vol. 9983 998301-1

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:

Author(s), "Title of Paper," in *Pacific Rim Laser Damage 2016: Optical Materials for High-Power Lasers*, edited by Takahisa Jitsuno, Jianda Shao, Wolfgang Rudolph, Proceedings of SPIE Vol. 9983 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510603578

ISBN: 9781510603585 (electronic)

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 © 2016, 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/16/\$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 six-digit CID article numbering system structured as follows:

- 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.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>
ix	<i>Introduction</i>

LIC+PLD+SLPC JOINT SESSION 1

9983 04	Modeling of laser-induced damage and optic usage at the National Ignition Facility (Invited Paper) [9983-3]
---------	--

PLENARY AND COATINGS

9983 08	Thin-film polarizer for high power laser system in China (Plenary Paper) [9983-7]
9983 0B	Ion-assisted coating for large-scale Bimorph deformable mirror [9983-10]

SHORT PULSE PHENOMENA

9983 0M	Spatial-temporal distortions and calibration of ultrashort pulses in complex optical systems [9983-21]
---------	---

MATERIAL DAMAGE

9983 0S	Laser damage measurement of thick silica plates using a new laser injection scheme (Invited Paper) [9983-37]
9983 0T	Nanosecond laser damage of optical multimode fibers (Invited Paper) [9983-38]
9983 0U	Adaptive laser beam forming for laser shock micro-forming for 3D MEMS devices fabrication (Invited Paper) [9983-39]

DEFECT, CONTAMINATION I

9983 0W	Refractive index change mechanisms in different glasses induced by femtosecond laser irradiation (Invited Paper) [9983-41]
9983 0Z	Enhanced internal reflection microscopy for subsurface damage inspection [9983-44]

- 9983 13 **Optimization design and laser damage threshold analysis of pulse compression multilayer dielectric gratings [9983-48]**

DEFECT, CONTAMINATION II

- 9983 14 **Effectiveness of ion cleaning to improve the laser damage threshold of HfO₂/SiO₂ optical coatings for high reflection and antireflection at 527 nm and 1054 nm [9983-49]**
- 9983 15 **LIC and LID considerations in the design and implementation of the MEMS laser pointing mechanism for the EUSO UV laser altimeter [9983-50]**
- 9983 16 **Source of contamination in damage-test sample and vacuum [9983-51]**

POSTER SESSION

- 9983 1A **Effect of laser beam parameters on melt mobilization and LIBS analysis of a special aluminum alloy containing zeolite [9983-29]**
- 9983 1B **Ultrashort pulse laser slicing of semiconductor crystal [9983-30]**
- 9983 1C **Synthesis of fluorescent nanocarbons by femtosecond laser induced plasma in liquid [9983-31]**
- 9983 1D **Mitigation of BSG damage caused by upstream flaw in the final optics assembly [9983-32]**
- 9983 1F **Damage analysis of CMOS electro-optical imaging system by a continuous wave laser [9983-34]**
- 9983 1G **Study on the data matching of ground-based radar and laser point cloud [9983-35]**

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four 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.

Agatsuma, Naoki, 1C	Mikami, Takuya, 0B, 16
Ams, M., 0W	Miura, Kiyotaka, 1B, 1C
Arriola, A., 0W	Miyanaga, Noriaki, 0B, 16
Bai, Liang, 13	Motokoshi, Shinji, 0B, 16
Bellum, John C., 14	Murakami, H., 16
Bonville, O., 0S	Nakimana, Agnes, 1A
Bozzo, Enrico, 15	Neronov, Andrii, 15
Bude, Jeff, 04	Ni, Kaizao, 0Z
Burch, Thomas, 15	Nostrand, Mike, 04
Carr, Wren, 04	Okamoto, Takayuki, 0B
Chang, S. Q., 0M	Penninckx, D., 0S
Chen, A. Q., 0M	Qiu, Zhiwei, 1G
Chen, Kevin P., 0U	Revol, Vincent, 15
Chen, Nana, 13	Sakakura, Masaaki, 1B, 1C
Ciapponi, Alessandra, 15	Samarkin, Vadim V., 0B
Courchinoux, R., 0S	Shao, Jianda, 08, 0Z
Dekker, P., 0W	Shimotsuma, Yasuhiko, 1B, 1C
Diaz, R., 0S	Shin, Wan-Soon, 1F
Fan, Shuwei, 13	Stanley, Ross, 15
Field, Ella S., 14	Sun, Mingying, 1D
Fuerbach, A., 0W	Suratwala, Tayyab I., 04
Fujimatsu, Yusei, 1C	Wang, Chenxi, 1G
Gross, S., 0W	Wang, Mohan, 0U
Heese, Clemens, 15	Wang, Shuliang, 0U
Hoogerwerf, Arno, 15	Withford, M., 0W
Huang, Sheng, 0U	Xu, Longbo, 0Z
Jhang, Kyung-Young, 1F	Yi, Kui, 08
Jiao, Zhaoyang, 1D	Yoon, Sunghee, 1F
Jitsuno, Takahisa, 0B, 16	Yoshida, Kunio, 0B
Kawanaka, Junji, 0B, 16	Yuan, F., 0M
Kawasaki, T., 16	Yue, Jianping, 1G
Khalil, Osama Mostafa, 1A	Zhang, Bo, 0Z
Kim, Eunho, 1B	Zhang, H. Y., 0M
Kletecka, Damon E., 14	Zhao, Dongfeng, 1D
Krüger, Jörg, 0T	Zheng, Z. R., 0M
Kudryashov, Alexis V., 0B	Zhu, Jianqiang, 1D
Lamaignère, L., 0S	Zhu, L. J., 0M
Lan, Nicholas, 15	Zhu, Meiping, 08
Li, Shuo, 0U	Zhu, Rihong, 0Z
Liao, Zhi M., 04	Zou, Ran, 0U
Lin, Yankun, 0U	
Little, D., 0W	
Liu, J., 0M	
Liu, S. Q., 0M	
Liu, Shijie, 0Z	
Liu, Xiaofeng, 0Z	
Luce, J., 0S	
Mann, Guido, 0T	
Mikami, K., 16	

Conference Committee

Conference Chairs

Takahisa Jitsuno, Osaka University (Japan)
Jianda Shao, Shanghai Institute of Optics and Fine Mechanics
(China)
Wolfgang Rudolph, The University of New Mexico (United States)

Organizing Committee

Hidetsugu Yoshida, Osaka University (Japan)
Jyunji Kawanaka, Osaka University (Japan)
Hajime Nishioka, Tokyo Electronic and Communication University
(Japan)
Tomozui Kamimura, Osaka Institute of Technology (Japan)
Norihiko Yamamura, Showa Optronics Company, Ltd. (Japan)
Kiyoshi Suda, Sigma Koki Company Ltd. (Japan)
Minako Azumi, Nikon Corporation (Japan)
Atsushi Yokotani, Miyazaki University (Japan)
Ryo Yasuhara, National Institute for Fusion Science (Japan)
Masayuki Fujita, Institute for Laser Technology (Japan)

International Program Committee

Norbert Kaiser, Fraunhofer-Institut für Angewandte Optik und
Feinmechanik (Germany)
Efim A. Khazanov, Institute of Applied Physics (Russian Federation)
Zunqi Lin, Shanghai Institute of Optics and Fine Mechanics (China)
Yongfeng Lu, University of Nebraska-Lincoln (United States)
Richard Moncorge, ENSICAEN (France)
Jean-Yves Natoli, Institut Fresnel (France)
Valdas Sirutkaitis, Vilnius University (Lithuania)
Christopher J. Stolz, Lawrence Livermore National Laboratory
(United States)
Koji Sugioka, RIKEN (Japan)
Takunori Taira, Institute for Molecular Science (Japan)
Mauro Tonelli, Università di Pisa (Italy)
Eric W. Van Stryland, CREOL, The College of Optics and Photonics,
University of Central Florida (Florida)
Zhouling Wu, Rx Technology Ltd. (China)
Xiaomin Zhang, China Academy of Engineering Physics (China)
Jiping Zou, École Polytechnique (France)
Seong-Ku Lee, GIST-APRI (Korea, Republic of)
Karol Adam Janulewicz, GIST-APRI (Korea, Republic of)

Session Chairs

LIC+PLD+SLPC Joint Session I

Kunihiko Washio, Paradigm Laser Research Ltd. (Japan)

LIC+PLD+SLPC Joint Session II

Kunihiko Washio, Paradigm Laser Research Ltd. (Japan)

Plenary and Coatings

Takahisa Jitsuno, Osaka University (Japan)

Nonlinear Materials

Juan Du, Shanghai Institute of Optics and Fine Mechanics
(China)

Short Pulse Phenomena

Takahisa Jitsuno, Osaka University (Japan)

High Power Resistant Coatings

Shinji Motokoshi, Institute for Laser Technology (Japan)

Material Damage

Tomozui Kamimura, Osaka Institute of Technology (Japan)

Defect, Contamination I

Kunie Yoshida, Okamoto Optical Works (Japan)

Defect, Contamination II

Takahisa Jitsuno, Osaka University (Japan)

Introduction

As a part of Optics and Photonics International Congress (OPIC), we organized the 6th Pacific-Rim Laser Damage conference 2016 (PLD'16), held at Yokohama from 18 to 20 May 2016. This conference was co-sponsored by SPIE, and Shanghai Institute of Optics and Fine Mechanics (SIOM) in China. The PLD conference was started at 2009 by Prof. Jianda Shao at SIOM as a satellite meeting of the SPIE Laser Damage conference in Boulder, Colorado, USA, a conference with 48 years of history. The main purpose of PLD is to offer a chance to many Chinese research staff and students to contribute to an international conference. At the first PLD conference, Dr. K. Sugioka of Riken served as the co-chair from Japan. I joined at the 2nd meeting in 2011 at the request of Prof. J. Shao, and since the 3rd meeting in 2013, I have acted as a co-chair of the conference. The 4th PLD meeting was held in Yokohama, Japan in 2014 as part of the OPIC conference due to a strong request by Prof. J. Shao.

The PLD meeting is held biyearly in Shanghai, China, but PLD'14 and PLD'16 were held in Yokohama. These conferences were co-chaired by Prof. J. Shao and Prof. W. Rudolph, The Univ. of New Mexico (United States), just like the other PLD meetings. The International Program Committee of PLD'16 was the almost the exact same as PLD'15, and we selected Japanese members as the Organizing Committee.

Joint session with LIC, SLPC conferences

At this conference, we planned joint sessions with the Laser Ignition conference (LIC'16) and Smart Laser Process conference (SLPC'16) because these conferences have common interests in the interaction of laser light and matter. The PLD, LIC, and SLPC conferences each nominated two invited talks, and we had two joint sessions on 18 May 2016.

From PLD, findings on high power coating research and modeling of laser damage in NIF (National Ignition Facility) were reported. From LIC, semiconductor dicing and applications of microchip lasers were reported. From SLPC, paint removal and the fiber transportation of ultra-short pulses were reported.

I wish to express deep thanks to Mr. K. Washio for organizing this joint session.

Oral and Invited talks

We had a total of 10 sessions including the poster session. We selected 10 invited talks according to the recommendations of the Program Committee members. One of them was the Plenary talk from SIOM reporting on the recent progress in high power optics, contamination problem and high power gratings. This talk was scheduled to be given by Prof. J. Shao, but unfortunately he could not come.

In the other 7 invited talks, selected speakers from 6 countries reported on the progress of their research. Most notably was the talk on harmonic generation from thin film coatings by The Univ. of New Mexico (United States). The promising point of this presentation was in the 10% harmonic conversion, which was possible in calculation without damage of the coating. This talk was planned as Prof. W. Rudolph's talk, but he was not able to come and it was presented by another person.

Poster session

In the poster session, 7 reports were presented concerning resist removal, the fundamental process of metal processing, the semiconductor process, fine-particle generation, the anti-reflection nano-structure, CMOS camera damage, and the stress control of coatings.

Contributions

At the beginning of the abstract registration, we had 54 people submit abstracts through the SPIE submission site, however after the announcement of the program, 9 withdrawals were made and 10 presenters were absent, so the final presentation count was 35. The ratio of over-sea papers was 74%, and over-sea attendees were 63% because of the small domestic population of research activity in Japan.

The contributions were from China 11, United States 6, Japan 9, France 3, Germany, Austria, Switzerland, Lithuania, Egypt, and Korea 1 each, respectively.

Conclusions

PLD'16 was held as a part of the OPIC conferences in Yokohama, Japan. This system is very effective to support small international conferences, which is difficult to achieve alone. The author wishes to express deep thanks to the organizing members of OPIC and SPIE as the chair of PLD'16.

Takahisa Jitsuno