

SPIE Laser Damage

Formerly Boulder Damage

41st Annual Symposium on

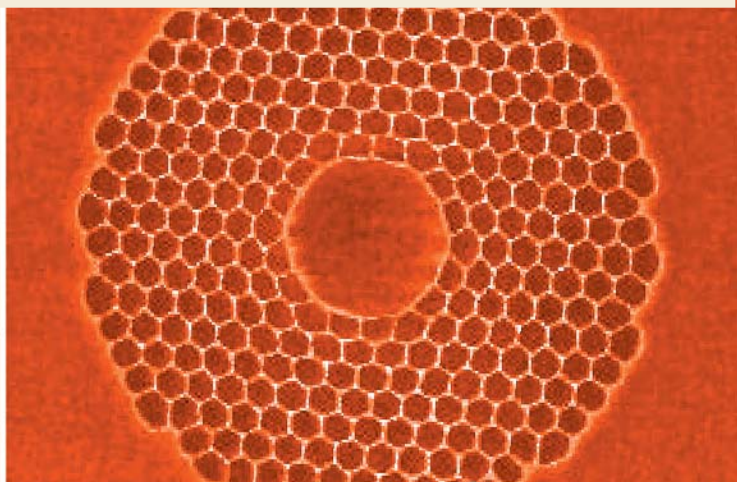
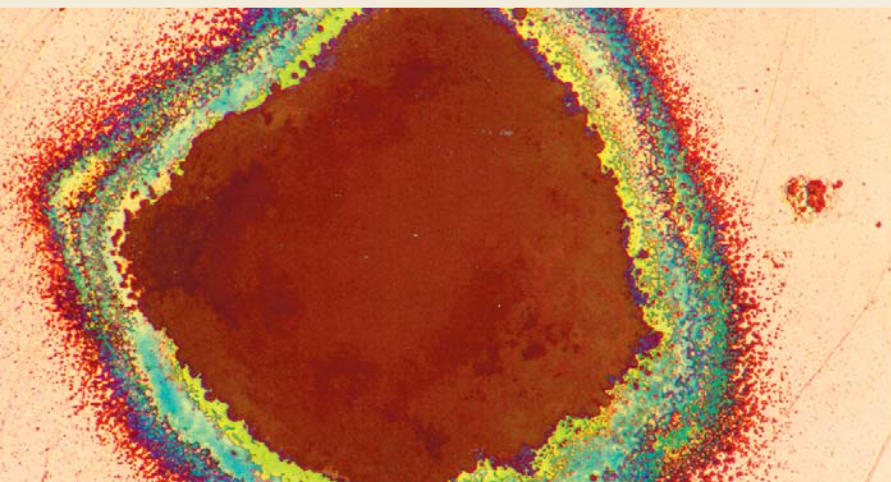
Optical Materials for High Power Lasers

21–23 September 2009

National Institute of Standards and Technology
Boulder, Colorado, USA

Advance
Technical
Program

NETWORK WITH PEERS — HEAR THE LATEST RESEARCH



▶ **Laser-Induced Damage Issues in:**

- ▶ Photonic bandgap materials
- ▶ High power fiber lasers
- ▶ Fibers for high power laser applications
- ▶ High power, ultra fast, lasers
- ▶ Multi-layer thin films
- ▶ Nonlinear optical and laser host materials

▶ **Other Laser-Induced Damage Related Issues**

- ▶ Measurement protocols
- ▶ Materials characterization
- ▶ Fundamental mechanisms
- ▶ Contamination of optical components
- ▶ Surface and bulk defects

▶ **MINI-SYMPOSIUM: Femtosecond Laser-Induced Damage**



SPIE

Connecting minds. Advancing light.

Organizer:



Co-Sponsors:

Lawrence Livermore National Laboratory
Laser Zentrum Hannover e.V. (Germany)
Office of Naval Research
Pacific Northwest National Lab.
Spica Technologies, Inc.

Cooperating Organizations:

National Institute of Standards and Technology
Electromagnetic Remote Sensing Defence
Technology Ctr. (United Kingdom)
School of Optics: CREOL & FPCE, College of
Optics and Photonics, Univ. of Central Florida

Founding Organizers: Arthur H. Guenther and
Alexander J. Glass

Conference Cochairs: Gregory J. Exarhos, Pacific
Northwest National Lab.; Vitaly E. Gruzdev, Univ. of
Missouri, Columbia; Detlev Ristau, Laser Zentrum
Hannover e.V. (Germany); M. J. Soileau, College
of Optics and Photonics, Univ. of Central Florida;
Christopher J. Stolz, Lawrence Livermore National
Lab.

International Program Committee: Detlev Ristau,
Laser Zentrum Hannover e.V. (Germany), Committee
Chair; James E. Andrew, Atomic Weapons
Establishment plc (United Kingdom); Jonathan
W. Arenberg, TRW Inc.; Mireille Commandré,
Institut Fresnel (France); Stavros Demos, Lawrence
Livermore National Lab; Jerry B. Franck, U.S. Army
Night Vision & Electronic Sensors Directorate; Leonid
B. Glebov, College of Optics and Photonics, Univ. of
Central Florida; Klaus Mann, Laser-Lab. Göttingen
e.V. (Germany); Masataka Murahara, Tokai Univ.
(Japan); Semyon Papernov, Amy L. Rigatti, Univ. of
Rochester; Jianda Shao, Shanghai Institute of Optics
and Fine Mechanics (China); Michelle Shinn, Thomas
Jefferson National Accelerator Lab.; Kunio Yoshida,
Osaka Institute of Technology (Japan)

Technical Contact: Kent Rochford, National Institute
of Standards and Technology

IMPORTANT!

You will need your registration badge to get into the
NIST parking lot. Visitors are required to show photo
identification upon arrival and must wear a visitor's badge
at all times while on the NIST campus.

SPIE would like to express its deepest appreciation to the co-chairs, program
committee, and session chairs 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.

Left cover photo courtesy of GJ Exarhos, PNNL Lab.
Right photo: JD Shephard, JDC Jones, DP Hand, JC Knight, SPIE 5991, 59911Y-1 (2005).

Conference 7504

Monday-Wednesday 21-23 September
2009 • Proceedings of SPIE Vol. 7504

SPIE Laser Damage

41st Annual Symposium on
Optical Materials for High Power Lasers

Sunday 20 September

New Special Event!

Sun. 17.30 to 19.00 at the Boulder Marriott

Roundtable Discussion:

**Experimental Identification of Fundamental LID Mechanisms:
Techniques, Challenges, and New Approaches**

Please join us on Sunday evening for an open discussion on the following
topics:

- Critical review of the traditional criteria of LID
- Techniques to identify LID mechanisms: dependence of LID threshold
on laser and material parameters vs. alternative approaches
- LID precursors: identification, detection, and relation to LID
- Relationship between the parametric dependences of LID threshold
and basic LID mechanisms: How reliable and unambiguous is it?
- Alternative and future approaches to identification of the basic LID
mechanisms

Visit our website for more information: <http://spie.org/laser-damage.xml>

Registration Material Pick-up and Mixer

Sun. 19.00 to 21.00

The Boulder Marriott, 2660 Canyon Blvd., Boulder

Monday 21 September

Registration Material Pick-up

Mon. 07.30 to 08.30

The Courtyard by Marriott Boulder, 4710 Pearl E Circle, Boulder

Poster Placement at NIST- Monday

Rooms 1 & 2 Mon. 07.30 to 08.30

Opening Remarks

Room: Auditorium Mon. 08.30 to 09.00

Session Chair: Vitaly E. Gruzdev, Univ. of Missouri, Columbia

SESSION 1

Room: Auditorium Mon. 09.00 to 10.00

Thin Films I

Session Chairs: M. J. Soileau, College of Optics and Photonics, Univ. of
Central Florida; Amy L. Rigatti, Univ. of Rochester

09.00: **Mirror characterization in the LIGO 4km interferometers** (Invited Paper),
Rana Adhikari, California Institute of Technology (United States). [7504-01]

09.40: **Design considerations for high damage threshold UV-Vis-IR mirrors**,
Volodymyr Pervak, Ludwig-Maximilians-Univ. München (Germany); Michael K.
Trubetskoy, Alexander V. Tikhonravov, Lomonosov Moscow State Univ. (Russian
Federation) [7504-02]

Poster Overview

Room: Auditorium Mon. 10.00 to 10.40

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 10.40 to 11.40

Fundamental Mechanisms Posters

Room 1 Mon. 10.40 to 11.40

Posters will be displayed between 10.40 to 11.40 and 15.00 to 16.00 for viewing.

Influence of Na-related defects on DUV nonlinear absorption in CaF₂: nanosecond versus femtosecond laser pulses, Christian Mühlig, Herbert Stafast, Wolfgang Triebel, Thomas Zeuner, IPHT Jena (Germany) [7504-03]

A model for long-term laser damage in calcium fluoride, Stephan Rix, SCHOTT AG (Germany) and Johannes Gutenberg Univ. Mainz (Germany); Martin Letz, Ute Natura, Lutz Parthier, SCHOTT AG (Germany); Claudia Felser, Johannes Gutenberg Univ. Mainz (Germany) [7504-04]

Laser-induced damage and non-linear absorption of ultra-short laser pulses in the bulk of fused silica, Marco Jupé, Lars O. Jensen, Marcus Turowski, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) [7504-05]

The dynamic characteristic of plasma explosion in laser-induced films damage, Zhilin Xia, Wuhan Univ. of Technology (China) [7504-06]

A theoretical investigation of the nonlinear optical property of four -conjugated salen compounds, Saeed Sheykshoaeekhtiarabadi, Chalmers Univ. of Technology (Sweden) [7504-07]

Transient response of laser-irradiated solids studied with femtosecond short-wavelength free-electron-lasers, Uladzimir Shymanovich, Univ. Duisburg-Essen (Germany); Anton Barty, Lawrence Livermore National Lab. (United States); Sebastien Boutet, Michael J. Bogan, SLAC National Accelerator Lab. (United States); Stefano Marchesini, Lawrence Berkeley National Lab. (United States); Nicola Stojanovic, Deutsches Elektronen-Synchrotron (Germany); Ryszard Sobierajski, Institute of Physics (Poland); W. Lu, M. El Kharrazi, M. Vattilana, F. Quirin, T. Brazda, Univ. Duisburg-Essen (Germany); Ulf Zastra, Friedrich-Schiller-Univ. Jena (Germany); Stefan Hau-Riege, Lawrence Livermore National Lab. (United States); J. Bonse, Bundesanstalt für Materialforschung und -prüfung (Germany); R. Tobey, H. Ehrke, Univ. of Oxford (United Kingdom); Andrea Cavalleri, Ctr. for Free-Electron Laser Science (Germany) and Univ. of Oxford (United Kingdom); H. Redlin, Stefan Düsterer, Deutsches Elektronen-Synchrotron (Germany); Matthias A. Frank, Lawrence Livermore National Lab. (United States); Saša Bajt, J. Schulz, Deutsches Elektronen-Synchrotron (Germany); M. Seibert, Janos Hajdu, Uppsala Univ. (Sweden); R. Treusch, Henry N. Chapman, Deutsches Elektronen-Synchrotron (Germany); Klaus Sokolowski-Tinten, Univ. Duisburg-Essen (Germany) [7504-08]

Characteristics of angle tuning and conversion efficiency of ZnGeP₂-DFG in mid-infrared laser, Li Wang, Beijing Univ. of Technology (China) [7504-49]

Thin Films Posters - Monday

Room 2 Mon. 10.40 to 11.40

Posters will be displayed between 10.40 to 11.40 and 15.00 to 16.00 for viewing.

Studies of femtosecond laser induced breakdown of HfO₂ thin film under atmospheric and vacuum environments, Duy N. Nguyen, Luke A. Emmert, Wolfgang Rudolph, The Univ. of New Mexico (United States); Dinesh Patel, Eric Krous, Carmen S. Menoni, Colorado State Univ. (United States); Michelle D. Shinn, Thomas Jefferson National Accelerator Facility (United States) [7504-09]

The effect of nitrogen-doping on the multiple-pulse subpicosecond dielectric breakdown of hafnia films, Duy N. Nguyen, Luke A. Emmert, Wolfgang Rudolph, The Univ. of New Mexico (United States); Dinesh Patel, Eric Krous, Carmen S. Menoni, Colorado State Univ. (United States) [7504-10]

Surface damage of thin AlN films with increased oxygen content by nanosecond and femtosecond laser pulses, Vitaly E. Gruzdev, J. K. Chen, Univ. of Missouri, Columbia (United States); Ildar Salakhutdinov, Queens College of the City Univ. of New York (United States); Yuriy Danylyuk, Erik McCullen, Gregory W. Auner, Wayne State Univ. (United States) [7504-11]

Laser damage resistant features in dielectric coatings created by femtosecond laser machining, Justin E. Wolfe, Siping R. Qiu, Christopher J. Stolz, Lawrence Livermore National Lab. (United States) [7504-12]

Thermal robustness of ion beam sputtered TiO₂/SiO₂, TiO₂/Al₂O₃ and Al₂O₃/SiO₂ IR anti-reflective coatings on YAG and sapphire substrates, Dale C. Ness, Ove Lyngnes, Nick Traggis, Precision Photonics Corp. (United States) [7504-13]

Comparative study of the laser damage resistance of ZrO₂-SiO₂ composite materials based high reflectors, Xinbin Cheng, Tongji Univ. (China); Bin Fan, Haruo Takahashi, Optron Co., Ltd. (Japan); Jiangtao Lu, Zhanshan Wang, Tongji Univ. (China) [7504-14]

Optimization of scandia thin films for high power laser coating applications, Erik M. Krous, Peter Langston, Dinesh Patel, Colorado State Univ. (United States); Ashot Markosyan, Stanford Univ. (United States); Luke A. Emmert, The Univ. of New Mexico (United States); Federico Furch, Brendan A. Reagan, Jorge J. Rocca, Colorado State Univ. (United States); Roger Route, Martin M. Fejer, Stanford Univ. (United States); Wolfgang Rudolph, The Univ. of New Mexico (United States); Michelle Shinn, Thomas Jefferson National Accelerator Facility (United States); Carmen S. Menoni, Colorado State Univ. (United States) [7504-15]

Laser conditioning of high reflectivity mirrors used in OPOs by 266 and 355 nm nanosecond pulses, Arturas Vaninas, Andrius Melnikaitis, Valdas Sirtukaitis, Vilnius Univ. (Lithuania) [7504-16]

193 nm laser induced spectral shift in HR coated mirrors, Byungil Cho, J. Earl Rudisill, Edward J. Danielewicz, Newport Corp. (United States) [7504-17]

Substrate temperature influence on the properties of ZnO thin films deposited by pulsed laser deposition, Li Wang, Beijing Univ. of Technology (China) [7504-18]

SESSION 2

Room: Auditorium Mon. 11.40 to 12.40

Thin Films II

Session Chairs: M. J. Soileau, College of Optics and Photonics, Univ. of Central Florida; Amy L. Rigatti, Univ. of Rochester

11:40: Investigation in oxide mixture coatings with adapted gradient index profiles, Kai Starke, Laser Zentrum Hannover e.V. (Germany) and Cutting Edge Coatings GmbH (Germany); Lars O. Jensen, Marco Jupé, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany); Giedrius Abromavicius, Institute of Physics (Lithuania) and Optida Co. Ltd. (Lithuania); Kestutis Juskevicius, Rytis Buzelis, Institute of Physics (Lithuania); Ramutis Drazdys, Institute of Physics (Lithuania) and Optida Co. Ltd. (Lithuania) [7504-19]

12:00: Meeting thin film design and production challenges for laser damage resistant optical coatings at the Sandia Large Optics Coating Operation, John C. Bellum, Sandia National Labs. (United States) [7504-20]

12:20: Influence of subsurface defects on 355 nm laser damage resistance of monolayer and multilayer coatings, Guohang Hu, Shuying Shao, Minghong Yang, Jianda Shao, Yuanan Zhao, Kui Yi, Zhengxiu Fan, Shanghai Institute of Optics and Fine Mechanics (China) [7504-21]

Lunch Break 12.40 to 14.00

SESSION 3

Room: Auditorium Mon. 14.00 to 15.00

Thin Films III

Session Chairs: Stavros G. Demos, Lawrence Livermore National Lab.; Semyon Papernov, Univ. of Rochester

14:00: Anti reflection coating damage threshold dependence on substrate material, Ove Lyngnes, Aiko Ode, Dale C. Ness, Precision Photonics Corp. (United States) [7504-22]

14:20: Optical coatings with ultralow refractive index SiO₂ films, Jue Wang, Corning Tropol Corp. (United States); Bin Zhou, Jun Shen, Guangming Wu, Tongji Univ. (China) [7504-23]

14:40: Heat and high electric insulation resistant protective coating of solar cell and thermoelectric element for offshore solar power generation, Masataka Murahara, Tokai Univ. (Japan); Yuji Sato, Tokyo Institute of Technology (Japan); Takahisa Jitsuno, Osaka Univ. (Japan); Yoshiaki Okamoto, Okamoto Optics Co., Ltd. (Japan) [7504-24]

Poster Session and Refreshment Break 15.00 to 16.00

Posters - Monday Afternoon

Rooms 1 & 2 Mon. 15.00 to 16.00

Fundamental Mechanisms and Thin Film Posters

Posters will be displayed between 10.40 to 11.40 and 15.00 to 16.00 for viewing.

Please see the list of poster papers in the morning session.

SESSION 4

Room: Auditorium Mon. 16.00 to 17.40

Fundamental Mechanisms I

Session Chairs: Christopher J. Stolz, Lawrence Livermore National Lab.; Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China)

16:00: Ultrafast laser-induced modifications of energy bands of non-metal crystals (Invited Paper), Vitaly E. Gruzdev, Univ. of Missouri, Columbia (United States) [7504-27]

16:40: Biaxial flexural strength of laser-window materials: failure-probability dependence on stressed area and surface finish, Claude A. Klein, C.A.K. Analytics, Inc. (United States) [7504-26]

17:00: Light intensification by conical pits within multilayer coatings, Siping R. Qiu, Christopher J. Stolz, Michael D. Feit, Lawrence Livermore National Lab. (United States); Thomas V. Pistor, Panoramic Technology Inc. (United States); Justin E. Wolfe, Lawrence Livermore National Lab. (United States) [7504-28]

17:20: Morphology of fractures, laser mitigation sites, and laser mitigation sites after wet chemical etching, Michael D. Feit, Tayyab I. Suratwala, Lana L. Wong, William A. Steele, Jeffrey D. Bude, Lawrence Livermore National Lab. (United States) [7504-29]

Open House and Reception Mon. 18.30 to 20.00

Alpine Research Optics

Tuesday 22 September

Poster Placement at NIST - Tuesday

Rooms 1 & 2 Tues. 07.30 to 08.10
Tuesday poster authors may set up their posters at this time.

SESSION 5

Room: Auditorium Tues. 08.20 to 10.00

Mini-Symposium: Femtosecond Laser Damage I

Session Chairs: Wolfgang Rudolph, The Univ. of New Mexico; Leonid B. Glebov, College of Optics and Photonics, Univ. of Central Florida

08.20: **Analysis in wavelength dependence of electronic damage**, Marco Jupé, Lars O. Jensen, Kai Starke, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany); Andrius Melninkaitis, Valdas Sirutkaitis, Vilnius Univ. (Lithuania) [7504-30]

08.40: **Time-resolved digital holography: a versatile tool for femtosecond laser-induced damage studies**, Andrius Melninkaitis, Tadas Balciunas, Andrius Vanagas, Valdas Sirutkaitis, Vilnius Univ. (Lithuania) [7504-31]

09.00: **Fundamental processes controlling the single and multiple femtosecond pulse damage behavior of dielectric oxide films**, Wolfgang Rudolph, The Univ. of New Mexico (United States) [7504-32]

09.20: **Subpicosecond pulse laser damage behavior of dielectric thin films prepared by different techniques**, Benoit Mangote, Laurent Gallais, Mireille Commandré, Myriam Zerrad, Jean Yves Natoli, Michel Lequime, Institut Fresnel (France) [7504-33]

09.40: **Damage of multilayer optics induced by intense femtosecond XUV pulses**, Ryszard Sobierajski, Institute of Physics (Poland) and FOM-Institute for Plasma Physics Rijnhuizen (Netherlands); Ali R. Khorsand, Eric Louis, Eddie D. van Hattum, Robbert W. van de Kruijs, Saskia Bruijn, FOM-Institute for Plasma Physics Rijnhuizen (Netherlands); Fred Bijkerk, FOM-Institute for Plasma Physics Rijnhuizen (Netherlands) and Univ. Twente (Netherlands); Marek Jurek, Dorota Klínger, Institute of Physics (Poland); Klaus Sokolowski-Tinten, Uladzimir Shymanovich, Univ. Duisburg-Essen (Germany); Nicola Stojanovic, Hubertus Wabnitz, Deutsches Elektronen-Synchrotron (Germany); Libor Juha, Jaromir Chalupsky, Institute of Physics of the ASCR, v.v.i. (Czech Republic); Sven Toleikis, Kai I. Tiedtke, Deutsches Elektronen-Synchrotron (Germany); Vera Hajkova, Jaroslav Cihelka, Institute of Physics of the ASCR, v.v.i. (Czech Republic) [7504-34]

Poster Overview

Room: Auditorium Tues. 10.00 to 10.40
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 10.40 to 11.40

Surfaces, Mirrors, and Contamination Posters

Room 1 Tues. 10.40 to 11.40

The surface layer of fused silica finished by various polishing techniques, Yaguo Li, Zhichao Liu, Jian Wang, Qiao Xu, Chengdu Fine Optical Engineering Research Ctr. (China) [7504-35]

Diagnostics tools for subsurface damage characterization of grinded silica parts, Philippe Cormont, Jérôme Néaupert, Nathalie Darbois, Julie Destribats, Chrystel Ambard, Olivier Rondeau, Commissariat à l'Énergie Atomique (France) . . [7504-36]

Birefringence and residual stress induced by CO₂ laser mitigation of damage growth in fused silica, Laurent Gallais, Institut Fresnel (France); Philippe Cormont, Jean-Luc Rullier, Commissariat à l'Énergie Atomique (France) [7504-37]

Thermal anneal of damage precursors on fused silica surfaces, Nan Shen, Jeffrey D. Bude, Theodore A. Laurence, William A. Steele, Phillip E. Miller, Michael D. Feit, Lana L. Wong, Tayyab I. Suratwala, Lawrence Livermore National Lab. (United States) [7504-38]

Loss analysis of a high reflective mirror at 193 nm, Jue Wang, Horst Schreiber, Corning Tropol Corp. (United States) [7504-39]

Accurate temperature measurement of conical cavity high-energy laser energy meter's temperature measuring system, Wenjian Chen, Aifen Yang, Xi'an Institute of Applied Optics (China); Hui Wang, Xiaoyan Shang, Qian Li, Xi'an Technological Univ. (China) [7504-40]

Cleaning practices and facilities for the National Ignition Facility, James A. Pryatel, William H. Gourdin, Susan C. Frieders, Lawrence Livermore National Lab. (United States) [7504-41]

Impact of outgassing organic contamination on laser induced damage of optics, Karell Bien-Aime, Jérôme Néaupert, Isabelle Tovena-Pecault, Commissariat à l'Énergie Atomique (France); Evelyne Fargin, Univ. Bordeaux 1 (France) [7504-57]

Materials and Measurements Posters

Room 2 Tues. 10.40 to 11.40

Numerical analysis of laser-induced damage threshold search algorithms and their uncertainty, Gintare Batavičiute, Andrius Melninkaitis, Valdas Sirutkaitis, Vilnius Univ. (Lithuania) [7504-42]

Spotsize dependence of the LIDT from the NIR to the DUV, Lars O. Jensen, Stefan Schrameyer, Marco Jupé, Holger Blaschke, Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) [7504-43]

Adaptive laser-induced damage detection, Julius Mirauskas, Andrius Melninkaitis, Valdas Sirutkaitis, Vilnius Univ. (Lithuania) [7504-44]

Optical damage testing at the Z-Backlighter Facility of Sandia National Laboratories, Mark Kimmel, Patrick K. Rambo, Jens Schwarz, Robin Broyles, John C. Bellum, Sandia National Labs. (United States) [7504-45]

Characterization of scattering defects structure in CaF₂ crystal, Tomosumi Kamimura, Yuichi Ikeda, Tatsuya Arai, Wataru Shirai, Osaka Institute of Technology (Japan) [7504-46]

Laser-induced damage thresholds in silica glasses at different temperature, Katsuhiro Mikami, Shinji Motokoshi, Masayuki Fujita, Takahisa Jitsuno, Junji Kawanaka, Osaka Univ. (Japan); Ryo Yasuhara, Hamamatsu Photonics K. K. (Japan) . [7504-47]

Control of laser damage and stimulated Brillouin scattering for multimode optical fibers, Shinji Motokoshi, Tatsuyuki Higashizawa, Takahisa Jitsuno, Osaka Univ. (Japan); Minoru Yoshida, Kinki Univ. (Japan) [7504-48]

Study of haze in 193nm high dose irradiated CaF₂ crystals, Ute Natura, Stephan Rix, Martin Letz, Lutz Parthier, SCHOTT AG (Germany) [7504-50]

Characterization of CaF₂ optics for 193nm microlithography, Klaus Mann, Uwe Leinhos, Bernd Schäfer, Laser-Lab. Göttingen e.V. (Germany); Masao Ariyuki, Yasuhiro Hashimoto, Naoto Mochizuki, Yoji Inui, Isao Masada, Teruhiko Nawata, Tokuyama Corp. (Japan) [7504-51]

Development of large size MgF₂ single crystal grown by the CZ method, Masao Ariyuki, Yasuhiro Hashimoto, Naoto Mochizuki, Yoji Inui, Isao Masada, Teruhiko Nawata, Tokuyama Corp. (Japan); Tsuguo Fukuda, Fukuda X'tal Lab. (Japan) [7504-52]

SESSION 6

Room: Auditorium Tues. 11.40 to 12.20

Mini-Symposium: Femtosecond Laser Damage II

Session Chairs: Wolfgang Rudolph, The Univ. of New Mexico; Leonid B. Glebov, College of Optics and Photonics, Univ. of Central Florida

11.40: **Mixed metal multilayer dielectric gratings for pulse compression applications**, Jérôme Néaupert, Stephanie Palmier, Commissariat à l'Énergie Atomique (France); Nicolas Bonod, Institut Fresnel (France); Eric A. Lavastre, Nathalie Baclet, Gabriel Dupuy, Commissariat à l'Énergie Atomique (France) [7504-53]

12.00: **Thin film femtosecond laser damage competition**, Christopher J. Stolz, Lawrence Livermore National Lab. (United States); Detlev Ristau, Laser Zentrum Hannover e.V. (Germany) [7504-54]

Lunch Break 12.20 to 13.40

SESSION 7

Room: Auditorium Tues. 13.40 to 15.00

Surfaces, Mirrors, and Contamination I

Session Chairs: Jonathan W. Arenberg, Northrop Grumman Aerospace Systems; Michelle D. Shinn, Thomas Jefferson National Accelerator Facility

13.40: **Aspects of laser optics qualification for space applications (Invited Paper)**, Wolfgang Riede, Paul Allenspacher, Helmut Schröder, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany); Denny Wernham, European Space Research and Technology Ctr. (Netherlands) [7504-55]

14.20: **The effects on glass surfaces of shrapnel and debris emissions from Petawatt laser driven solid targets**, James E. Andrew, Katie A. Wallace, Atomic Weapons Establishment (United Kingdom) [7504-56]

14.40: **Chemical characterizations of optical materials: a tool for high quality components**, Chrystel Ambard, Fabien Pilon, Olivier Rondeau, Bruno Pintault, Philippe Cormont, Jérôme Néaupert, Commissariat à l'Énergie Atomique (France) . [7504-58]

Poster Session and Refreshment Break Tues. 15.00 to 16.00

Posters - Tuesday Afternoon

Rooms 1 & 2 Tues. 15.00 to 16.00

Surfaces, Mirrors, and Contamination, and Materials and Measurements Posters

Posters will be displayed between 10.40 to 11.40 and 15.00 to 16.00 for viewing.

Please see the list of poster papers in the morning session.

SESSION 8

Room: Auditorium Tues. 16.00 to 17.40

Surfaces, Mirrors, and Contamination II

Session Chairs: Detlev Ristau, Laser Zentrum Hannover e.V. (Germany); Jérôme Néauport, Commissariat à l'Énergie Atomique (France)

16.00: **Identification of laser damage precursors in fused silica**, Philip E. Miller, Tayyab I. Suratwala, Jeffrey D. Bude, Joseph A. Menapace, Nan Shen, William A. Steele, Theodore A. Laurence, Michael D. Feit, Lana L. Wong, Lawrence Livermore National Lab. (United States). [7504-59]

16.20: **Residual stress and damage-induced critical fracture on CO₂ laser treated fused silica**, Manyalibo J. Matthews, James S. Stolken, Ryan M. Vignes, Mary A. Norton, Steven T. Yang, J. D. Cooke, Gabe Guss, John J. Adams, Lawrence Livermore National Lab. (United States). [7504-60]

16.40: **The effect of pulse duration on the growth rate of laser-induced damage sites on fused silica optics at 351 nm**, Raluca A. Negres, Mary A. Norton, Zhi M. Liao, David Cross, Jeffrey D. Bude, Christopher W. Carr, Lawrence Livermore National Lab. (United States). [7504-61]

17.00: **Study of CO₂ laser smoothing of surface roughness in fused silica and its effect on field intensification**, Nan Shen, Lawrence Livermore National Lab. (United States); W. D. Henshaw, J. D. Fair, Lawrence Berkeley National Lab. (United States); Gabe Guss, Isaac L. Bass, Manyalibo J. Matthews, Lawrence Livermore National Lab. (United States). [7504-62]

17.20: **Magnetorheological finishing (MRF) of potassium dihydrogen phosphate (KDP) crystals: non-aqueous fluids development, optical finish, and laser damage performance at 1064 nm and 532 nm**, Joseph A. Menapace, Paul R. Ehrmann, Robert C. Bickel, Lawrence Livermore National Lab. (United States) [7504-63]

NCAR Reception Tues. 18.30 to 20.00
Wine and Cheese Reception at NCAR

Wednesday 23 September

SESSION 9

Room: Auditorium Wed. 08.20 to 10.40

Materials and Measurements I

Session Chairs: Vitaly E. Gruzdev, Univ. of Missouri, Columbia; James E. Andrew, Atomic Weapons Establishment (United Kingdom)

08.20: **Nonlinear optical spectroscopy: absorption and refraction** (*Invited Paper*), Eric W. Van Stryland, David J. Hagan, Scott Webster, Lazaro A. Padilha, College of Optics and Photonics, Univ. of Central Florida (United States). [7504-64]

09.00: **Ultra-fast photoluminescence as a diagnostic for laser damage initiation**, Ted A. Laurence, Jeffrey D. Bude, Nan Shen, Phillip E. Miller, William A. Steele, Gabe Guss, John J. Adams, Lana L. Wong, Michael D. Feit, Tayyab I. Suratwala, Lawrence Livermore National Lab. (United States). [7504-65]

09.20: **Photoluminescence and photothermal deflection measurements in KDP crystals for high power applications.**, Alessandra Ciapponi, Frank R. Wagner, Jean-Yves Natoli, Institut Fresnel (France); Bertrand Bertussi, Commissariat à l'Énergie Atomique (France) [7504-66]

09.40: **Time-resolved imaging of material cluster ejection during exit-surface damage initiation and growth in fused silica**, Stavros G. Demos, Rajesh N. Raman, Raluca A. Negres, Lawrence Livermore National Lab. (United States). [7504-67]

10.00: **High temperature thermographic measurements of laser heated silica**, Selim Elhadj, Steven T. Yang, Manyalibo J. Matthews, Ryan M. Vignes, James S. Stolken, Jeffrey D. Colvin, Jeffrey D. Bude, Lawrence Livermore National Lab. (United States). [7504-68]

10.20: **Early thermal damage in optical coatings identified by infrared spectral signatures**, Sangho S. Kim, Nicholas T. Gabriel, Wing S. Chan, Joseph J. Talghader, Univ. of Minnesota (United States) [7504-69]
Coffee Break 10.40 to 11.20

SESSION 10

Room: Auditorium Wed. 11.20 to 12.40

Materials and Measurements II

Session Chairs: Vitaly E. Gruzdev, Univ. of Missouri, Columbia; James E. Andrew, Atomic Weapons Establishment (United Kingdom)

11.20: **Process for rapid detection of light intensifying optical flaws using Line-scan Phase-differential Imaging**, Frank L. Ravizza, Michael C. Nostrand, Ruth A. Hawley, Michael A. Johnson, Lawrence Livermore National Lab. (United States) [7504-70]

11.40: **Laser-induced surface damage density measurements of fused silica optics: a parametric study**, Laurent Lameignère, Stéphane Reyné, Thierry Donval, Roger Courchinoux, Jean-Christophe Poncetta, Bertrand Bertussi, Commissariat à l'Énergie Atomique (France) [7504-71]

12.00: **Analysis of N on 1 tests: an initial inquiry**, Jonathan W. Arenberg, Northrop Grumman Aerospace Systems (United States). [7504-72]

12.20: **Damage tests on EUV optics and sensors using focused radiation from a table-top laser-produced plasma source**, Frank Barkusky, Armin Bayer, Bernhard Flöter, Christian Peth, Klaus Mann, Laser-Lab. Göttingen e.V. (Germany). [7504-73]
Lunch Break 12.40 to 14.00

SESSION 11

Room: Auditorium Wed. 14.00 to 16.00

Materials and Measurements III

Session Chairs: Gregory J. Exarhos, Pacific Northwest National Lab.; Masataka Murahara, Tokai Univ. (Japan)

14.00: **Modeling laser conditioning of KDP crystals**, Guillaume Duchateau, Commissariat à l'Énergie Atomique (France) [7504-74]

14.20: **Laser conditioning process combining N/1 and S/1 programs to improve the damage resistance of KDP crystals**, Yuan'an Zhao, Guohang Hu, Jianda Shao, Xiaofeng Liu, Hongbo He, Zhengxiu Fan, Shanghai Institute of Optics and Fine Mechanics (China). [7504-75]

14.40: **Nanosecond-laser induced damage at 1064nm, 532nm, and 355nm in LiB₃O₅**, Frank R. Wagner, Anne Hildenbrand, Jean-Yves Natoli, Mireille Commandre, Institut Fresnel (France). [7504-76]

15.00: **Laser induced damage of sapphire and titanium doped sapphire crystals under femtosecond to nanosecond laser irradiation**, Benoit Bussiere, Lasers, Plasmas et Procédés Photoniques (France) and Amplitude Technologies (France) and Institut Fresnel (France); Olivier P. Uteza, Nicolas Sanner, Marc L. Sentis, Lasers, Plasmas et Procédés Photoniques (France); Gilles Riboulet, Luc M. Vigroux, Amplitude Technologies (France); Mireille Commandre, Franck Wagner, Jean-Yves Natoli, Institut Fresnel (France); Jean-Paul Chambaret, Ecole Nationale Supérieure de Techniques Avancées (France) [7504-77]

15.20: **Deterministic single-shot and multiple-shot bulk damage thresholds for doped and undoped, crystalline, and ceramic YAG**, Binh Trong Do, Sandia National Labs. (United States); Arlee V. Smith, AS-Photonics, LLC (United States) [7504-78]

15.40: **Zinc oxide nanostructures synthesized by pulsed laser ablation in methanol**, Subhash C. Singh, Univ. of Allahabad (India) [7504-79]

Closing Remarks Wed. 16.00 to 16.10

Open House Wed. 16.30 to 18.00
Precision Photonics Corp.

IMPORTANT DATES

▶ **MANDATORY Preregistration: 7 September 2009**

No onsite registration is offered due to security clearance at NIST.

▶ **Hotel Reservations: 21 August 2009**

▶ **Manuscript Due Date: 2 November 2009**
The proceedings of this symposium will be available after the meeting.

Order your Proceedings volume now and receive low prepublication prices

Laser-Induced Damage in Optical Materials 2009

Conference Co-Chairs: **Gregory J. Exarhos**, Pacific Northwest National Lab.; **Vitaly E. Gruzdev**, Univ. of Missouri, Columbia; **Detlev Ristau**, Laser Zentrum Hannover e.V. (Germany); **M. J. Soileau**, College of Optics and Photonics, Univ. of Central Florida; **Christopher J. Stolz**, Lawrence Livermore National Lab.

Proc. of SPIE Vol. 7504
Prepublication price: \$100

To Order

Fax: +1 360 647 1445 • Tel: +1 360 676 3290
customerservice@spie.org • spie.org/bookstore

2008 Award Winners

Best Oral Presentation:

Femtosecond laser breakdown of gases and transparent solid states: ultrafast space-time and spectrum-time resolved diagnostics of multicharged microplasma

paper 7132-3

Authors: **Sergey Garnov, Vladimir Bukin, Vasily Strelkov, Alexander Malutin**, A.M. Prokhorov General Physics Institute (Russian Federation)

Best Poster Presentation:

Investigation of bulk laser damage in transparent YAG ceramics controlled with microstructural refinement

paper 7132-41

Authors: **Tomosumi Kamimura, Yutaka Kawaguchi, Tatsuya Arie, Wataru Shirai**, Osaka Institute of Technology (Japan); **Takuya Mikami, Takayuki Okamoto**, Okamoto Optics Co., Ltd. (Japan); **Yan Lin Aung, Akio Ikesue**, World Lab Co., Ltd. (Japan)

General Information

Apply now for your Visa!

If you need a travel visa, begin the visa application process now! Strict security requirements may cause delays in visa processing. More information about applying for a USA visa is available at:

<http://national-academies.org/visas>

Letters of Invitation

If you require an invitation letter in order to receive a visa, please complete the Invitation Letter Request Form and return it to SPIE.

Please fill out a separate form for each person requesting a letter. Fax completed form to SPIE at 1-360-647-1445. All letters of invitation will be sent by airmail and by email (as a PDF attachment) unless a courier account number or credit card number with expiration date is provided with the original request.

Please allow up to 15 business days to process your request. SPIE is not able to contact U.S. Embassies in support of an individual attempting to gain entry to attend an SPIE meeting. We recommend that you secure your travel visa before registering for the conference as cancellations after the preregistration cutoff can result in a cancellation fee.

Registration Fee Policy and Registration Form

MANDATORY
Preregistration
7 September 2009

For security reasons, it is mandatory to register before **7 September 2009**. The registration fee is \$550 (US\$) and \$150 (US\$) for students. Registrations received after 7 September, if accepted and security clearance granted, will be charged an additional \$100 (\$650 total), \$50 for students (\$200 total). Onsite registration will not be available. Registration can be completed online at: <http://spie.org/ldadvance>. It is mandatory that you include your passport number, birth date, birth place, and citizenship on the registration form.

Included in the registration fee are:

- Admission to all technical sessions
- Wine and Cheese Reception
- Refreshment breaks (lunches are not included)
- One copy of the book of abstracts, attendance list, and proceedings volume (not included with student registration).

Manuscripts

Manuscripts for all presentations (invited, contributed, oral, poster) are required and must be submitted by the 2 November 2009 manuscript due date.

IMPORTANT DATES

▶ **MANDATORY Preregistration:**
7 September 2009

No onsite registration is offered due to security clearance at NIST.

▶ **Hotel Reservations: 21 August 2009**

▶ **Manuscript Due Date: 2 November 2009**

The proceedings of this symposium will be available after the meeting.

Conference Site

National Institute of Standards and Technology (NIST)
Building 1 (Radio Building) 325 Broadway · Boulder, Colorado
www.boulder.nist.gov

Reserve by
21 August 2009

Conference Hotel

COURTYARD BY MARRIOTT - BOULDER
4710 Pearl East Circle • Boulder, Colorado 80301 USA
SPIE Laser Damage Conference Room Rate is \$119 (plus tax).

Online Reservations:

- 1) Go to www.marriott.com/denbd
- 2) Under "Check rates and availability," enter the dates you wish to stay and your Marriott Rewards number (optional).
- 3) Scroll to the bottom of the page and enter the following 7-digit GROUP CODE: BDSBDSA)
- 4) Continue through the screens with your personal information and credit card number until you receive a confirmation number.

Toll Free Reservations:

- 1) Dial 1-800-321-2211 toll free and identify yourself with the SPIE group.
- 2) Ask the agent for the Courtyard by Marriott Boulder.
- 3) State your arrival date and the type of accommodations you require. Requests will be honored on a first come, first served basis.
- 4) Have a credit card available. Giving a credit card or sending an advance deposit is required to guarantee your reservation. The hotel cancellation policy is 6:00 pm on the day of arrival.
- 5) Please make your reservation by **21 August 2009**. Reservations made after this date are subject to availability.

Check in time 3:00 pm. Check out time 12:00 pm.

Need a Ride from Denver International Airport to the Hotel?

Super Shuttle — 303 227 0000
Boulder Express Shuttle — 303 457 4646

Reservations recommended.



Hertz Car Rental has been selected as the official car rental agency for this Symposium. To reserve a car, identify yourself as a Laser Damage Conference attendee using the **Hertz Meeting Code CV# 029B0011**. Note: When booking from International Hertz locations, the CV # must be entered with the letters CV before the number, i.e. CV029B0011.

- In the United States call 1-800-654-2240
- In Canada call 1-800-263-0600, or 1-416-620-9620 in Toronto
- In Europe and Asia call the nearest Hertz Reservation Center or travel agent
- Outside of these areas call 1-405-749-4434.

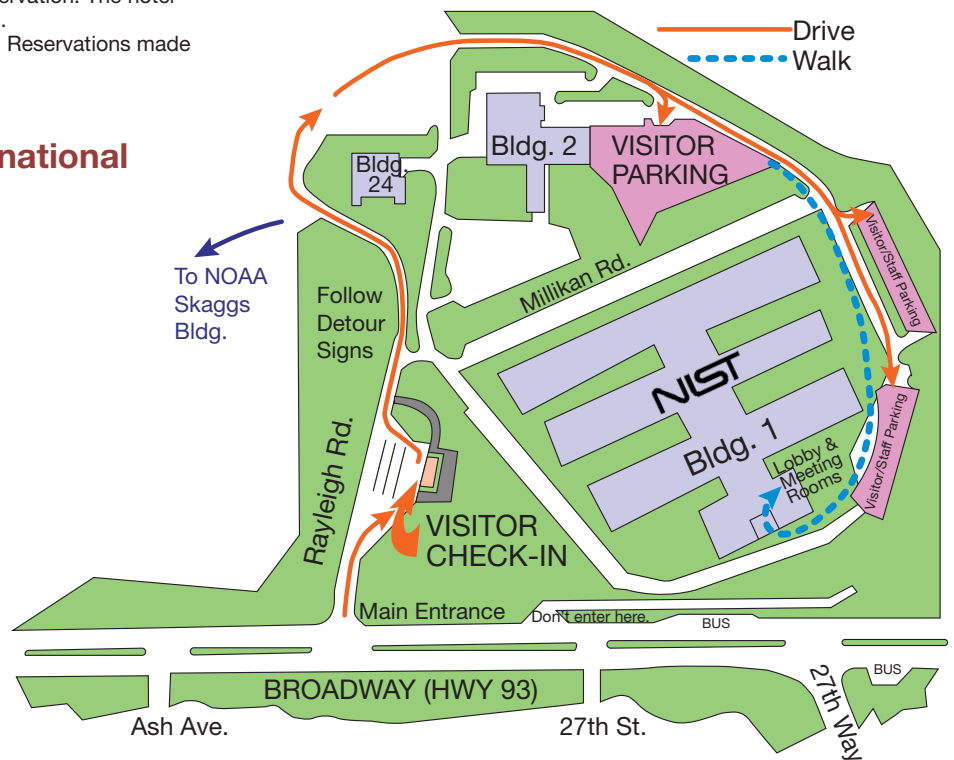
Book on-line at www.hertz.com.

Driving Directions from the Denver International Airport to the Courtyard by Marriott Boulder Hotel

Take Pena Blvd. to Interstate 70 West. Take I-70 to Highway 270 West (heading Northwest) to Hwy 36 (West). Take Highway 36 West to Boulder. Stay on Highway 36 for approximately 20 miles. Exit Highway 157 North (Foothills Parkway). Stay left because Foothills Parkway is a double exit. Take Foothills Parkway to Pearl Street (3 stop lights). After the third light, exit Pearl Street. Go east (right) to Pearl East Circle. (The hotel will be on your right). The second right hand turn, after the RTD park-n-ride, will bring you into the parking lot.

Directions from the Courtyard-Boulder to NIST

1. EAST on PEARL EAST CIR. <0.1 miles
2. LEFT to stay on PEARL EAST CIR. <0.1 miles
3. LEFT onto PEARL PKWY. 0.6 miles
4. Stay STRAIGHT to go onto PEARL ST. 0.3 miles
5. LEFT onto 28TH ST / US-36 E / CO-119 S. Continue to follow 28TH ST / US-36 E. 1.3 miles
6. Take the BASELINE RD ramp toward CO-93. 0.2 miles
7. RIGHT onto BASELINE RD. 0.1 miles
8. LEFT onto BROADWAY ST / CO-93 S. 0.2 miles
9. End at National Institute-Standards: 325 Broadway St, Boulder, CO 80305



IMPORTANT!

You will need your registration badge to get into the NIST parking lot. Visitors are required to show photo identification upon arrival and must wear a visitor's badge at all times while on the NIST campus.

Registration Form



Formerly Boulder Damage
41st Annual Symposium on
Optical Materials for High Power Lasers

21-23 September 2009
National Institute of Standards and Technology
Boulder, Colorado, USA

Mail or fax this form to
SPIE
PO Box 10
Bellingham, WA 98227-0010 USA
Phone +1 360 676 3290
Fax +1 360 647 1445
Web: www.spie.org/bd
E-mail: customerservice@spie.org
Submit one form per person.

SPIE ID #

7164-RBD09AW

First Name	MI	Last Name
Job Title		
Company		
Address (include Mail Stop)		
City	State	Zip/Postal Code
Country other than USA		
MANDATORY: Place of Birth (City, State, Country)		Date of Birth
MANDATORY FOR NON-US CITIZENS: Passport No.		
Phone	Fax	
E-Mail Address		

**NOTE: On-site registration
WILL NOT be available.**

Registration requests submitted before 7 September 2009 are guaranteed to receive full security clearance review. Late registrations will be accepted after 7 September 2009, but rates increase \$100 (\$650 total), \$50 for students (\$200 total), and there is no guarantee that there will be adequate time for security clearance review.

Check this box if you do not wish to receive relevant information from organizations other than SPIE.

Symposium Registration

Regular/Author \$550
Student (Valid Student ID Card must be presented when picking up badge)
(Does not include proceedings Volume) \$150

Included in the registration fee are admission to all technical sessions, wine and cheese reception, refreshment breaks (lunches are not included), one copy of the book of abstracts, attendance list, and the proceedings volume from this meeting.

**Registration
Total**

\$

SPIE Membership

To receive the Member discount, check appropriate box(es) below and fax or mail this form.

Regular/Fellow Membership: \$105 Student Membership: \$20 (Est. graduation date: _____)
 Early Career Professional (Offered for 3 years following graduation): \$55 (Graduation date: _____)
 Regular/Fellow 3-year Membership: \$297 Regular/Fellow Life Membership: \$995

Online Journal Option (choose one):

Optical Engineering Electronic Imaging Biomedical Optics
 Micro/Nanolithography, MEMS, and MOEMS Applied Remote Sensing Nanophotonics

**Membership
Total**

\$

**Payment must accompany
registration.**

Payment Method **Date:** _____

Credit card payments will be charged in USD and converted to your local currency by your card company or bank.

TOTAL

\$

Check # _____ Amount USD\$ _____ (payable to SPIE) Security Code from on back of card.

Credit Card: Card Number:

- VISA
 MasterCard
 American Express
 Diners Club
 Discover

I authorize SPIE to charge total payment fee (as indicated on this form) to my credit card.

Expiration Date _____ / _____ Signature _____
Month / Year

Refund Policy for Preregistration: There is a \$40 service charge for processing refunds. A letter requesting the refund should state the preregistrant's name and to whom the check should be made payable. Requests for preregistration refunds must be received no later than 11 September 2009. Membership dues are not refundable.