SPIE.OPTIFAB

TECHNICAL PROGRAM

Optifab 2019

TECHNICAL PROGRAM

Conference and Courses: 14–17 October 2019

Exhibition: 15–17 October 2019

Rochester Riverside Convention Center
Rochester, New York, USA

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OPTIFAB 2019

North America's premier optical fabrication show

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14–17 October 2019
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Contents

SPIE and APOMA would like to express their deepest appreciation to the symposium chairs, conference chairs, program committees, session chairs, and authors who have so generously given their time and advice to make this symposium possible.

The symposium would not be possible without the dedicated contribution 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.

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ADVANCING LIGHT.

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www.SPIE.org

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American Precision Optics Manufacturers Association

The American Precision Optics Manufacturers Association represents a broad constituency of precision optics manufacturers, and the supporting industry along with academic associates, whose mutual interest is the advancement and expansion of optics manufacturing and technology.

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Paul Tolley, Stretford End Solutions (USA)

Martin J. Valente, Arizona Optical Systems, LLC (USA)

Kirk J. Warden, LaCroix Precision Optics (USA

Daily Event Schedule

MONDAY • 14 October	**TUESDAY** • 15 October	
		MORNING
SESSION 1: **Advancements in Conventional Fabrication Methods** 8:30 am to 10:30 am, p. 10	SESSION 5: **Plenary Session: Building Tomorrow's Workforce Today** 8:00 am to 10:00 am	
SC863 Drawings – the ISO 10110 Standard (Aikens) 8:30 am to 12:30 pm		
SC1179 Optical Glass – Properties and Application-oriented Specification (Davis) 8:30 am to 5:30 pm		
SC690 Optical System Design: Layout Principles and Practice (Greivenkamp) 8:30 am to 5:30 pm		
	EXHIBITION — Walk the floor and see the 10:00 am to 5:00 pm	
	JOB Fair 10:00 am to 5:00 pm	
SESSION 2: **Integrating Automation and Lasers into Optics Fabrication** 11:00 am to 12:30 pm, p. 10		
		Lunch

	WEDNESDAY • 16 October	**THURSDAY** • 17 October
SESSIONS		
	SESSION 8: **Freeform Manufacturing** 8:00 am to 9:50 am	SESSION 12: **Optical Coatings** 8:00 am to 9:50 am
	SC1279 Introduction to Magnetorheological Finishing (Dumas) 8:00 am to 10:00 am	**SC1280 Measuring Precision Freeform Optics** (DeFisher) 8:00 am to 10:00 am
	APOMA General Meeting 8:30 am to 9:30 am	
	SC1040 Geometric Dimensioning and Tolerancing (Prystaj) 8:30 am to 5:30 pm	**SC1017 Optics Surface Inspection Workshop** (Aikens) 8:30 am to 12:30 pm
	SC1171 Seeing, Analyzing and Controlling Mid-Spatial Frequency (MSF) and Surface Roughness Errors on Optical Surfaces (DeGroote Nelson) 8:30 am to 12:30 pm	**SC1169 Optical Manufacturing Fundamentals** (Williamson) 8:30 am to 5:30 pm
latest in optical fabrication technologies		
	10:00 am to 5:00 pm	10:00 am to 3:00 pm
	JOB Fair 10:00 am to 5:00 pm	
	SESSION 9: **Advances in Freeform and Novel Metrology Techniques** 10:20 am to 12:00 pm	SESSION 13: **Structured Optical Surfaces** 10:30 am to 12:50 pm
Break		

Daily Event Schedule

MONDAY • 14 October	**TUESDAY** • 15 October	
		AFTERNOON
SESSION 3: **Deterministic Processing of Optics** 1:30 pm to 3:10 pm	**SC1278 Introduction to Freeform Optics: Design, Testing, and Applications** (Howard) 1:30 pm to 5:30 pm	
SC1114 The Proper Care of Optics: Cleaning, Handling, Storage and Shipping (Schalck) 1:30 pm to 5:30 pm	SESSION 6: **New Advances in Optical Materials** 1:20 pm to 3:00 pm	
	SC848 Fundamentals of Single Point Diamond Turning (Schaefer, Owen) 1:30 pm to 5:30 pm	
	SC1178 Fundamentals of Molded Optics (Symmons/Schaub) 1:30 pm to 5:30 pm	
SESSION 4: **Deterministic Finishing Processes** 3:40 to 5:30 pm	SESSION 7: **Optical Engineering** 3:30 to 5:30 pm	
	20th Annual Photonics Clambake 5:30 pm to 9:00 pm	

	WEDNESDAY • 16 October	**THURSDAY** • 17 October
SESSIONS		
	SESSION 10: **Surface Roughness and Optical Alignment** 1:00 pm to 2:20 pm	
	SC1224 Fundamentals of Optical Engineering (Vogt) 1:30 pm to 3:30 pm	
	SESSION 11: **Mid-spatial Frequency and Wavefront Error Measurement Methods** 3:00 pm to 4:30 pm	
	SC700 Understanding Scratch and Dig Specifications (Aikens) 1:30 pm to 5:30 pm	
	Networking Reception and Poster Viewing 5:00 to 6:30 pm	

PLENARY SESSION

Building Tomorrow's Workforce Today

Tuesday 15 October 2019 • 8:30 AM - 10:00 AM
Location: Highland A

8:30 AM:

Alexis Vogt, Monroe Community College (USA)

Our precious engineers are increasingly disabled by a shortage of optics technicians. What can be done?

Our global optics, photonics, and imaging industry is growing, but we have a worldwide shortage of optics technicians. Engineers are being called upon to do the work of optics technicians. Monroe Community College, the United States' only community college awarding associate degrees in precision optics, is educating diverse optics and photonics technicians and working to increase the number of highly skilled optics technicians around the country.

8:45 AM:

Berndt Zingrebe, Sill Optics GmbH & Co. KG (Germany)

Apprenticeship for optics workman

A dual apprenticeship system has been launched in Germany in order to develop young people into skilled technicians. The practical training is organized by the production companies. The theoretical portion is managed by the Technic-School for apprentices (Beruf-Schule), and controlled by the IHK (Chamber of Commerce) in accordance with government law. The contract for the apprenticeship is signed for 3.5 years between the partners. Apprentices learn about the manufacturing techniques for optical glass for lenses, prisms, filters et cetera by grinding, polishing, centering, cementing and coating. Apprentices are tested on manufacturing techniques mid-way and a final test is administered by the Technic -Schools. After the apprentice has successfully finished both tests a certificate as a skilled workman (Facharbeiter) is awarded. This certificate (Facharbeiter-Brief) opens several ways to further jobs, like floor-shop- manager. Graduates are also eligible to further their studies through engineering programs.

9:00 AM:

James VanKouwenberg, Optimax Systems, Inc. (USA)

Apprenticeship: Precision optics manufacturing technician

As U.S. manufacturing works to overcome a technical skills gap, apprenticeship is gaining favor as a path to a successful career. This paper describes how an Occupation Title was defined for the industry, and approved by the Federal Department of Labor. The occupation was later deemed apprenticeable by the DOL, and the apprenticeship was registered with NY State. Being a federally recognized occupation allows the trade to be registered for apprenticeship in all 50 states. In this program, structured, hands on technical training with an employer is combined with theoretical class room learning to develop highly skilled manufacturing technicians. We will discuss the process of developing and deploying the program, and share outcomes from the first three years of operation.

9:15 AM:

Panel Discussion

9:50 AM:
CLOSING REMARKS:
What is the most important thing that the optics community can do today to build tomorrow's workforce?

Special Events

Joint SPIE IR Materials Working Group and ASCOP TF6 IR Materials Standards Meeting

Tuesday 15 October 2019 • 8:00 AM - 10:00 AM
Location: Highland G

The Optics and Electro-Optics Standards Council (OEOSC) and the SPIE IR Materials Standards Working Group have joined efforts in the development of new infrared materials standards and data. The Accredited Standards Committee for Optics (ASC-OP), which operates under the supervision of the OEOSC, created a subcommittee called Task Force 6, Infrared Materials. The SPIE created the Infrared Materials Working Group (IRMWG). Together, these committees are developing standards for infrared materials that will be published as American National Standards. In the future, these domestic standards may serve as starting points for ISO standards, too. Participation is open to all registered attendees, and any person or organization with an interest in the topic of infrared materials. Currently, the Committees are working on the establishment of several IR standards and of high-accuracy, standard values for the refractive index of different IR materials.

OFB Exhibition Opening - Ribbon-Cutting Ceremony

Tuesday 15 October 2019 • 9:45 AM - 10:00 AM
Location: Exhibition Hall entrance

SPIE Job Fair

Tuesday 15 October 2019 • 10:00 AM - 5:00 PM

Wednesday 16 October 2019 • 10:00 AM - 5:00 PM

Location: Exhibition Hall

Happy Hour at SPIE Booth #514

Tuesday 15 October 2019 • 4:00 PM - 5:00 PM

Enjoy a beer or wine on us at the SPIE Booth #514. Come chat and see what SPIE can do for you.

21st Annual Photonics Clambake

Tuesday 15 October 2019 • 5:30 PM - 9:00 PM

Location: Hyatt Ballroom

Tickets are sold separately Attendees and Exhibitors are welcome to attend.
Limited space available.
Contact Matthew Sydor, Sydor Optics, Inc. via email at **Matthew@sydor.com** to inquire about tickets.

PRESENTED BY:

SYDOR OPTICS

APOMA General Meeting

Wednesday 16 October 2019 • 8:30 AM - 9:30 AM
Location: Highland E/F

APOMA General Meeting, all Members and potential members are welcome to attend.

Networking Reception and Poster Session

Wednesday 16 October 2019 • 5:00 PM - 6:30 PM
Location: Galleria

Symposium attendees are invited to attend the Poster/Networking Reception on Wednesday evening. Authors of poster papers will be present during the Poster Session from 4:30 to 6:00 pm to answer questions concerning their papers. The reception provides an opportunity for attendees to meet with colleagues, network, view poster papers, and interact with the authors. Refreshments will be served. Attendees are required to wear their conference badges to this session.

DAILY SCHEDULE
Poster Set Up - Beginning at 10:00
Extended Poster Viewing from 10:00 to 4:30
Poster Session and Reception from 5:00 to 6:30 (with authors present)

POSTER AUTHOR SET-UP INSTRUCTIONS
Paper numbers will be included on the poster boards in numerical order; please find your paper number and display your poster in the designated space. Authors are encouraged to display their posters early in the day for extended viewing. A poster author or coauthor is required to stand by the poster during the scheduled poster session to answer questions from attendees. Presenters who have not displayed their posters on their assigned board at least one-half hour before the interactive poster session begins will be considered a "no show". Please remove posters at the end of the poster session. Posters not removed will be considered unwanted and will be discarded.

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LUMINATE ACCELERATOR TOUR

Wednesday 16 October 2019 • 6:15 PM - 8:30 PM

Please join Luminate for an interactive experience at NextCorps. Get a glimpse at the activities that are defining Rochester's Innovation Zone and how the Luminate accelerator is helping startups bring the most novel optics-, photonics-, and imaging-enabled applications to the market. Drinks and heavy hors d'oeuvres will be served (as well as fun!).

Tickets are limited due to venue size. RSVP at https://bit.ly/2kq84yg

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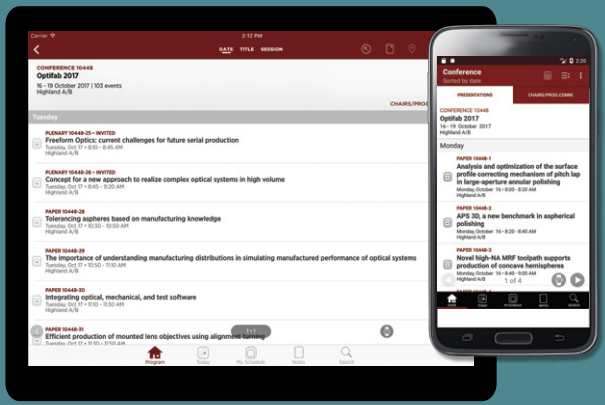

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OPTIFAB EXHIBITION

EXHIBITION DAYS AND TIMES

Empire Hall

Tuesday 15 October . . . . . .10:00 am to 5:00 pm
Wednesday 16 October . . . . . .10:00 am to 5:00 pm
Thursday 17 October . . . . . .10:00 am to 3:00 pm

Experience North America's premier optical fabrication show

Come walk the floor at North America's largest optical fabrication exhibition. Your badge will give you access to over 180 leading companies. Take advantage of this valuable opportunity to learn new methods, improve your processes, cut costs, and discuss your requirements face-to-face.

Product Demos

Learn new possibilities at these in-booth sessions, which are free to all attendees. Exhibiting companies will be showcasing products in half-hour demonstrations.

Thursday 17 October 2019 • Exhibition Hall

10:30 AM

SUPERIOR POLISHING AND ULTRA-PRECISE MACHINING

Schneider Optical Machines Inc. • Booth 1021
Daniel Gauch

The Schneider team presents its ultra-precise single point diamond turning center UPC 300 and the high-quality aspherical lens polisher ALP 120.

PROSURF FREEFORM CAM SOFTWARE

OptiPro Systems • Booth 820
Frank Wolfs

The flexibility and power of the freeform CAM package PROSurf will be demonstrated. Come see how PROSurf can benefit your freeform manufacturing process.

11:00 AM

SPO80 CNC ASPHERE POLISHING

OptoTech Optical Machinery Inc. • Booth 323
Lars Burghardt

OptoTech's SPO 80 CNC is the ideal low cost version of a high speed CNC polisher. Designed for spherical optics between (2)5 and (2)80 mm in diameter, it can be upgraded to incorporate our patented HydroSpeed technology as well as aspheric capability. With the Aspheric upgrade, the machine also includes our patented Active Fluid Jet Polishing Technology (A-FJP), the ability to use FEM tools, as well as our patented Advanced Wheel Polishing Technology (A-WPT). Come see a demonstration of aspheric processing at our Booth #323.

USING MRF FOR SMALL, HIGHER ORDER SURFACE CORRECTIONS

QED Technologies • Booth 621
Bruce S. Forman

In this presentation we will share our latest 10 mm wheel MRF polishing tool for correcting mid spatial frequencies and making corrections on small, concave radius parts less than 10 mm.

LATEST ADVANCEMENTS IN THIN GLASS METROLOGY

Zygo Corporation • Booth 423
Tyler Steele

Demonstration of precise optical metrology solutions for thin glass manufacturing and advanced applications, including simultaneous measurement of surface form and thickness.

11:30 AM

DZM 20 CNC CENTERING MACHINE FOR MICRO OPTICS

OptoTech Optical Machinery Inc. • Booth 323
Lars Burghardt

OptoTech is introducing it's new DZM 20 CNC Centering Machine to the US market. The DZM 20 CNC is a compact and easy to operate CNC controlled centering machine, especially designed for super micro or endoscopic optics. Clamping can be done manually or via CNC controller, using traditional clamping bell technology or an HD 12 runner. With 2 CNC axes and 1 clamping axis in a horizontal configuration, this versatile machine is able to perform multiple grinding operations as well as CT measurement and compensation. It can be used for edging diameters, chamfers, steps and plunge cutting. Please visit the OptoTech Booth #323 to see a demonstration of this new machine.

3D OPTICAL PROFILING FOR OPTICS PRODUCTION

Zygo Corporation • Booth 423
Eric Felkel

A demonstration of the latest advancements in non-contact measurement and characterization of surface texture and micro-topography in production applications.

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STUDENT DAY

Thursday, 17 October

Welcome, students

All students and accompanying adults are welcome to participate in the program.

SCHEDULE

7:30 am–3:00 pm	Onsite Registration and Badge Pickup Hours
10:00–10:30 am	Introduction by industry leaders
10:30 am–12:00 pm	Walk the floor and view demos
12:00–1:00 pm	Free pizza lunch— Must register by 4 October*
	Sponsored by **The Institute of Optics, Univ. of Rochester**

**To be included in the pizza lunch, you had to be registered for the student program by 4 October.*

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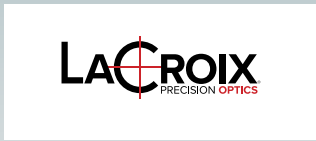
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MONDAY

The Proper Care of Optics: Cleaning, Handling, Storage and Shipping

SC1114 • 1:30 PM - 5:30 PM • Course Level: Introductory
Instructor: **Robert Schalck,** Consultant (USA)
$435.00 Members • $495.00 Non-members • $273.00 Student Member

Optical Glass – Properties and Application-oriented Specification

SC1179 • 8:30 AM - 5:30 PM • Course Level: Intermediate
Instructor: **Mark J. Davis,** SCHOTT North America, Inc. (USA)
$700.00 Members • $790.00 Non-members • $391.00 Student Member

Optical System Design: Layout Principles and Practice

SC690 • 8:30 AM - 5:30 PM • Course Level: Introductory
Instructor: **John E. Greivenkamp,** James C. Wyant College of Optical Sciences (USA)
$690.00 Members • $780.00 Non-members • $387.00 Student Member

Introduction to Modern Optical Drawings – the ISO 10110 Standard

SC863 • 8:30 AM - 12:30 PM • Course Level: Introductory
Instructor: **David M. Aikens,** Savvy Optics (USA)
$390.00 Members • $450.00 Non-members • $255.00 Student Member

TUESDAY

Fundamentals of Molded Optics

SC1178 • 1:30 PM - 5:30 PM • Course Level: Introductory
Instructors: **Alan Symmons,** LightPath Technologies, Inc. (USA); **Michael Schaub**, Facebook Technologies, LLC (USA)
$425.00 Members • $485.00 Non-members • $269.00 Student Member

Introduction to Freeform Optics: Design, Testing, and Applications NEW

SC1278 • 1:30 PM - 5:30 PM • Course Level: Introductory
Instructor: **Joseph M. Howard,** NASA Goddard Space Flight Ctr. (USA)
$390.00 Members • $450.00 Non-members • $255.00 Student Member

Fundamentals of Single Point Diamond Turning

SC848 • 1:30 PM - 5:30 PM • Course Level: Introductory
Instructors: **John P. Schaefer,** Raytheon EO Innovations (USA); **Joseph Owen,** Raytheon (USA)
$390.00 Members • $450.00 Non-members • $255.00 Student Member

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We are confident that once you experience an SPIE course for yourself you will look to us for your future education needs. However, if for any reason you are dissatisfied, we will gladly refund your money. We just ask that you tell us what you did not like; suggestions for improvement are always welcome.

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SPIE is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU.

WEDNESDAY

Geometric Dimensioning and Tolerancing
SC1040 • 8:30 AM - 5:30 PM • Course Level: Introductory
Instructor: **Walt Prystaj,** PEN Associates, LLC (USA)
$655.00 Members • $745.00 Non-members • $373.00 Student Member

Seeing, Analyzing and Controlling Mid-Spatial Frequency (MSF) and Surface Roughness Errors on Optical Surfaces
SC1171 • 8:30 AM - 12:30 PM • Course Level: Introductory
Instructor: **Jessica DeGroote Nelson,** Optimax Systems, Inc. (USA)
$390.00 Members • $450.00 Non-members • $255.00 Student Member

Fundamentals of Optical Engineering
SC1224 • 1:30 PM - 3:30 PM • Course Level: Introductory
Instructor: Alexis K. S. Vogt, Monroe Community College (USA)
$260.00 Members • $285.00 Non-member • $189.00 Student Member s

Understanding Scratch and Dig Specifications
SC700 • 1:30 PM - 5:30 PM • Course Level: Introductory
Instructor: **David M. Aikens,** Savvy Optics (USA)
$390.00 Members • $450.00 Non-members • $255.00 Student Member

COURSE FOR TECHNICIANS
Introduction to Magnetorheological Finishing NEW
SC1279 • 8:00 AM - 10:00 AM • Course Level: Introductory
Instructor: **Paul Dumas,** QED Technologies, Inc. (USA)
$260.00 Members • $285.00 Non-members • $189.00 Student Member

THURSDAY

Optics Surface Inspection Workshop
SC1017 • 8:30 AM - 12:30 PM • Course Level: Introductory
Instructor: **David M. Aikens,** Savvy Optics (USA)
$490.00 Members • $550.00 Non-members • $295.00 Student Member

Optical Manufacturing Fundamentals
SC1169 • 8:30 AM - 5:30 PM • Course Level: Introductory
Instructor: **Ray Williamson,** Ray Williamson Consulting (USA)
$685.00 Members • $775.00 Non-members • $385.00 Student Member

COURSE FOR TECHNICIANS
Measuring Precision Freeform Optics NEW
SC1280 • 8:00 AM - 10:00 AM • Course Level: Introductory
Instructor: **Scott DeFisher,** OptiPro Systems, LLC (USA)
$260.00 Members • $285.00 Non-members • $189.00 Student Member

Conference 11175

Monday–Thursday 14–17 October 2019
• Proceedings of SPIE Vol. 11175

Optifab 2019

Conference Chairs: **Blair L. Unger,** Rochester Precision Optics, LLC (USA); **Jessica DeGroote Nelson,** Optimax Systems, Inc. (USA)

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MONDAY 14 OCTOBER

SESSION 1

ROOM: HIGHLAND A/B . . . . . MON 8:30 AM TO 10:30 AM

Advancements in Conventional Fabrication Methods

Session Chair: **Blair L. Unger,** Rochester Precision Optics, LLC

8:30 am: **Creating sub angstrom surfaces on planar and spherical substrates**, Jayson J. Nelson, Shawn M. Iles, Edmund Optics Inc. (USA) . . . . . [11175-1]

8:50 am: **A method to discriminate between upper and lower side material removal in double-side polishing**, Cedric Maunier, Melanie Redien, Benoit Da Costa Fernandes, Jerome Neauport, CEA (France) . . . . . [11175-2]

9:10 am: **Three-dimensional configurable IC Optic material for precision CNC optical polishing**, William Gemmill, Eminess Technologies, Inc. (USA); Terry Knight, Nicholas Kraft, Tony R Martin, Eminess Technologies (USA) . . . . . [11175-3]

9:30 am: **Subsurface damage measurement of single crystal germanium and borosilicate glass BK-7**, Jing Xu, Univ. of Rochester (USA); Lauren Taylor, Jie Qiao, Chester F. Carlson Ctr. for Imaging Science, Rochester Institute of Technology (USA); Michael Pomerantz, John C. Lambropoulos, Univ. of Rochester (USA) . . . . . [11175-4]

9:50 am: **Automated polishing of partially concealed surfaces for x-ray crystal optics**, Elina Kasman, Jonathan Montgomery, Sunil Bean, XianRong Huang, Lahsen Assoufid, Argonne National Lab. (USA)[11175-5]

10:10 am: **Particle distribution characterization on material removal uniformity in chemical mechanical polishing**, Shijie Zhao, Ruiqing Xie, Defeng Liao, Xianhua Chen, Qinghua Zhang, Jian Wang, Qiao Xu, Research Ctr. of Laser Fusion, China Academy of Engineering Physics (China) . . . . . [11175-6]

Coffee Break . . . . . Mon 10:30 am to 11:00 am

SESSION 2

ROOM: HIGHLAND A/B . . . . . MON 11:00 AM TO 12:30 PM

Integrating Automation and Lasers into Optics Fabrication

Session Chair: **Matthew J. Brunelle,** Optimax Systems, Inc.

11:00 am: **Robotic polishing in manufacturing**, Michael Rinkus, Optimax Systems, Inc. (USA). . . . . .[11175-7]

11:20 am: **Autonomous fabrication of optics**, Roland Mandler, OptoTech Optikmaschinen GmbH (Germany). . . . . .[11175-8]

11:40 am: **Ultra precision glass machining through ultrasonic assisted diamond turning**, Benjamin Bulla, Olaf Dambon, son-x GmbH (Germany) . . . . . .[11175-9]

12:00 pm: **High speed ultraprecision machining of germanium**, Hossein Shahinian, Jayesh A. Navare, Charan Bodlapati, Dmytro Zaytsev, Di Kang, Deepak Ravindra, Micro-LAM, Inc. (USA) . . . . . .[11175-10]

12:20 pm: **Micro-laser assisted single point diamond turning of fused silica glass**, Hossein Shahinian, Jayesh A. Navare, Dmytro Zaytsev, Charan Bodlapati, Di Kang, Deepak Ravindra, Micro-LAM, Inc. (USA). . . . . [11175-11]

Lunch Break . . . . . Mon 12:30 pm to 1:30 pm

SESSION 3

ROOM: HIGHLAND A/B . . . . . MON 1:30 PM TO 3:10 PM

Deterministic Processing of Optics

Session Chair: **Dan Gauch,** Schneider Optical Machines Inc.

1:30 pm: **The dynamics of grinding glass with Trizact™ diamond tile**, John A. Gagliardi, Vincent Romero, 3M Co. (USA). . . . . .[11175-12]

1:50 pm: **Precision machining of strong aspheres made of calcium fluoride and fused silica**, Olaf Schmelzer, Thomas Waak, Felix Lucas, JENOPTIK Optical Systems GmbH (Germany). . . . . .[11175-13]

2:10 pm: **Material removal for small compressions on fused silica on an OptiPro UltraForm Finishing Machine**, Noah Leibowitz, John C. Lambropoulos, Michael Pomerantz, Univ. of Rochester (USA) . .[11175-14]

2:30 pm: **Ultra-precision robotic sub-aperture polishing of Schmidt corrector**, Songlin Wan, Chaoyang Wei, Jianda Shao, Shanghai Institute of Optics and Fine Mechanics (China). . . . . .[11175-15]

2:50 pm: **Fabrication of continuous phase plates based on bonnet polishing**, Bo Zhong, Xianhua Chen, Wenhui Deng, Nan Zheng, Shenglin Wen, China Academy of Engineering Physics (China) .[11175-16]

Coffee Break. . . . . Mon 3:10 pm to 3:40 pm

SESSION 4

ROOM: HIGHLAND A/B . . . . . .MON 3:40 PM TO 5:30 PM

Deterministic Finishing Processes

Session Chair: **Kirk J. Warden,** LaCroix Precision Optics

3:40 pm: **Wavefront improvement by IBF-processed correction surfaces**, Roman Feldkamp, JENOPTIK Optical Systems GmbH (Germany) . . . . . .[11175-24]

4:00 pm: **Study on the performances of dwell time algorithms in ion beam figuring**, Tianyi Wang, Lei Huang, Kashmira Tayabaly, Mourad Idir, Brookhaven National Lab. (USA) . . . . . .[11175-26]

4:20 pm: **Extending magnetorheological finishing to address high precision short radius concave surfaces and mid-spatial frequency errors**, Chris Maloney, Bill Messner, QED Technologies, Inc. (USA) . . . . . .[11175-28]

4:40 pm: **Accounting for MRF® spot removal rate variation caused by plunge depth deviation**, Stephen M. Watson, Chris Hall, Mike DeMarco, QED Optics (USA). . . . . .[11175-30]

5:00 pm: **Polishing of ultra-precision ground aspherical surfaces with MRF**, Armin Rumpel, Thomas Ruppel, SwissOptic AG (Switzerland) . . . . . .[11175-32]

5:20 pm: **New meter-class MRF platforms offer multiple size and capability options**, Chris Maloney, Paul Dumas, QED Technologies, Inc. (USA) . . . . . .[11175-34]

TUESDAY 15 OCTOBER

SESSION 5

ROOM: HIGHLAND A/B . . . . . .TUE 8:30 AM TO 10:00 AM

Plenary Session: Building Tomorrow's Workforce Today

Session Chair: **Jessica DeGroote Nelson,** Optimax Systems, Inc.

8:00 am: **Precision optics manufacturing apprenticeship** *(Invited Paper)*, James VanKouwenberg, Optimax Systems, Inc. (USA). . . . . [11175-17]

Coffee Break. . . . . .Tue 10:00 am to 10:30 am

EXHIBIT VIEWING

ROOM: HIGHLAND A/B . . . . . .10:30 AM TO 12:00 PM

Lunch Break . . . . . .Tue 12:00 pm to 1:20 pm

SESSION 6

ROOM: HIGHLAND A/B . . . . . TUE 1:20 PM TO 3:00 PM

New Advances in Optical Materials

Session Chair: **Nicholas Billis,** Ohara Corp.

1:20 pm: **Negative thermal expansion ALLVAR alloys for athermalization**, James A. Monroe, Jeremy S. McAllister, Jay Zgarba, David Squires, ALLVAR (USA); John P. Deegan, Rochester Precision Optics, LLC (USA). . . . . .[11175-18]

1:40 pm: **Defect-free crystal optics: the impact of polishing and fabrication methods on lattice defects, strain, flatness, and roughness**, Elina Kasman, XianRong Huang, Jun Qian, Michael Wieczorek, Lahsen Assoufid, Argonne National Lab. (USA) . . . .[11175-19]

2:00 pm: **Analysis of the effects of laser powder bed fusion process for developing high strength material**, Md Salah Uddin, Brahmananda Pramanik, Montana Tech (USA). . . . . .[11175-20]

2:20 pm: **Index of refraction change in commercially available chalcogenide glasses due to precision glass molding**, George P. Lindberg, John P. Deegan, Peter F. Wachtel, Arie C. Beckens, J. David Musgraves, Jamie L. Ramsey, W. David Schmidt, Rochester Precision Optics, LLC (USA) . . . . . .[11175-21]

2:40 pm: **Intelligent material design for infrared optics**, J. David Musgraves, George P. Lindberg, Peter F. Wachtel, John P Deegan, Rochester Precision Optics, LLC (USA). . . . . .[11175-22]

Coffee Break. . . . . Tue 3:00 pm to 3:30 pm

SESSION 7

ROOM: HIGHLAND A/B . . . . . TUE 3:30 PM TO 4:30 PM

Optical Engineering

Session Chair: **Jamie L. Ramsey,** Rochester Precision Optics, LLC

3:30 pm: **Design, simulation and manufacturing a CFRP prototype mirror for active/adaptive optics**, Hadi Baghsiahi, Peter Doel, David Brooks, Univ. College London (United Kingdom); Martyn Jones, Glyndwr Univ. (United Kingdom) . . . . . .[11175-23]

3:50 pm: **A comparison study of laser based additive manufacturing techniques applied to chalcogenide glass**, Peter F. Wachtel, J. David Musgraves, George P. Lindberg, John P. Deegan, Rochester Precision Optics, LLC (USA). . . . . .[11175-31]

4:10 pm: **Conceptual design of ground-based Twenty Meter Telescope based on SiC mirrors**, Fei Yang, Haifeng Cao, Peng Guo, Haibo Jiang, Wenqiang Fan, Changchun Institute of Optics, Fine Mechanics and Physics (China); Jing Zhang, Changchun Univ. of Science and Technology (China); Xuejun Zhang, Changchun Institute of Optics, Fine Mechanics and Physics (China). . . . . .[11175-33]

WEDNESDAY 16 OCTOBER

SESSION 8

ROOM: HIGHLAND A/B . . . . . WED 8:00 AM TO 9:50 AM

Freeform Manufacturing

Session Chair: **Scott DeFisher,** OptiPro Systems, LLC

8:00 am: **Freeform testability considerations for subaperture stitching interferometry**, Paul E. Murphy, Christopher Supranowitz, QED Technologies, Inc. (USA) . . . . . .[11175-35]

8:20 am: **Definitions of criteria for assessing feasibility and measurability of freeform surfaces**, Julien Fourez, Christian du Jeu, Hassan El Handrioui, Matthieu Gilles, Thales SESO S.A.S. (France) . . . . . .[11175-36]

8:40 am: **Advances in freeform manufacturing**, Frank L. Wolfs, James Ross, Scott DeFisher, OptiPro Systems, LLC (USA). . . . .[11175-37]

8:50 am: **Near-conformal window assembly for airborne payloads: improved time on-station and optical performance**, Keith M. Hinrichs, Christopher D. Roll, MIT Lincoln Lab. (USA); Joel D. Berkson, College of Optical Sciences, The Univ. of Arizona (USA); Thomas Sebastian, MIT Lincoln Lab. (USA) . . . . . .[11175-38]

9:10 am: **Measurement of form and mid-spatial-frequency errors of specular freeform surfaces**, Tobias Binkele, David Hilbig, Mahmoud Essameldin, Friedrich Fleischmann, Thomas Henning, Hochschule Bremen Univ. of Applied Sciences (Germany); Walter Lang, Univ. Bremen (Germany) . . . . . .[11175-39]

9:30 am: **Scaling-up freeform manufacturing: challenges and solutions**, Jennifer Coniglio, Matthew J. Brunelle, Ian Ferralli, Brian W. Myer, Timothy P. Lynch, Todd F. Blalock, Nick Quattrocioccchi, Jessica DeGroote Nelson, Optimax Systems, Inc. (USA) . . . . . .[11175-40]

Coffee Break. . . . . Wed 9:50 am to 10:20 am

SESSION 9

ROOM: HIGHLAND A/B . . . . . WED 10:20 AM TO 11:40 AM

Advances in Freeform and Novel Metrology Techniques

Session Chair: **Edward Fess,** OptiPro Systems, LLC

10:20 am: **Advancements in non-contact freeform metrology with datum structures**, Scott DeFisher, James Ross, OptiPro Systems, LLC (USA) . . . . . [11175-41]

10:40 am: **Advantages of a low coherence interferometer for optical testing**, Chris L. Koliopoulos, Klaus Freischlad, InterOptics, LLC (USA) . . . . . [11175-43]

11:00 am: **Low measurement uncertainty radius measurement in low cost set up**, Chase Salsbury, Artur Olszak, Äpre Instruments, LLC (USA); Robert Smythe, Äpre Instruments (USA). . . . . [11175-44]

11:20 am: **Multi-wavelength large optics wavefront error measurement in the SWIR range**, Valentin D. Genuer, PHASICS Corp. (USA) . . . . . [11175-45]

Lunch Break . . . . . Wed 11:40 am to 1:00 pm

SESSION 10

ROOM: HIGHLAND A/B . . . . . WED 1:00 PM TO 2:20 PM

Surface Roughness and Optical Alignment

Session Chair: **Matthias Pfaff,** OptoTech Optikmaschinen GmbH

1:00 pm: **Sub-angstrom surface roughness metrology with the white light interferometer**, Shawn M. Iles, Jayson J. Nelson, Edmund Optics Inc. (USA) . . . . . [11175-46]

1:20 pm: **Measurement of surface roughness of the fractured surface by using optical technology**, Md Salah Uddin, Montana Tech (USA) . . . . . [11175-47]

1:40 pm: **Rotation-free centration measurement for fast and flexible inspection of optical lens systems**, Patrik Langehanenberg, Felix Hahne, Josef Heinisch, TRIOPTICS GmbH (Germany) . . . . [11175-48]

1:50 pm: **Novel active alignment technique for measuring tilt errors in aspheric surfaces during optical assembly using Lens Alignment Station (LAS)**, Mark E. Green, Ron Garden, Opto-Alignment Technology, Inc. (USA) . . . . . [11175-49]

2:00 pm: **Beyond centration: how to create, read, and use a datum system per ISO-10110-6 (2015)**, Ray Williamson, Ray Williamson Consulting (USA) . . . . . [11175-50]

Coffee Break. . . . . Wed 2:20 pm to 3:00 pm

SESSION 11

ROOM: HIGHLAND A/B . . . . . .WED 3:00 PM TO 4:30 PM

Mid-spatial Frequency and Wavefront Error Measurement Methods

Session Chair: **John Nemechek,** Metrology Concepts LLC

3:00 pm: **Analysis of mid-spatial frequency errors in two dimensions at metal mirror fabrication**, Tom Pertermann, Matthias Beier, Johannes Hartung, Fraunhofer-Institut für Angewandte Optik und Feinmechanik IOF (Germany); Herbert Gross, Institut für Angewandte Physik, Friedrich-Schiller-Univ. Jena (Germany). . . . . .[11175-51]

3:20 pm: **Full-field deflectometry for detection of mid-spatial frequency errors of high-precision mirrors**, Philippe Antoine, Luc Boussemaere, Arno Bouwens, LAMBDA-X sa (Belgium); Vincent Moreau, Benoit Borguet, Ksenia Sharshavina, AMOS Ltd. (Belgium) . . . .[11175-52]

3:40 pm: **Large dynamic range wavefront error metrology bench**, Valentin D. Genuer, PHASICS Corp. (USA) . . . . . .[11175-53]

4:00 pm: **Quality measurements of high NA optical objectives**, David Compertore, Donald Gibson, Lumetrics, Inc. (USA); Russ Hudyma, Navitar Inc. (USA); Filipp V. Ignatovich, Lumetrics, Inc. (USA) . . .[11175-54]

4:10 pm: **Measurement of a concave spherical mirror with 50 mm radius of curvature by three dimensional nanoprofiler using normal vector tracing**, Yui Toyoshi, Kota Hashimoto, Jungmin Kang, Katsuyoshi Endo, Osaka Univ. (Japan) . . . . . .[11175-55]

NETWORKING RECEPTION AND POSTER SESSION

ROOM: GALLERIA . . . . . .WED 5:00 PM TO 6:30 PM

Symposium attendees are invited to attend the Poster/Networking Reception on Wednesday evening. The reception provides an opportunity for attendees to meet with colleagues, network, view poster papers, and interact with the authors. Refreshments will be served.

Attendees are required to wear their conference registration badges.

The Growth of ZnO nanostructure arrays by using hydrothermal method for enhance the sensing ability, Heesang Ahn, Tae Young Kang, Hyerin Song, Kyujung Kim, Pusan National Univ. (Korea, Republic of) . . . . . .[11175-69]

A rapid extrinsic calibration method for multiple probing systems operation in coordinate measuring machines, Sen Zhou, Jian Xu, Chongqing Institute of Metrology and Quality Inspection (China). . . . . .[11175-70]

Silicone grating fabricated using photoresist mold, Itsunari Yamada, Setsunan Univ. (Japan); Yusuke Ikeda, Univ. of Shiga Prefecture (Japan). . . . . [11175-71]

Converging mechanism and deterministic control of surface figure in the full-aperture polishing process, Defeng Liao, China Academy of Engineering Physics (China). . . . . [11175-72]

An effective way to calibrate the external errors which are contributed in the interferometric test for spherical surfaces, Wei-Cheng Lin, Shenq-Tsong Chang, Hung-Pin Chen, Yu-Wei Lin, Hua-Lin Chen, Taiwan Instrument Research Institute (Taiwan); Cheng-Kuo Sung, National Tsing Hua Univ. (Taiwan). . . . . [11175-73]

Experimental investigation on processing of fused silica microchannels by high repetition rate femtosecond laser, Kai Liao, Wenjun Wang, Xuesong Mei, Bin Liu, Aifei Pan, Xi'an Jiaotong Univ. (China) . . . . . [11175-74]

Micro-structures with structural colors produced by femtosecond laser two-photon polymerization, Xiaoyun Sun, Wenjun Wang, Xuesong Mei, Aifei Pan, Xi'an Jiaotong Univ. (China) . . . . . [11175-75]

Study of thermal deformation monitoring system with long short term memory network in alignment turning system, Chung-Ying Wang, Chien-Yao Huang, Jung-Hsing Wang, Jun-Cheng Chen, Wei-Cheng Lin, Fong-Zhi Chen, Taiwan Instrument Research Institute (Taiwan) . . . . . [11175-76]

Assembly of inorganic oxide nanorods for mesomorphic ceramics, Wenshi Zhang, Xinquan Cheng, Mitchell Anthamatten, Shaw H. Chen, Univ. of Rochester (USA) . . . . . [11175-78]

Optomechanics, assembly, and alignment of endoscopic optical systems in the < 1.5mm regime, David Vega, Jennifer K. Barton, Gabriella Romano, Kelli Kiekens, Dominique B. Galvez, The Univ. of Arizona (USA) . . . . . [11175-79]

Development of a reflective spiral phase plate based on MRF polishing, Min Woo Jeon, Sangwon Hyun, Korea Basic Science Institute (Korea, Republic of); Seok-Kyeong Jeong, Jong-Gyun Kang, Woojong Yeo, Korea Basic Science Institute (Korea, Republic of) and Chungnam National Univ. (Korea, Republic of); Geon-Hee Kim, Korea Basic Science Institute (Korea, Republic of) . . . . . [11175-80]

Vertical hybrid nanoantenna arrays with SiO_2 nanopillars array capped an Au nandisk for extreme light localization in plasomon-based fluorescence imaging, Soojung Kim, Hyerin Song, Heesang Ahn, Tae Young Kang, Taeyeon Kim, Seunghun Lee, Kyujung Kim, Pusan National Univ. (Korea, Republic of) . . . . . [11175-81]

THURSDAY 17 OCTOBER

SESSION 12

ROOM: HIGHLAND A/B . . . . . THU 8:00 AM TO 9:50 AM

Optical Coatings

Session Chair: **Thomas Battley,**
New York Photonics Industry Association

8:00 am: **Innovations in thin-film coatings and process equipment for polymer optics**, Dane Clark, Satisloh North America Inc. (USA)[11175-56]

8:20 am: **Optical films of glassy cholesteric liquid crystal for simultaneous selective wavelength reflection and circular dichroism**, Mitchell Anthamatten, Shaw H. Chen, Univ. of Rochester (USA) . . . . . .[11175-57]

8:40 am: **Large-scale freeform surface ultra-thin film coating uniformity measurement based on dynamic spectroscopic ellipsometer**, Daesuk Kim, Vamara Dembele, Chonbuk National Univ. (Korea, Republic of) . . . . . .[11175-58]

9:00 am: **Hybrid broadband optical endpoint monitoring with virtual deposition system**, Michael Chesaux, Dino Deligiannis, IntIvac (Canada) . . . . . .[11175-59]

9:20 am: **Update on optics manufacturing for directed energy applications**, Paul Doerner, Optimax Systems, Inc. (USA) . . . . .[11175-60]

9:30 am: **Influence of ion assistance on optical properties, residual stress and laser induced damage threshold of HfO_2 thin film by use of different ion sources**, Feng Pan, Jian Wang, Yaowei Wei, Chengdu Fine Optical Engineering Research Ctr. (China) . . . . . .[11175-61]

Coffee Break. . . . . .Thu 9:50 am to 10:30 am

SESSION 13

ROOM: HIGHLAND A/B . . . . . THU 10:30 AM TO 12:50 PM

Structured Optical Surfaces

Session Chair: **Dhananjay Joshi,** Clemson Univ.

10:30 am: **Microlens array based three-dimensional light field projection and possible applications in photolithography**, Hongjie Zhang, Sy-Bor Wen, Texas A&M Univ. (USA) . . . . . .[11175-62]

10:50 am: **A comparative study of various structures fabricated by transmitted light and diffracted light with gap distance control**, Taeyeon Kim, Heesang Ahn, Hyerin Song, Pusan National Univ. (Korea, Republic of); Jong-ryul Choi, Medical Device Development Ctr., Daegu-Gyeongbuk Medical Innovation Foundation (Korea, Republic of); Kyujung Kim, Pusan National Univ. (Korea, Republic of) . . . . . .[11175-63]

11:10 am: **Reversible nano lithography between materials**, Jae Hong Park, National Nanofab Ctr. (Korea, Republic of) . . . . . .[11175-64]

11:30 am: **Multi-functional immersion grating by homemade freeform cutting machine**, Takashi Sukegawa, Yukinobu Okura, Canon Inc. (Japan). . . . . .[11175-65]

11:50 am: **Fabrication of multilayer Laue lenses by a combination of mechanical polishing and focused ion beam milling**, Juan Zhou, Matthew Vescovi, Abram Ledbetter, Hanfei Yan, Nathalie Bouet, Brookhaven National Lab. (USA). . . . . .[11175-66]

12:10 pm: **Molded anti-reflective structures for infrared optics by precision glass molding**, Anh Tuan Vu, Cornelia Rojacher, Tim Grunwald, Fraunhofer-Institut für Produktionstechnologie IPT (Germany); Thomas Bergs, Fraunhofer-Institut für Produktionstechnologie IPT (Germany) and RWTH Aachen Univ. (Germany) . . . . . .[11175-67]

12:30 pm: **Approaches and methodologies for process development of thin glass forming**, Paul-Alexander Vogel, Anh Tuan Vu, Hendrik Mende, Tim Grunwald, Thomas Bergs, Fraunhofer-Institut für Produktionstechnologie IPT (Germany); Robert H. Schmitt, RWTH Aachen Univ. (Germany). . . . . .[11175-68]

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INDEX OF AUTHORS, CHAIRS, PANELISTS, AND COMMITTEE MEMBERS

General Information

Registration

Onsite Registration and Badge Pickup Hours
Rochester Convention Center - Galleria

Monday 14 October . . . . . 7:30 am to 5:00 pm
Tuesday 15 October . . . . . 7:30 am to 5:00 pm
Wednesday 16 October . . . . . 7:30 am to 5:00 pm
Thursday 17 October . . . . . 7:30 am to 3:00 pm

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- Coffee breaks
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Author / Presenter Information

POSTER SETUP INSTRUCTIONS

Location: Galleria

Wednesday 16 October

Setup . . . . . Beginning at 10:00 am

Session. . . . . .5:00 pm to 6:30 pm

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Exhibition Hall: Everyone who attends the exhibition must be registered and have a badge. Badges for children are free and available onsite at the registration desk. Children under 14 years of age must be accompanied by an adult at all times. Guardians are asked to help maintain a professional, disturbance-free exhibition environment. Children under 18 are not allowed in the exhibition area during exhibition move-in and move-out.

Identification Requirement

To verify registered participants and provide a measure of security, SPIE will ask attendees to present a government-issued photo identification at registration to collect registration materials. Individuals are not allowed to pick up badges for other attendees. Further, attendees may not have some other person participate in their place at any conference-related activity. Such other individuals will be required to register on their own behalf to participate.

Laser Pointer Safety Policy

SPIE supplies tested and safety-approved laser pointers for all conference meeting rooms. For safety reasons, SPIE requests that presenters use provided laser pointers. Use of a personal laser pointer represents the user's acceptance of liability for use of a non-SPIE-supplied laser pointer. If you choose to use your own laser pointer, it must be tested to ensure

No-Smoking Policy

Attendees will observe all non-smoking regulations that are publicly posted by the facilities used by the event.

Payment Policy

Registrations must be fully paid before access to the conference is allowed. SPIE accepts VISA, MasterCard, American Express, Discover, Diner's Club, checks and wire transfers. Onsite registrations can also be paid with cash.

Recording Policy

Conferences, courses, and poster sessions: For copyright reasons, recordings of any kind are prohibited without prior written consent of the presenter or instructor. Attendees may not capture or use materials presented in any meeting/course room or in course notes on display without written permission. Consent forms are available at Speaker Check-In or SPIE Registration. Individuals not complying with this policy will be asked to leave a given session and/or asked to surrender their recording media. Refusal to comply with such requests is grounds for expulsion from the event. Exhibition Hall: Recordings of any kind are prohibited without explicit permission from on-site company representatives. Individuals not complying with this policy will be asked to surrender their recording media and to leave the exhibition hall. Refusal to comply with such requests is grounds for expulsion from the event.

Reporting of Unethical or Inappropriate Behavior

Onsite at an SPIE meeting, contact any SPIE Staff with concerns or questions. If you feel in immediate danger, please dial the local emergency number for police intervention. SPIE has established a confidential reporting system for staff and all meeting participants to raise concerns about possible unethical or inappropriate behavior within our community. Complaints may be filed by phoning toll-free to +1-888-818-6898 from within the United States and Canada or online at www.SPIE.ethicspoint.com and may be made anonymously.

Unauthorized Solicitation

Unauthorized solicitation in the Exhibition Hall is prohibited. Any non-exhibiting manufacturer or supplier observed to be distributing information or soliciting business in the aisles, or in another company's booth, will be asked to leave immediately.

Unsecured Items

Personal belongings should not be left unattended in meeting rooms or public areas. Unattended items are subject to removal by security. SPIE is not responsible for items left unattended.

Wireless Internet Service

At most events, SPIE provides wireless access for attendees. Properly secure your computer before accessing the public wireless network. SPIE is not responsible for computer viruses or other kinds of computer damage.

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