## Contents

<table>
<thead>
<tr>
<th>Conference Committee</th>
</tr>
</thead>
</table>

### PLENARY PAPER

8884 03  
**NASA funding opportunities for optical fabrication and testing technology development**  
(Plenary Paper) [8884-501]  
H. P. Stahl, NASA Marshall Space Flight Ctr. (United States)

### GRINDING AND POLISHING PROCESSES I

8884 04  
**Cost effective fabrication method for large sapphire sensor windows** [8884-1]  

8884 05  
**Effects of varying machine stiffness and contact area in UltraForm Finishing** [8884-2]  
D. E. Briggs, S. Echaves, B. Pidgeon, N. Travis, J. D. Ellis, Univ. of Rochester (United States)

8884 06  
**Determination of a suitable parameter field for the active fluid jet polishing process** [8884-3]  
R. Maurer, H. Biskup, C. Trum, R. Rascher, C. Wünsche, Hochschule Deggendorf (Germany)

8884 07  
**Magnetorheological finishing with chemically modified fluids for studying material removal of single-crystal ZnS** [8884-4]  
S. Salzman, H. J. Romanofsky, Univ. of Rochester (United States); Y. I. Clara, Rochester Institute of Technology (United States); L. J. Giannichini, G. West, J. C. Lambropoulos, S. D. Jacobs, Univ. of Rochester (United States)

8884 08  
**Dressing of fine grained diamond grinding wheels for ultra precision grinding of structured molds in brittle hard materials** [8884-5]  
T. Bletek, F. Klocke, M. Hünten, O. Dambon, Fraunhofer-Institut für Produktionstechnologie (Germany)

### GRINDING AND POLISHING PROCESSES II

8884 0A  
**Efficiency of magnetorheological fluid finishing on the elimination of defects in fused silica optics** [8884-7]  
R. Catrin, D. Taroux, P. Cormont, C. Maunier, T. Corbion, G. Razé, J. Néauport, Commissariat à l’Énergie Atomique (France)

8884 0C  
**Relationships between subsurface damage depth and surface roughness of grinded glass optics** [8884-9]  
P. Blaineau, R. Laheurte, P. Darnis, Univ. Bordeaux 1 (France); N. Darbois, Commissariat à l’Énergie Atomique (France); O. Cahuc, Univ. Bordeaux 1 (France); J. Néauport, Commissariat à l’Énergie Atomique (France)
**GRINDING AND POLISHING PROCESSES III**

8884 0G  **Deterministic polishing process for aspheric lenses in a production environment** [8884-13]  
G. Stach, F. Schwalb, Satisloh GmbH (Germany)

8884 0H  **Deterministic finishing of aspheric optical components** [8884-14]  
T. Lambropoulos, E. Fess, S. DeFisher, OptiPro Systems (United States)

8884 0I  **Efficient grinding and polishing processes for asphere manufacturing** [8884-15]  
M. Hinn, Schneider GmbH & Co. KG (Germany); A. Pisarski, Schneider Optical Machines Inc. (United States)

8884 0J  **Getting the most out of your cerium oxide glass polishing slurry: reducing risk and improving performance with plasma produced particles** [8884-16]  
P. G. Murray, A. Hooper, Nanophase Technologies Corp. (United States); J. Keleher, J. Kaiser, M. Nichol, Lewis Univ. (United States)

**OPTICAL FABRICATION OF FREEFORM SURFACES**

8884 0L  **Developments in precision optical grinding technology** [8884-18]  
E. Fess, M. Bechtold, F. Wolfs, R. Bechtold, OptiPro Systems (United States)

8884 0M  **Additive manufacturing of tools for lapping glass** [8884-19]  
W. B. Williams, The Univ. of North Carolina at Charlotte (United States)

8884 0N  **Freeform polishing with UltraForm Finishing** [8884-20]  
F. Wolfs, E. Fess, S. DeFisher, OptiPro Systems (United States)

8884 0O  **Fabricating freeform multispectral-ZnS corrector lenses** [8884-21]  

8884 0P  **Integrated manufacturing of complex freeform surfaces** [8884-23]  
F. Niehaus, S. Huttenhuis, Schneider GmbH & Co. KG (Germany); A. Pisarski, Schneider Optical Machines Inc. (United States)

8884 0Q  **Efficient machining of ultra precise steel moulds with freeform surfaces** [8884-22]  
B. Bulla, son-x GmbH (Germany); D. J. Robertson, Durham Univ. (United Kingdom); O. Dambon, F. Klocke, Fraunhofer-Institut für Produktionstechnologie (Germany)
Conformal window manufacturing process development and demonstration for polycrystalline materials [8884-24]

Fabrication of high precision metallic freeform mirrors with magnetorheological finishing (MRF) [8884-91]
M. Beier, S. Scheiding, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) and Friedrich-Schiller-Univ. Jena (Germany); A. Gebhardt, R. Loose, S. Risse, R. Eberhardt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); A. Tünnermann, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany) and Friedrich-Schiller-Univ. Jena (Germany)

Comparison of alignment errors in asphere metrology between an interferometric null-test measurement and a non-null measurement with the tilted-wave-interferometer [8884-25]
G. Baer, J. Schindler, C. Pruss, W. Osten, Univ. Stuttgart (Germany)

Comparison of contact and non-contact asphere surface metrology devices [8884-26]
S. DeFisher, E. M. Fess, OptiPro Systems (United States)

Non-contact metrology of aspheric surfaces based on MWLI technology [8884-27]
G. Berger, J. Petter, Luphos GmbH (Germany)

Vertical interferometer workstation for testing large spherical optics [8884-28]
B. Truax, Zygo Corp. (United States)

Retrace error: interferometry’s dark little secret [8884-29]
C. B. Kreischer, Kreischer Optics, Ltd. (United States)

Round-robin measurements of toroidal window [8884-30]
K. Medicus, Optimax Systems, Inc. (United States); S. DeFisher, OptiPro Systems (United States); M. Bauza, Carl Zeiss Industrial Metrology LLC (United States); P. Dumas, QED Technologies, Inc. (United States)

Improved averaging for non-null interferometry [8884-31]
J. F. Fleig, P. E. Murphy, QED Technologies, Inc. (United States)

Development of a high-speed nanoprofiler using normal vector tracing method for high-accuracy mirrors [8884-32]
K. Okuda, T. Kitayama, K. Usuki, T. Kojima, K. Okita, J. Uchikoshi, Osaka Univ. (Japan); Y. Higashi, High Energy Accelerator Research Organization (Japan); K. Endo, Osaka Univ. (Japan)
Fabrication and metrology of high-precision freeform surfaces [8884-34]
C. Supranowitz, P. Dumas, T. Nitzsche, QED Technologies, Inc. (United States); J. DeGroote Nelson, B. Light, K. Medicus, N. Smith, Optimax Systems, Inc. (United States)

A simple procedure to include a free-form measurement capability to standard coordinate measurement machines [8884-35]
F. Schneider, Hochschule Deggendorf (Germany) and Univ. of the West of England (United Kingdom); R. Rascher, Hochschule Deggendorf (Germany); R. Stamp, G. Smith, Univ. of the West of England (United Kingdom)

3D-form metrology of arbitrary optical surfaces by absorption in fluids [8884-36]
J. C. Martínez Antón, J. M. Plaza Ortega, J. Alonso, Univ. Complutense de Madrid (Spain)

Worthwhile optical method for free-form mirrors qualification [8884-37]
G. Sironi, R. Canestrari, INAF - Osservatorio Astronomico di Brera (Italy); G. Toso, INAF - IASF Milano (Italy); G. Pareschi, INAF - Osservatorio Astronomico di Brera (Italy)

Characterization of structural relaxation in As$_2$Se$_3$ for analysis of lens shape change in glass press mold cooling and post-process annealing [8884-38]
E. Koontz, P. Wachtel, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); J. D. Musgraves, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States), Clemson Univ. (United States), and iRradiance Glass, Inc. (United States); K. Richardson, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States)

Compositional-tailoring of optical properties in IR transparent chalcogenide glasses for precision glass molding [8884-39]
B. Gleason, P. Wachtel, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); J. D. Musgraves, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States), Clemson Univ. (United States), and iRradiance Glass, Inc. (United States); A. Qiao, N. Anheier, Pacific Northwest National Lab. (United States); K. Richardson, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States)

SP-100 the fast and reliable machine for coating application in precision optics [8884-41]
G. Monaco, Satisloh Italy S.r.l. (Italy); M. Peter, Satisloh Photonics AG (Switzerland); A. Colautti, Satisloh Italy S.r.l. (Italy); T. Godin, Satisloh North America Inc. (United States); S. Gold, Satisloh GmbH (Germany); M. Witzany, Satisloh Italy S.r.l. (Italy) and Satisloh GmbH (Germany); F. Breme, Satisloh Photonics AG (Switzerland)

Development of a high specification coating [8884-42]
P. E. MacKay, M. Wilde, Gooch & Housego Ltd. (United Kingdom)
Refractive index of thin films realized by Satisloh SP reactive sputtering system [8884-43]
G. Monaco, A. Colautti, C. Allegro, Satisloh Italy S.r.l. (Italy); T. Godin, Satisloh North America Inc. (United States); S. Gold, Satisloh GmbH (Germany); M. Witzany, Satisloh Italy S.r.l. (Italy) and Satisloh GmbH (Germany)

Optical Design

Optical design with orthogonal surface descriptions [8884-44]
G. W. Forbes, QED Technologies, Inc. (United States); C. Menke, Carl Zeiss AG (Germany)

Design of systems involving easily measurable aspheres [8884-45]
P. E. Murphy, QED Technologies, Inc. (United States); D. Stephenson, JENOPTIK Optical Systems (United States); A. E. W. Jones, G. W. Forbes, QED Technologies, Inc. (United States)

Using Microsoft Excel as a pre-processor for CODE V optimization of air spaces when building camera lenses [8884-46]
D. Stephenson, JENOPTIK Optical Systems (United States)

Integration of measurement data in the comprehensive modelling approach [8884-47]
I. Sieber, Karlsruher Institut für Technologie (Germany); O. Rübenach, INGENERIC GmbH (Germany)

Rapid design of LED optical elements with two free-form surfaces generating uniformly illuminated rectangular area [8884-48]
M. A. Moiseev, L. L. Doskolovich, S. V. Kravchenko, Image Processing Systems Institute (Russian Federation)

Design of freeform optical elements generating a line-shaped directivity diagram [8884-49]

Optical Engineering

Optical characterization of window materials for aerospace applications [8884-50]
K. K. Tedjojuwono, N. Clark, W. M. Humphreys Jr., NASA Langley Research Ctr. (United States)

Development of a calibration standard for spherical aberration [8884-51]
D. C. Compertore, F. V. Ignatovich, M. E. Herbrand, M. A. Marcus, Lumetrics, Inc. (United States)

Precision interferometric measurements of refractive index of polymers in air and liquid [8884-53]
M. A. Marcus, K. J. Hadcock, D. S. Gibson, M. E. Herbrand, F. V. Ignatovich, Lumetrics, Inc. (United States)
Optical test bench for high precision metrology and alignment of zoom sub-assembly components [8884-54]
F. Leprêtre, E. Levillain, Thales Angénieux S.A. (France); B. Wattellier, P. Delage, D. Brahmi, A. Gascon, PHASICS S.A. (France)

METER CLASS OPTICS

Low weight mirror substrates [8884-55]
P. E. MacKay, Gooch & Housego Ltd. (United Kingdom); N. L. Beveridge, Gooch & Housego Ltd. (United Kingdom) and Univ. of Glasgow (United Kingdom); T. Wood, Surrey Satellite Technology Ltd. (United Kingdom)

Model-based polishing of meter size optics [8884-57]
J.-C. Kupfer, M. Achtsnick, E. Becker, Berliner Glas KGaA Herbert Kubatz GmbH & Co. (Germany)

Slumping technique for the manufacturing of a representative x-ray grazing incidence mirror module for future space missions [8884-58]
M. Ghigo, INAF - Osservatorio Astronomico di Brera (Italy); L. Proserpio, INAF - Osservatorio Astronomico di Brera (Italy) and Max-Planck-Institut für extraterrestrische Physik (Germany); S. Basso, O. Citterio, M. M. Civitani, G. Pareschi, B. Salmaso, G. Sironi, D. Spiga, G. Tagliaterri, G. Vecchi, A. Zambra, INAF - Osservatorio Astronomico di Brera (Italy); G. Parodi, F. Martelli, BCV Progetti S.r.l. (Italy); D. Gallieni, M. Tintori, A.D.S. International S.r.l. (Italy); M. Bavdaz, E. Wille, European Space Research and Technology Ctr. (Netherlands); I. Ferrario, Media Lario Technologies S.r.l. (Italy); V. Burwitz, Max-Planck-Institut für extraterrestrische Physik (Germany)

Thin monolithic glass shells for future high angular resolution and large collecting area x-ray telescope [8884-60]
M. M. Civitani, O. Citterio, M. Ghigo, INAF - Osservatorio Astronomico di Brera (Italy); E. Mattaini, INAF - Osservatorio Astronomico di Brera (Italy) and INAF - IASF Milano (Italy); G. Pareschi, INAF - Osservatorio Astronomico di Brera (Italy); G. Parodi, BCV Progetti S.r.l. (Italy)

Effect of polishing plane vibration on large-size optical workpieces in continuous polishing [8884-60]
H. Shan, Shanghai Institute of Optics and Fine Mechanics (China) and Univ. of Chinese Academy of Sciences (China); C. Wei, X. Xu, H. He, S. Liu, Y. Li, K. Yi, J. Shao, Shanghai Institute of Optics and Fine Mechanics (China)
MOLDED OPTICS

8884 1T Nanoscale optical features via hot-stamping of As$_2$Se$_3$ glass [8884-61]
S. Danto, E. Koontz, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); Y. Zou, T. O. Ogbuu, Univ. of Delaware (United States); B. Gleason, P. Wachtel, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); J. D. Musgraves, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States), Clemson Univ. (United States), and IRradiance Glass, Inc. (United States); J. Hu, Univ. of Delaware (United States); K. Richardson, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States)

8884 1U Chalcogenide-mold interactions during precision glass molding (PGM) of GeAsSe glasses [8884-62]
B. Gleason, P. Wachtel, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); J. D. Musgraves, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States), Clemson Univ. (United States), and IRradiance Glass, Inc. (United States); R. Steinkopf, R. Eberhardt, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); K. Richardson, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States), Clemson Univ. (United States), and IRradiance Glass, Inc. (United States)

8884 1V Novel testing facility for investigating wear on PGM sample tools [8884-64]
F. Bernhardt, K. Georgiadis, O. Dambon, F. Klocke, Fraunhofer-Institut für Produktionstechnologie (Germany)

8884 1W Melt spun aluminium alloys for moulding optics [8884-65]
G. Gubbels, RSP Technology (Netherlands); L. Tegelaers, Oerlikon Balzers Coating Benelux N.V. (Belgium); R. Senden, RSP Technology (Netherlands)

8884 1X Shaping of thin glass foils for the fabrication of mirrors with pronounced asphericity [8884-66]
R. Canestrari, G. Pareschi, G. Sironi, INAF - Osservatorio Astronomico di Brera (Italy); G. Toso, INAF - IASF Milano (Italy)

8884 1Y Interaction of N-FK5 and L-BAL35 optical glass with various carbide and other precision glass mold tooling [8884-90]
E. Koontz, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); P. Wachtel, Clemson Univ. (United States); J. D. Musgraves, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States), Clemson Univ. (United States), and IRradiance Glass, Inc. (United States); K. Richardson, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States) and Clemson Univ. (United States); S. Mourad, M. Huber, A. Kunz, M. Forrer, FISBA OPTIK AG (Switzerland)

POSTER SESSION

8884 20 Properties of Kummer beams in the structure of metamaterials [8884-69]
M. Marin-Suárez, Univ. EAFIT (Colombia)
Simulations and first manufacturing steps of a fully integrated WDM-element in the visible spectrum [8884-71]
S. Höll, M. Haupt, U. H. P. Fischer, Hochschule Harz (Germany)

Off-axis mirror fabrication from spherical surfaces under mechanical stress [8884-72]
R. Izazaga-Pérez, D. Aguirre-Aguirre, M. E. Percino-Zacarías, F. S. Granados-Agustín, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)

4D phase profile measurements using a single-shot phase shifting technique [8884-77]
N.-I. Toto-Arellano, Univ. Tecnológica de Tulancingo (Mexico); A. Montes-Pérez, A. Martínez García, D. Serrano-García, Ctr. de Investigaciones en Óptica, A.C. (Mexico); L. R. Castelán Olvera, J. Martínez Lozano, A. Jorge Muñoz, Univ. Tecnológica de Tulancingo (Mexico)

Wavefront measurements through optical diffraction interpretation [8884-80]
S. Bouillet, S. Chico, L. Eupherte, C. Rouyer, J. Daurios, Commissariat à l’Énergie Atomique (France)

Absolute testing of freeform lens [8884-81]
X. Jia, T. Xing, Institute of Optics and Electronics (China)

Fabrication of solid immersion lens applied to infrared microscopy to improve the spatial resolution over its diffraction limit [8884-84]
H. Sung, Korea Basic Science Institute (Korea, Republic of) and Chungnam National Univ. (Korea, Republic of); M. S. Huh, Osong Medical Innovation Foundation (Korea, Republic of); G. J. Lee, K. Lee, Korea Basic Science Institute (Korea, Republic of); Y. Kim, College of Optical Sciences, The Univ. of Arizona (United States); G. Ryu, Korea Basic Science Institute (Korea, Republic of) and Chungnam National Univ. (Korea, Republic of); S. C. Yang, Osong Medical Innovation Foundation (Korea, Republic of); K.-J. Yee, C. Park, Chungnam National Univ. (Korea, Republic of); G. Kim, Korea Basic Science Institute (Korea, Republic of) and Chungnam National Univ. (Korea, Republic of)

Slope-sensitive optical probe for freeform optics metrology [8884-85]
M. A. Echter, A. D. Keene, C. D. Roll, J. D. Ellis, Univ. of Rochester (United States)

Smart and precise alignment of optical systems [8884-88]
P. Langehanenberg, J. Heinisch, D. Stickler, TRIOPTICS GmbH (Germany)

OptiCentric lathe centering machine [8884-89]
C. Buß, J. Heinisch, TRIOPTICS GmbH (Germany)

Hexapods with fieldbus interfaces for automated manufacturing of opto-mechanical components [8884-95]
S. Schreiber, C. Muellerleile, M. Frietsch, R. Gloess, Physik Instrumente (PI) GmbH & Co. KG (Germany)

Experimental study on SPDT machining of Gallium Phosphide [8884-92]
J. Vaclavík, R. Daleček, V. Lédl, P. Psota, Institute of Plasma Physics of the ASCR, v.v.i. (Czech Republic)
Improved MRF spot characterization with QIS metrology [8884-94]
S. Westover, Univ. of Rochester (United States); C. Hall, M. DeMarco, QED Technologies, Inc. (United States)

Author Index
Conference Committee

Symposium Chairs

Julie L. Bentley, University of Rochester (United States)
Matthias Pfaff, OptoTech Optikmaschinen GmbH (Germany)

Conference Chairs

Julie L. Bentley, University of Rochester (United States)
Matthias Pfaff, OptoTech Optikmaschinen GmbH (Germany)

Conference Program Committee

Thomas Battley, New York Photonics Industry Association (United States)
Michael J. Bechtold, OptiPro Systems (United States)
Christopher T. Cotton, ASE Optics (United States)
Walter C. Czajkowski, Edmund Optics, Inc. (United States)
Thomas Danger, Schneider GmbH & Company KG (Germany)
Michael A. DeMarco, QED Technologies, Inc. (United States)
Apostolos Deslis, JENOPTIK Optical Systems, Inc. (United States)
Toshihide Dohi, OptiWorks, Inc. (Japan)
Tom Godin, Satisloh North America Inc. (United States)
Heidi Hofke, OptoTech Optical Machinery Inc. (United States)
Jay Kumler, JENOPTIK Optical Systems, Inc. (United States)
Justin J. Mahanna, Universal Photonics Inc. (United States)
Michael A. Marcus, Lumetrics (United States)
Paul Meler-Wang, AccuCoat Inc. (United States)
Ted Mooney, ITT Exelis (United States)
Richard A. Nasca, Corning Tropel Corporation (United States)
Michael N. Naselaris, Sydor Optics, Inc. (United States)
John J. Nemechek, Metrology Concepts LLC (United States)
Buzz Nesti, Naked Optics Corporation (United States)
Robert F. Novak, BAN Optical (United States)
Paul R. Tolley, Smart System Technology & Commercialization Center (United States)
Martin J. Valente, Arizona Optical Systems, LLC (United States)
Kirk J. Warden, LaCroix Optical Company (United States)
Robert Anton Wiederhold, Optimax Systems, Inc. (United States)

Session Chairs

1. Grinding and Polishing Processes I
   Matthias Pfaff, OptoTech Optikmaschinen GmbH (Germany)
2 Grinding and Polishing Processes II  
**Jessica E. DeGroote Nelson**, Optimax Systems, Inc. (United States) 

3 Grinding and Polishing Processes III  
**Michael J. Bechtold**, OptiPro Systems (United States) 

4 Optical Fabrication of Freeform Surfaces  
**Jonathan D. Ellis**, University of Rochester (United States) 

5 Metrology I  
**Paul Dumas**, QED Technologies, Inc. (United States) 

6 Plenary Session I  
**Julie L. Bentley**, University of Rochester (United States) 

7 Metrology II  
**Kate Medicus**, Optimax Systems, Inc. (United States) 

8 Optical Materials, Cleaning, and Coating  
**Dave Stephenson**, JENOPTIK Optical Systems (United States) 

9 Optical Design  
**Theodore Tienvieri**, Corning Tropel Corporation (United States) 

10 Optical Engineering  
**Christopher T. Cotton**, ASE Optics (United States) 

11 Plenary Session II  
**Julie L. Bentley**, University of Rochester (United States) 

12 Meter Class Optics  
**Ted Mooney**, ITT Exelis (United States) 

13 Molded Optics  
**Michael A. Marcus**, Lumetrics, Inc. (United States)