

2013 Laser Damage

XLV Annual Symposium on

Optical Materials for High Power Lasers

Technical Program

www.spie.org/LD

Conference

22–25 September 2013

Location

National Institute of Standards
and Technology (NIST)
Boulder, Colorado, USA

The leading forum
on materials for high
power/high energy
lasers

Thank you to the following organizations for their generous sponsorship

Conference Co-Sponsors



LDS Competition Testing Site



Refreshment Breaks



Open House and Reception Host



Wine and Cheese Tasting Reception Food and Drink Sponsor



Conference Site

Monday – Wednesday
NIST Building 1 (Radio Bldg.)
325 Broadway
Boulder, Colorado, USA
www.boulder.nist.gov

Sunday Events Hotel

Boulder Marriott
2660 Canyon Blvd.
Boulder, Colorado, USA
Tel: 303 440 8877

Hotel and Lodging Accommodations

Hotel and Travel Information:
www.spie.org/LDht
Visit boulderlodging.com

Questions?

SPIE, PO Box 10,
Bellingham, WA 98227-0010 USA
www.spie.org/ld • help@spie.org
Tel: +1 360 676 3290 • Fax: +1 360 647 1445

Conference 8885

Sunday - Wednesday 22-25 September 2013
Proceedings of SPIE Vol. 8885



XLIV Annual Symposium on

Optical Materials for High Power Lasers

Conference Chairs:

Gregory J. Exarhos, Pacific Northwest National Lab. (USA)

Vitaly E. Gruzdev, Univ. of Missouri-Columbia (USA)

Joseph A. Menapace, Lawrence Livermore National Lab. (USA)

Detlev Ristau, Laser Zentrum Hannover e.V. (Germany)

MJ Soileau, Univ. of Central Florida Office of Research &
Commercialization (USA)

International Program Committee:

Detlev Ristau, Laser Zentrum Hannover e.V. (Committee Chair)
(Germany)

James E. Andrew, AWE plc (United Kingdom)

Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA)

Mireille Commandré, Institut Fresnel (France)

Stavros G. Demos, Lawrence Livermore National Lab. (USA)

Leonid Glebov, CREOL, The College of Optics and Photonics, Univ.
of Central Florida (USA)

Takahisa Jitsuno, Osaka Univ. (Japan)

Klaus Mann, Laser-Lab. Göttingen e.V. (Germany)

Carmen S. Menoni, Colorado State Univ. (USA)

Masataka Murahara, Tokai Univ. (Japan)

Jérôme Néauport, Commissariat à l'Énergie Atomique (France)

Semyon Papernov, Univ. of Rochester (USA)

Amy L. Rigatti, Univ. of Rochester (USA)

Wolfgang Rudolph, The Univ. of New Mexico (USA)

Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China)

Michelle D. Shinn, Thomas Jefferson National Accelerator Facility (USA)

Christopher J. Stolz, Lawrence Livermore National Lab. (USA)

Mini-Symposium Chair:

Leonid Glebov, CREOL, Univ. of Central Florida (USA)

Founding Organizers:

Arthur H. Guenther and **Alexander J. Glass**

Organizer:

Co-Sponsor  **SPIE**

Lawrence Livermore National Lab.

Spica Technologies, Inc.

Cooperating Organizations:

National Institute of Standards and Technology

**CREOL & FPCE, College of Optics and Photonics,
Univ. of Central Florida**

Laser Zentrum Hannover e.V.

Univ. of Missouri, Columbia

Pacific Northwest National Lab.

Lab. for Laser Energetics, Univ. of Rochester

Office of Naval Research

NIST Technical Sponsor:

James Burrus, National Institute of Standards and Technology (USA)

Sunday 22 September

Sunday Events

Boulder Marriott, 2660 Canyon Blvd., Boulder

REGISTRATION MATERIAL PICK-UP

Room: Montrachet Room (1st floor)

Sun. 5:30 pm to 8:30 pm

ROUND TABLE DISCUSSION

Boulder Marriott, Montrachet Room (1st floor)

Sun. 6:00 pm to 7:00 pm

Effects of Laser Field Enhancement in Laser-induced Damage

Moderators: **MJ Soileau**, CREOL, College of Optics and Photonics, Univ. of Central Florida (USA);

Vitaly Gruzdev, Dept. of Mechanical and Aerospace Engineering, Univ. of Missouri (USA)

The Round-Table discussion is a pre-symposium event that takes place during the registration on Sunday evening. The main purpose of the round table is to warm up symposium participants intellectually and to prepare them for active discussions during the Symposium. This year, the Round Table discussion is on the propagation of laser radiation through materials results in several fundamental effects of field enhancement. Those effects are capable of producing local high electrical fields that enforce laser-material interactions and initiate them at the locations of enhanced field (e. g, Fresnel reflection at rear surface of optical windows, interference in multilayer coatings, local field enhancement at surface scratches). This Round Table Discussion is focused on the enhancement effects with the major objective to study relations between the field enhancements and amount of laser fluence calculated from measured pulse energy divided by laser-spot area. Of special attention is the correct evaluation of laser fluence and local electric field at front and rear surfaces of thin transparent slabs in view of the well-established low damage threshold of the rear surfaces compared to the front surface.

WELCOME AND SOCIAL MIXER

Room: Montrachet Room (1st floor)

Sun. 7:00 to 8:30 pm

Registration Material Pick-up continues until 8:30 pm.

SPIE would like to express its deepest appreciation to the co-chairs, international program committee, session chairs, and authors who have so generously given of their time and advice to make this symposium possible. The symposium, like our other conferences and activities, would not be possible without the dedicated contributions of our participants and members.

This program is based on commitments received up to the time of publication and is subject to change without notice. The SPIE Event Manager for this symposium is Diane Cline.

Monday 23 September

CONFERENCE LOCATION: NIST

Building 1 (Radio Bldg.)
324 Broadway, Boulder, CO

REGISTRATION MATERIAL PICK-UP

NIST Lobby Area Mon. 7:30 am to 4:00 pm

Attendees must check in with NIST Security at entrance
and have photo ID available.

Please allow for 15 minutes extra time on Monday.

POSTER PLACEMENT AT NIST

Rooms: 1 & 2 Mon. 7:50 to 8:30 am

OPENING REMARKS AND 2012 AWARDS PRESENTATION

Room: NIST Auditorium Mon. 8:30 to 9:00 am

2012 AWARD WINNERS

Best Oral Presentation:

**What role do defects play in the last damage
behavior of metal oxides?** (Invited Paper)

Paper [8530-15]

**Carmen S. Menoni, Peter Langston, Erik M. Krous,
Dinesh Patel, Colorado State Univ. (USA); Luke A.
Emmert, The Univ. of New Mexico (USA); Ashot S.
Markosyan, Stanford Univ. (USA); Brendan A. Reagan,
Keith Wensing, Colorado State Univ. (USA); Roger
Route, Martin M. Fejer, Stanford Univ. (USA); Jorge J.
Rocca, Colorado State Univ. (USA); Wolfgang Rudolph,
The Univ. of New Mexico (USA)**

Best Poster Presentation:

**Bayesian approach of laser-induced damage
threshold analysis and determination of error
bars**

Paper [8530-73]

**Gintare Bataviciute, Povilas Grigas, Linas Smalakys,
Andrius Melninkaitis, Vilnius Univ. (Lithuania)**

SESSION 1

Room: NIST Auditorium Mon 9:00 am to 10:00 am

Thin Films I

Session Chairs: **Joseph A. Menapace**, Lawrence Livermore National Lab. (USA); **MJ Soileau**, Univ. of Central Florida Office of Research & Commercialization (USA)

9:00 am: **Defect insensitive 100 J/cm² multilayer mirror coating process** (*Plenary*), Christopher J. Stolz, Justin E. Wolfe, Paul B. Mirkarimi, James A. Folta, John J. Adams, Marlon G. Menor, Nick E. Teslich, Regina Soufli, Lawrence Livermore National Lab. (USA); Carmen S. Menoni, Dinesh Patel, Colorado State Univ. (USA) [8885-1]

9:40 am: **Investigation of multiple pulse laser-induced damage on high-reflection coatings**, Zhichao Liu, Chengdu Fine Optical Engineering Research Ctr. (China) [8885-2]

MONDAY POSTER OVERVIEW

Room: NIST Auditorium 10:00 am to 10:40 am

Poster authors are asked to give a 2-minute/2-viewgraph overview of their posters in the order they appear in the program.

Poster Viewing-Monday Morning 10:40 am to 11:30 am

Posters will be displayed for viewing during refreshment breaks on Monday from 10:40 to 11:30 am and again from 3:10 to 4:00 pm.

Materials and Measurements

Suppression of transverse stimulated Raman scattering with laser-induced damage pinpoints in large-aperture KDP crystals, Fuquan Li, Wei Han, Fang Wang, Bing Feng, China Academy of Engineering Physics (China) [8885-18]

Commissioning and first results of the ELI-beamlines LIDT test station, Daniel Kramer, Rui Barros, Michaela Kozlova, Bedrich Rus, Tomas Medrik, Institute of Physics of the ASCR, v.v.i. (Czech Republic) [8885-50]

New tools for the description of the dynamics of high-power phased lasers and complex interacting systems, Erik J. Bochove, Air Force Research Lab. (USA); Alejandro B. Aceves, Southern Methodist Univ. (USA) [8885-53]

Correlating defects and damage initiation in CVD silica films produced under different chemical environment using vibrational spectroscopy, Nan Shen, Manyalibo J. Matthews, Selim Elhadj, Rajesh N. Raman, Arun K. Sridharan, Lawrence Livermore National Lab. (USA) [8885-55]

Algorithm for cumulative damage probability calculations in S-on-1 laser damage testing, Stefan Schrameyer, Laser Zentrum Hannover e.V. (Germany) and Cutting Edge Coatings GmbH (Germany); Marco Jupé, Lars O. Jensen, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) [8885-56]

Measuring residual bulk absorption in highly-transparent optical materials: a comparison between photoacoustic spectroscopy and photothermal common-path interferometry, Stephan Fieberg, Niklas Waasem, Frank Kühnemann, Fraunhofer-Institut für Physikalische Messtechnik (Germany); Karsten Buse, Fraunhofer-Institut für Physikalische Messtechnik (Germany) and Freiburg Univ. (Germany) [8885-60]

Laser calorimetric absorptance testing of samples with varying geometry, Istvan Balasa, Lars O. Jensen, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany)[8885-61]

Effect of longitudinal laser mode beating in damage probability measurements, Gintare Bataviciute, Egidijus Pupka, Linas Smalakys, Viktorija Pyragaite, Andrius Melninkaitis, Vilnius Univ. (Lithuania)[8885-62]

Laser-induced damage threshold (LIDT) measurements of photopolymers used in 3D ultrafast laser micro/nano-lithography, Albertas Žukauskas, Gintare Bataviciute, Mindaugas Šciuka, Egidijus Pupka, Linas Smalakys, Roaldas Gadonas, Andrius Melninkaitis, Mangirdas Malinauskas, Valdas Sirutkaitis, Vilnius Univ. (Lithuania)[8885-63]

Accelerated life time testing of fused silica for DUV laser applications revised, Christian Mühlig, Simon Bublitz, Institut für Photonische Technologien e.V. (Germany)[8885-64]

An empirical investigation of the laser survivability curve: IV, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA); Wolfgang Riede, Alessandra Ciapponi, Paul Allenspacher, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Jonathan H. Herringer, Arrow Thin Films, Inc. (USA); Denny Wernham, European Space Research and Technology Ctr. (Netherlands)[8885-65]

Laser damage of thick components, Laurent Lamaignère, Romain Diaz, Thierry Donval, Roger Courchinoux, Commissariat à l'Énergie Atomique (France)[8885-66]

Photothermal absorption measurements for improved thermal stability of high-power laser optics, Martin Stubenvoll, Bernd Schäfer, Klaus Mann, Laser-Lab. Göttingen e.V. (Germany); Annette Walter, Ludmilla Zittel, Sill Optics GmbH & Co. KG (Germany)[8885-67]

Fundamental Mechanisms

Suppression of ultrafast laser-induced ionization in transparent solids, Vitaly E. Gruzdev, Univ. of Missouri-Columbia (USA)[8885-51]

A theoretical analysis for temperature dependences of laser-induced damage threshold, Katsuhiro Mikami, Osaka Univ. (Japan) and JSPS (Japan); Shinji Motokoshi, Toshihiro Somekawa, Institute for Laser Technology (Japan); Takahisa Jitsuno, Osaka Univ. (Japan); Masayuki Fujita, Institute for Laser Technology (Japan); Kazuo A. Tanaka, Osaka Univ. (Japan)[8885-52]

Modeling femtosecond pulse laser damage on conductors and dielectrics using particle-in-cell (PIC) simulations, Robert Mitchell III, Douglass W. Schumacher, Enam Chowdhury, The Ohio State Univ. (USA)[8885-54]

Dependence of fs laser resistance of optical materials on wavelength, Laurent Gallais-During, Dam-Be L. Douti, Institut Fresnel (France); Gintare Bataviciute, Egidijus Pupka, Mindaugas Šciuka, Linas Smalakys, Andrius Melninkaitis, Vilnius Univ. (Lithuania); Fabien Lemarchand, Institut Fresnel (France); Valdas Sirutkaitis, Vilnius Univ. (Lithuania); Mireille Commandre, Institut Fresnel (France)[8885-57]

CW and pulsed laser-induced absorption changes in Titania films, Xuerong Zhang, Luke A. Emmert, Wolfgang Rudolph, The Univ. of New Mexico (USA)[8885-59]

SESSION 2

Room: NIST Auditorium Mon. 11:30 am to 12:50 pm

Thin Films II

Session Chairs: **James E. Andrew**, AWE plc (United Kingdom); **Mireille Commandré**, Institut Fresnel (France)

11:30 am: **Near-ultraviolet absorption annealing effects in HfO₂ thin films subjected to continuous-wave laser irradiation at 355 nm**, Semyon Papernov, Alexei A. Kozlov, James B. Oliver, Terrance J. Kessler, Univ. of Rochester (USA); Brendan T. Marozas, Cornell Univ. (USA) [8885-3]

11:50 am: **Nanosecond laser-induced damage study of Ta₂O₅/SiO₂ dielectric multilayers**, Xinbin Cheng, Ganghua Bao, Hongfei Jiao, Zhanshan Wang, Tongji Univ. (China). [8885-4]

12:10 pm: **Investigation of non-quarter wave design on multilayer optical thin film coatings from a heat transfer point of view**, Mustafa Ocak, ASELSAN Inc. (Turkey); Cüneyt Sert, Tuba O. Özyurt, Middle East Technical Univ. (Turkey) [8885-5]

12:30 pm: **High-power laser mirror coating for laser beam welding in hot high-pressure water**, Masataka Murahara, Tokai Univ. (Japan) and Toyko Institute of Technology (Japan); Yuji Sato, Takahisa Jitsuno, Osaka Univ. (Japan); Yoshiaki Okamoto, Okamoto Optics Works (Japan) [8885-6]

Lunch Break Mon 12:50 pm to 2:30 pm

SESSION 3

Room: NIST Auditorium Mon. 2:30 pm to 3:10 pm

Thin Films III

Session Chairs: **Carmen S. Menoni**, Colorado State Univ. (USA);

Detlev Ristau, Laser Zentrum Hannover e.V. (Germany)

2:30 pm: **Study on the laser-induced damage performance of HfO₂, Al₂O₃, Y₂O₃, Sc₂O₃ and SiO₂ monolayer coatings**, Meiping Zhu, Kui Yi, Dawei Li, Hongji Qi, Yuanan Zhao, Xiaofeng Liu, Guohang Hu, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China). [8885-8]

2:50 pm: **Brewster angle polarizing beamsplitter laser-damage competition: "S" polarization**, Christopher J. Stolz, Lawrence Livermore National Lab. (USA); Jeff Runkel, Quantel USA (USA) [8885-9]

POSTER VIEWING-MONDAY AFTERNOON

Room: Auditorium Mon. 3:10 pm to 4:00 pm

Posters will be displayed for viewing during refreshment breaks on Monday from 10:40 to 11:30 am and again from 3:10 to 4:00 pm.

SESSION 4

Room: NIST Auditorium Mon 4:00 pm to 5:40 pm

Materials and Measurements I

Session Chairs: **Stavros G. Demos**, Lawrence Livermore National Lab. (USA); **Takahisa Jitsuno**, Osaka Univ. (Japan)

4:00 pm: **National Ignition Facility laser performance: status and thoughts on future capabilities** (*Plenary*), Paul J. Wegner, Lawrence Livermore National Lab. (USA) [8885-10]

4:40 pm: **The pressure dependence of laser-induced damage in high-power laser facility**, Ping Li, Runchang Zhao, Wei Wang, Jingqin Su, China Academy of Engineering Physics (China) [8885-11]

5:00 pm: **From ground to space: How to increase the confidence level in your flight optics**, Wolfgang Riede, Paul Allenspacher, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Denny Wernham, Alessandra Ciapponi, Clemens Heese, European Space Research and Technology Ctr. (Netherlands); Lars O. Jensen, Heinrich Maedebach, Stefan Schrameyer, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) [8885-12]

5:20 pm: **Qualification testing of optical components with 1 trillion shot lifetime requirement for ICESAT-II space flight project**, Oleg A. Konoplev, Aleksey A. Vasilyev, Furqan L. Chriaqh, Sigma Space Corp. (USA); Demetrios Poullos, American Univ. (USA); Mark A. Stephen, NASA Goddard Space Flight Ctr. (USA); Kathy Strickler, ASRC Federal Space and Defense (USA); Michael A. Krainak, NASA Goddard Space Flight Ctr. (USA) [8885-13]

MONDAY CLOSING REMARKS

Room: NIST Auditorium 5:40 pm to 5:55 pm

Open House and Reception

Mon. 6:30 to 8:00 pm
Location to be announced

Sponsored by



www.atf-ppc.com

Invitation and Driving Instructions
included in Registration Packet.



www.atf-ppc.com

Tuesday 24 September

REGISTRATION MATERIAL PICK-UP

Room: NIST Lobby Area Tues. 7:30 am to 4:00 pm

Attendees must wear the NIST Security Badge when returning to NIST property.

POSTER PLACEMENT AT NIST

Room: 1 & 2. Tue. 7:50 am to 8:30 am

SESSION 5

Room: NIST Auditorium Tue. 8:30 am to 9:50 am

Materials and Measurements II

Session Chairs: **Gregory J. Exarhos**,
Pacific Northwest National Lab. (USA);

Vitaly E. Gruzdev, Univ. of Missouri-Columbia (USA)

8:30 am: **Round Robin experiment on LIDT measurements at 1064nm in vacuum for space qualification of optics**, Stefan Schrameyer, Heinrich Maedebach, Lars O. Jensen, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany); Clemens Heese, Jorge Piris, Alessandra Ciapponi, Bruno Sarti, European Space Research and Technology Ctr. (Netherlands); Andrius Melninkaitis, Gintare Bataviciute, Linas Smalakys, Valdas Sirutkaitis, Vilnius Univ. (Lithuania); Paul Allenspacher, Wolfgang Riede, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany) [8885-14]

8:50 am: **1-on-1 pulse nanosecond laser-damage studies of thin films using time-resolved transmission**, Yejia Xu, Luke A. Emmert, The Univ. of New Mexico (USA); Dinesh Patel, Carmen S. Menoni, Colorado State Univ. (USA); Wolfgang Rudolph, The Univ. of New Mexico (USA). [8885-15]

9:10 am: **Method for studying laser-induced damage from sparse defects**, Sam Richman, Alexander R. Martin, Quentin Turchette, Trey Turner, Research Electro-Optics, Inc. (USA). [8885-16]

9:30 am: **Influence of growth behavior on laser-induced bulk damage in deuterated potassium di-hydrogen phosphate (DKDP) crystals**, Zhi M. Liao, Lawrence Livermore National Lab. (USA); Roshea Roussell, Southern Univ. and A&M College (USA); John J. Adams, Michael J. Runkel, Lawrence Livermore National Lab. (USA); W. T. Frenk, Jeffrey Luken, Gooch & Housego, Cleveland (USA); Christopher W. Carr, Lawrence Livermore National Lab. (USA) [8885-17]

TUESDAY POSTER OVERVIEW

Room: NIST Auditorium Tues. 9:50 am to 10:30 am

Poster authors are asked to give a 2-minute/2-viewgraph overview of their posters in the order they appear in the program

Poster Session and Refreshment Break 10:30 to 11:20

POSTERS-TUESDAY MORNING

Room: 1 & 2 Tues. 10:30 to 11:20 am

Posters will be displayed for viewing during refreshment breaks on Tuesday from 10:30 to 11:20 am and again from 3:00 to 3:50 pm.

POSTER SESSION

Room: 1 & 2 Tues. 10:30 am to 11:20 am

Thin Films

Laser damage comparisons of broad-bandwidth high-reflection coatings having high index layers produced by e-beam evaporation of Ti_3O_5 , Ta_2O_5 , and Nb_2O_5 , Ella S. Field, John C. Bellum, Damon Kletecka, Sandia National Labs. (USA) . . . [8885-68]

Photothermal microscopy of thin films based on etalon effects, Zhangliang Sun, Luke A. Emmert, Xuerong Zhang, The Univ. of New Mexico (USA); Dinesh Patel, Carmen S. Menoni, Colorado State Univ. (USA); Wolfgang Rudolph, The Univ. of New Mexico (USA) . . . [8885-72]

Development of high-resistant anti- and high-reflection coatings using Al_2O_3/SiO_2 layers, Yoshihiro Ochi, Keisuke Nagashima, Hajime Okada, Momoko Tanaka, Japan Atomic Energy Agency (Japan); Ryo Tateno, Yasuyuki Furukawa, Shimadzu Corp. (Japan); Akira Sugiyama, Japan Atomic Energy Agency (Japan) . . . [8885-76]

A comparison of laser-induced-damage-thresholds of two types of dielectric polarizing beam splitters, Václav Škoda, Crytur Ltd. (Czech Republic) . . . [8885-78]

Characterization and application of hafnia-silica mixtures produced by ion-beam sputtering technology, Simonas Kicas, Kestutis Juskevicius, Tomas Tolenis, Rytis Buzelis, Ramutis Drazdys, Institute of Physics (Lithuania); Gintare Bataviciute, Egidijus Pupka, Linas Smalakys, Andrius Melninkaitis, Vilnius Univ. (Lithuania) . . . [8885-80]

Laser damage behavior of Ta_2O_5/SiO_2 interference coatings in the infrared, Dinesh Patel, Drew D. Schiltz, Peter Langton, Colorado State Univ. (USA); Luke A. Emmert, The Univ. of New Mexico (USA); Leandro Acquaroli, Cory Baumgarten, Brendan A. Reagan, Jorge J. Rocca, Colorado State Univ. (USA); Wolfgang Rudolph, The Univ. of New Mexico (USA); Ashot S. Markosyan, Roger Route, Martin M. Fejer, Stanford Univ. (USA); Carmen S. Menoni, Colorado State Univ. (USA) . . . [8885-82]

Performance of multilayer optical coatings under long-term 532nm laser exposure, Demetrios Poullos, American Univ. (USA); Oleg A. Konoplev, Furqan L. Chiragh, Sigma Space Corp. (USA); Aleksey A. Vasilyev, Science Systems and Applications, Inc. (USA); Mark A. Stephen, NASA Goddard Space Flight Ctr. (USA); Kathy Strickler, ASRC Management Services, Inc. (USA) . . . [8885-84]

Laser-induced damage resistance of 266nm AR coatings, Byungil Cho, Li-Ji Lyu, Newport Corp. (USA); Mark S. Feldman, Spectra-Physics®, a Newport Corp. Brand (USA) . . . [8885-85]

Database on damage thresholds for dichroic mirrors of 1064nm and 532nm, Shinji Motokoshi, Institute for Laser Technology (Japan); Katsuhiro Mikami, Takahisa Jitsuno, Osaka Univ. (Japan) . . [8885-86]

Surfaces, Mirrors, and Contamination

Localized planarization of optical damage using laser-based chemical vapor deposition, Manyalibo J. Matthews, Selim Elhadj, Gabe M. Guss, Arun K. Sridharan, Isaac L. Bass, Norman D. Nielsen, Lawrence Livermore National Lab. (USA) . . . [8885-69]

Improving UV laser lifetimes by minimizing trace contamination, Timothy Shuman, Floyd E. Hovis, Fibertek, Inc. (USA); Chris A. Hostetler, NASA Langley Research Ctr. (USA) . . . [8885-71]

Laser removal of ion-implanted novolak resist without occurring surface laser-induced damage to the silicon wafer,

|Hiroki Muraoka, Osaka Institute of Technology (Japan); Yousuke Goto, Kanazawa Institute of Technology (Japan); Yuta Kuroki, Kiwamu Kuroda, Takuya Kiriya, Hiroyuki Kuramae, Tomosumi Kamimura, Osaka Institute of Technology (Japan); Hideo Horibe, Kanazawa Institute of Technology (Japan) [8885-73]

Investigation of subsurface damage impact to resistance of laser radiation of fused silica substrates,

Kestutis Juskevicius, Simonas Kicas, Tomas Tolenis, Rytis Buzelis, Ramutis Drazdys, Institute of Physics (Lithuania); Gintare Bataviciute, Egidijus Pupka, Linas Smalakys, Andrius Melninkaitis, Vilnius Univ. (Lithuania) [8885-75]

Pilot scale demonstration of scratch repair by using a CO₂ laser on fused silica optic,

Philippe Cormont, Sandy Cavarro, Gael Gaborit, Commissariat à l'Énergie Atomique (France); Laurent Gallais-During, Institut Fresnel (France); Laurent Lamaignère, Jean-Luc Rullier, Patrick Combis, Commissariat à l'Énergie Atomique (France) [8885-77]

Effects of subsurface removal on surface damage resistance of optical coatings in deep-UV wavelength,

Yoshiaki Matsura, Yuta Kuroki, Kiwamu Kuroda, Takuya Kiriya, Tomosumi Kamimura, Osaka Institute of Technology (Japan); Katsuhiko Mikami, Shinji Motokoshi, Takahisa Jitsuno, Osaka Univ. (Japan) [8885-79]

Rapid evaporation of fused silica under single infrared laser pulse exposure,

Rajesh N. Raman, Norman D. Nielsen, Gabriel M. Guss, Manyalibo J. Matthews, Lawrence Livermore National Lab. (USA) [8885-81]

Magneto-rheological fluid finishing: A tool to study and remove pre-existing defects in fused silica optics,

Jérôme Néauport, Commissariat à l'Énergie Atomique (France) [8885-83]

SESSION 6

Room: NIST Auditorium Tue 11:20 am to 12:40 pm

Materials and Measurements III

Session Chairs: **Semyon Papernov,**

Univ. of Rochester (USA); **Jianda Shao,** Shanghai Institute of Optics and Fine Mechanics (China)

11:20 am: **Contamination resistant antireflection nano-textures in fused silica for laser optics,**

Douglas S. Hobbs, Bruce D. MacLeod, Ernest Sabatino III, TelAztec LLC (USA); Jerald A. Britten, Christopher J. Stolz, Lawrence Livermore National Lab. (USA) [8885-87]

11:40 am: **High-power laser testing of 3D meta-optics,**

Aaron J. Pung, Indumathi Raghu, Yuan Li, Eric G. Johnson, Clemson Univ. (USA); Michelle D. Shinn, Thomas Jefferson National Accelerator Facility (USA); Robert Magnusson, The Univ. of Texas at Arlington (USA); Joseph J. Talghader, Luke Taylor, Univ. of Minnesota, Twin Cities (USA); Lawrence Shah, Martin C. Richardson, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA) [8885-19]

12:00 pm: **Damage threshold studies for ceramic Yb:YAG at cryogenic and room temperatures,**

Paul J. Phillips, Klaus Ertel, Paul Mason, Saumyabrata Banerjee, Justin Greenhalgh, Rutherford Appleton Lab. (United Kingdom); Joachim Hein, Jorg Koerner, Friedrich-Schiller-Univ. Jena (Germany); John L. Collier, Rutherford Appleton Lab. (United Kingdom) [8885-20]

12:20 pm: **Compositional dependent response of silica-based glasses after femtosecond laser pulse irradiation**, Thomas Seuthe, Fraunhofer-Institut für Keramische Technologien und Systeme (Germany); Moritz Grehn, Technische Univ. Berlin (Germany); Alexandre Mermillod-Blondin, Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie (Germany); Jörn Bonse, Bundesanstalt für Materialforschung und -prüfung (Germany); Markus Eberstein, Fraunhofer-Institut für Keramische Technologien und Systeme (Germany)[8885-21]
Lunch Break Tue 12:40 pm to 2:00 pm

SESSION 7

Room: NIST Auditorium Tue 2:00 pm to 3:00 pm

Materials and Measurements IV

Session Chairs: **Amy L. Rigatti**, Univ. of Rochester (USA); **Christopher J. Stolz**, Lawrence Livermore National Lab. (USA)

2:00 pm: **Comparative measurements of laser damage thresholds at the nanosecond and femtosecond pulse duration domain**, Tamas Somoskoi, Csaba Vass, Univ. of Szeged (Hungary); Mark Mero, Univ. of Szeged (Hungary) and Max-Born-Institut (Germany); Robert Mingesz, Zoltan Bozoki, Univ. of Szeged (Hungary); Karoly Osvay, Univ. of Szeged (Hungary) and ELI-Hu Nkft (Hungary)[8885-22]

2:20 pm: **Laser damage threshold measurements via maximum likelihood estimation**, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (USA); Michael D. Thomas, Spica Technologies, Inc. (USA)[8885-58]

2:40 pm: **Examination of multi-shot laser-induced damage on uncoated fused-silica substrates at the surface and in the bulk material using P-polarized 1 ns 1.5 kHz laser pulses at 1064nm**, Furqan L. Chiragh, Oleg A. Konoplev, Alexey A. Vasilyev, Sigma Space Corp. (USA); Demetrios Poullos, American Univ. (USA); Mark A. Stephen, Michael A. Krainak, NASA Goddard Space Flight Ctr. (USA)[8885-24]

POSTER VIEWING-TUESDAY AFTERNOON

Room: 1 & 2 Tue. 3:00 pm to 3:50 pm

Posters will be displayed for viewing during refreshment breaks on Tuesday from 10:30 to 11:30 am and again from 3:00 to 3:50 pm.

SPIE Conference Apps

Create your schedule with the SPIE Conference App for iPhone and Android. Search and browse the Technical Program, special events, and participants. The mobile app is available at www.spie.org/mobile and at the Android Market and AppStore.



SESSION 8

Room: NIST Auditorium Tue 3:50 pm to 5:50 pm

Surfaces, Mirrors, and Contamination I

Session Chairs: **Stavros G. Demos**,
Lawrence Livermore National Lab. (USA);
Wolfgang Rudolph, The Univ. of New Mexico (USA)

3:50 pm: **A review of laser target debris and shrapnel studies by AWE (Plenary)**, James E. Andrew, AWE plc (United Kingdom) [8885-25]

4:30 pm: **Laser-induced contamination and its impact on laser damage threshold**, Helmut B. Schröder, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Dimitrios Kokkinos, Univ. de Liège (Belgium); Wolfgang Riede, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Adrian P. Tighe, European Space Research and Technology Ctr. (Netherlands) [8885-26]

4:50 pm: **Quantitative study of effect of contaminations on the damage threshold in optical coating**, Hidetoshi Murakami, Osaka Univ. (Japan) and Promotion Ctr. for Laser Technology (Japan); Takahisa Jitsuno, Osaka Univ. (Japan); Kota Kato, Osaka Univ. (Japan) and Promotion Ctr. for Laser Technology (Japan); Katsuhiro Mikami, Osaka Univ. (Japan); Shinji Motokoshi, Institute for Laser Technology (Japan); Tetsuji Kawasaki, Noriaki Miyanaga, Hiroshi Azechi, Osaka Univ. (Japan) [8885-27]

5:10 pm: **Phase modulation in high-power optical systems caused by pulsed laser-driven particle ablation events**, Manyalibo J. Matthews, Nan Shen, Alexander M. Rubenchik, John Honig, Jeffrey D. Bude, Lawrence Livermore National Lab. (USA) . [8885-28]

5:30 pm: **Laser-induced damage and ripples on the surface of fused silica by nanosecond laser pulse**, OuYang Sheng, Chengdu Fine Optical Engineering Research Ctr. (China) [8885-29]

CLOSING REMARKS

Room: NIST Auditorium Tue 5:50 pm to 6:15 pm

Wine and Cheese Tasting Reception

Tues. 6:30 pm to 8:00 pm

Sponsored by SPIE and the Conference Co-chairs of Laser Damage XLV

Reception at NCAR

1850 Table Mesa Dr., Boulder, CO

All attendees are invited to join us for the enjoyable evening of wine tasting, local brews, and a selection of cheese appetizers.

Guest tickets are available for purchase, \$25 (USD).

FOOD AND DRINK SPONSORED BY:



Wednesday 25 September

REGISTRATION MATERIAL PICK-UP

Room: NIST Lobby Area 7:30 am to 4:00 pm

Attendees must check in with NIST Security at entrance and have photo identification available.

SESSION 9

Room: NIST Auditorium Wed 8:20 am to 10:40 am

Surfaces, Mirrors, and Contamination II

Session Chairs: **James E. Andrew**, AWE plc (United Kingdom); **Takahisa Jitsuno**, Osaka Univ. (Japan)

8:20 am: **The influence of scratches on laser-induced damage threshold of 3ω mirrors**, Hongfei Jiao, Xinbin Cheng, Ganghua Bao, Bin Ma, Pengfei He, Zhanshan Wang, Tongji Univ. (China) .[8885-30]

8:40 am: **Investigation of the dynamics of material ejection in various optical materials during exit surface breakdown by ns pulses**, Stavros G. Demos, Raluca A. Negres, Rajesh N. Raman, Michael D. Feit, Alexander M. Rubenchik, Lawrence Livermore National Lab. (USA)[8885-31]

9:00 am: **Mapping of total scattering as a tool for long-term investigations in the cleaning state of the functional coated samples**, Puja Kadkhoda, Laser Zentrum Hannover e.V. (Germany)[8885-32]

9:20 am: **Removing subsurface damage by micro-jet polishing process**, Junlin Wang, Changchun Institute of Optics, Fine Mechanics and Physics (China)[8885-33]

9:40 am: **Mitigation of laser damage on NIF optics in volume production**, James A. Folta, Michael C. Nostrand, John Honig, Jen N. Wong, Frank Ravizza, Paul Geraghty, Michael G. Taranowski, Gary W. Johnson, Glenn R. Larkin, Douglas L. Ravizza, John E. Peterson, Paul J. Wegner, Lawrence Livermore National Lab. (USA)[8885-34]

10:00 am: **Thermal-dynamical analysis of blister formation in chirped mirror irradiated by single femtosecond lasers**, Shunli Chen, Yuanan Zhao, Yanzhi Wang, Meiping Zhu, Zhou Fang, Yuxin Leng, Xiaofeng Liu, Guohang Hu, Kui Yi, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China).[8885-35]

10:20 am: **Study on wavefront precompensation of thermal deformation aberrations in a beam path by FEM and Zernike polynomials**, Qiong Zhou, Werguang Liu, Zongfu Jiang, National Univ. of Defense Technology (China)[8885-36]

Refreshment Break Wed 10:40 am to 11:10 am

SESSION 10

Room: NIST Auditorium Wed 11:10 am to 12:50 pm

Mini Symposium: To High Power Limits of Fiber Lasers

Session Chairs: **Leonid Glebov**, CREOL, The College of Optics and Photonics, Univ. of Central Florida (USA); **Jonathan W. Arenberg**, Northrop Grumman Aerospace Systems (USA)

11:10 am: **Feasibility of maximum achievable powers and energies in fiber lasers** (*Keynote Presentation*), Valentin P. Gapontsev, IPG Photonics Corp. (USA) [8885-37]

11:40 am: **Power limits of narrow-linewidth Raman fiber lasers** (*Plenary*), Mike Klopfer, Ravinder K. Jain, The Univ. of New Mexico (USA); Leanne J. Henry, Air Force Research Lab. (USA) . . . [8885-38]

12:10 pm: **Time-dependent investigation of single-mode fiber output damage by 405nm CW laser light**, Cornell P. Gonschior, Technische Hochschule Mittelhessen (Germany) and City Univ. London (United Kingdom); Karl-Friedrich Klein, Technische Hochschule Mittelhessen (Germany); Tong Sun, Ken T. V. Grattan, City Univ. London (United Kingdom). [8885-39]

12:30 pm: **Theory of phase-locking of multistable fiber amplifier arrays**, Erik J. Bochove, Air Force Research Lab. (USA); Mohammad R. Zunoubi, State Univ. of New York at New Paltz (USA); Christopher J. Corcoran, Corcoran Engineering Inc. (USA) [8885-40]

Lunch Break Wed 12:50 pm to 2:40 pm



NIST Facility Tours

Wed. 1:45 pm to 2:40 pm

**2 tours offered,
Wednesday, during lunch**

NIST has generously offered to provide 2 limited tours of the facility, including one of the NIST-F1 and NIST-F2 Atomic Clocks. Space is limited. Sign up onsite by 2:00 pm on Tuesday to reserve your place. First come, first served for Laser Damage Attendees only. A sign-up sheet will be at the registration desk.

SESSION 11

Room: NIST Auditorium Wed 2:40 pm to 4:20 pm

Fundamental Mechanisms I

Session Chairs: **Jérôme Néauport**,

Commissariat à l'Énergie Atomique (France);

Gregory J. Exarhos, Pacific Northwest National Lab. (USA)

2:40 pm: **Laser damage in dielectric films: What we know and what we don't** (*Plenary*), Wolfgang Rudolph, Luke A. Emmert, The Univ. of New Mexico (USA); Carmen S. Menoni, Dinesh Patel, Colorado State Univ. (USA) [8885-41]

3:20 pm: **General model for nanosecond-laser induced damage in KTP**, Frank R. Wagner, Aix-Marseille Univ. (France); Guillaume Duchateau, Univ. Bordeaux 1 (France); Jean-Yves Natoli, Mireille Commandré, Aix-Marseille Univ. (France) [8885-42]

3:40 pm: **Understanding of the physics and material dynamics of multipulse femtosecond laser interactions with surfaces**, Troy Anderson, Craig Zuhlke, Chris Wilson, Corey Kruse, Sidy Ndao, George Gogos, Dennis R. Alexander, Univ. of Nebraska-Lincoln (USA) [8885-43]

4:00 pm: **Two different growth mechanisms of laser-induced damage in fused silica optics with nanosecond pulses at 355nm**, Chunhong Li, Xin Ju, Univ. of Science and Technology Beijing (China); Yingao Ma, Shanghai Jiaguang Optics Group (China) [8885-44]

Refreshment Break Wed 4:20 pm to 4:50 pm

SESSION 12

Room: NIST Auditorium Wed 4:50 pm to 6:30 pm

Fundamental Mechanisms II

Session Chairs: **Vitaly E. Gruzdev**,

Univ. of Missouri-Columbia (USA); **Joseph A. Menapace**,

Lawrence Livermore National Lab. (USA)

4:50 pm: **Application of time-resolved digital holographic microscopy to study femtosecond damage process in thin films**, Nerijus Siaulys, Andrius Melninkaitis, Vilnius Univ. (Lithuania); Laurent Gallais-During, Institut Fresnel (France) [8885-45]

5:10 pm: **Investigating high-damage mechanisms and precursor properties in fused silica**, Nan Shen, Jeffrey D. Bude, Lawrence Livermore National Lab. (USA) [8885-46]

5:30 pm: **Plasma dynamics during bulk damage of borosilicate glass generated by 1.064 micron nanosecond laser pulses**, Binh T. Do, Ball Aerospace & Technologies Corp. (USA); Mark W. Kimmel, Sandia National Labs. (USA); Arlee V. Smith, AS-Photonics, LLC (USA); Michael V. Pack, Sandia National Labs. (USA); Stavros G. Demos, Lawrence Livermore National Lab. (USA) [8885-47]

5:50 pm: **Interaction of laser pulse with confined plasma during exit surface ns laser damage**, Michael D. Feit, Alexander M. Rubenchik, Stavros G. Demos, Lawrence Livermore National Lab. (USA) [8885-48]

6:10 pm: **Thermal kinetics of annealed optical damage**, Rajesh N. Raman, Christopher W. Carr, Selim Elhadj, Manyalibo J. Matthews, Lawrence Livermore National Lab. (USA) [8885-49]

WEDNESDAY CLOSING REMARKS

Room: NIST Auditorium Wed 6:30 pm to 6:40 pm

Order additional Proceedings volumes or CDs now and receive low prepublication prices



Proceedings of SPIE

Laser-Induced Damage in Optical Materials: 2013

Conference Chairs:

Gruzdev, Exarhos, Menapace, Ristau, Soileau

Proceedings of SPIE Vol. 8885

Prepublication price: \$105

Proceedings on CD

Full-text papers from the Proceedings volume.

Searchable CDs are now available within 8 weeks of the meeting. PC, Macintosh, and Unix compatible.

Laser-Induced Damage in Optical Materials: 45th Anniversary Collection (2009-2013)

(Includes Vols. 7504, 7842, 8190, 8530, and 8885)

Order No. **CDP57** • Est. pub. November 2013

Meeting attendee: \$100

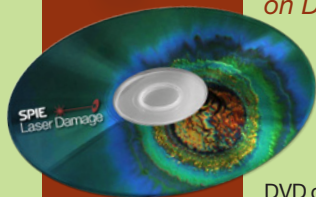
Nonattendee member price: \$100

Nonattendee nonmember price: \$125

To Order: Tel: +1 360 676 3290 · www.spie.org/LD

40
YEARS

40 Years of Proceedings from the Laser Damage Symposium on DVD (1969-2008)



Laser-Induced Damage in Optical Materials

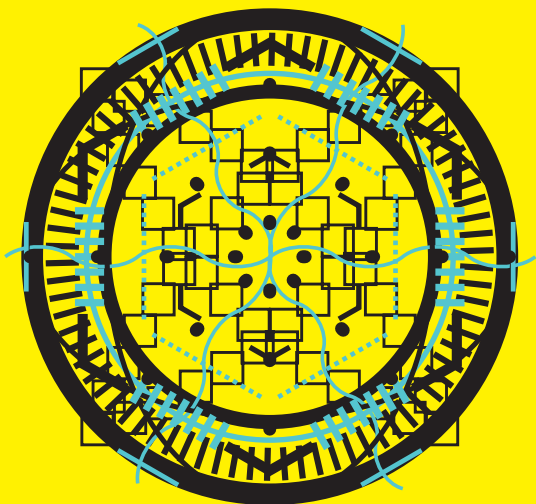
PRICE:
\$100.00 (USD)
payable during pickup or delivery

DVD containing the complete Proceedings for the specified years in fully searchable PDF format, supplemented by a browsable Table of Contents containing links to the full-text articles.

Reserve a copy by pre-ordering or purchase from available stock at the Symposium. Pre-order DVDs by contacting:

Ms. Artika Lal at lal2@lnl.gov or
Dr. Joseph A. Menapace at menapace1@lnl.gov

Or purchase onsite at the Registration Desk.



Helping engineers and
scientists stay current
and competitive



Optics &
Astronomy



Biomedical
Optics



Optoelectronics &
Communications



Defense
& Security



Energy



Lasers



Nano/Micro
Technologies



Sensors

SPIE
Digital
Library

Find the answer
SPIDigitalLibrary.org

Mark your Calendar

2014 Laser Damage

XLVI Annual Symposium on
Optical Materials for High Power Lasers

Conference
21–24 September 2014

Location
National Institute of Standards
and Technology
Boulder, Colorado, USA

www.spie.org/ld2014

The leading forum
on materials for high
power/high energy
lasers