DOMO, OF&T and IODC

Diffractive Optics & Micro-Optics

June 3–6, 2002

Optical Fabrication and Testing

June 3–5, 2002

International Optical Design Conference

June 3–5, 2002

Please note: the IODC conference dates have been changed to June 3-5, 2002.

Collocated Topical Meetings and Tabletop Exhibits

Doubletree Hotel at Reid Park, Tucson, AZ

DOMO Technical Program Committee

Committee Chairs

- Robert Magnusson, Univ. of Connecticut, USA
  General Chair
- Daniel Raguin, Rochester Photonics Corp., USA
  Program Co-chair
- Chris Slinger, DERA Malvern, UK
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- Markus Testorf, Univ. of Massachusetts-Lowell, USA
- Lifeng Li, Tsinghua Univ., China
- Eric Johnson, Univ. of Central Florida, USA
- Frank Wyrowski, Univ. of Jena, Germany
- Jyrki Saarinen, Heptagon, Finland
- Shogo Ura, Kyoto Inst. of Tech., Japan
- Hisao Kikuta, Osaka Perf. Univ., Japan
- Liren Liu, Shanghai Inst. Optics and Mechanics, China
- Rick Morrison, Distant Focus Corp., USA
- Gregory P. Nordin, Univ. of Alabama-Huntsville, USA
- Philippe Lalanne, Inst. D'Optique, France
- Daniel W. Wilson, Jet Propulsion Lab, USA
- Shawn-Yu Lin, Sandia Natl. Labs, USA
- Sverker Hard, Chalmers Univ. of Tech., Sweden

OF & T Technical Program Committee

Committee Chairs

- Lisa Rich, Corning Tropel, USA
  General Chair
- Arne Lindquist, Schneider Optical Machines, USA
  Program Chair
- Lynn Sheehan, Thermawave, USA
  Program Chair

Committee Members

- Steven Jacobs, Univ. of Rochester, USA*
- Philip Stahl, Marshall Space Flight Ctr., USA
- Paul Dumas, QED Tech., USA
- Roland Loercher, Zeiss Corp., Germany
- Richard Nasca, Corning Tropel, USA
- Oliver Fahnle, Fisba Optik, Switzerland
- Buddy Martin, Univ. of Arizona, USA
- Roland Geyl, Sagem, France
- James Sydor, Sydor Optics, USA
- Bergit Gillman, ZYGO Corp., USA

*Indicates Technical Council Member

IODC Technical Program Committee

Committee Chairs

- Paul Manhart, Raytheon Missile Systems Co., USA
  Program Chair
- Jose Sasian, Univ. of Arizona, USA
  Program Chair

Committee Members

- Yasuhiro Aono, Nikon Corp., Japan
- Joseph J. Braat, Delft Univ. of Tech., Netherlands
- Robert Breault, Breault Res. Organization, Inc., USA
- William Cassarly, Optical Res. Assoc., USA
- Thomas Caudell, Univ. of New Mexico, USA
- Michael Chrisp, Ball Aerospace & Tech. Corp., USA
- Leo Gardner, Lambda Res. Corp., USA
- John Greivenkamp, Univ. of Arizona, USA
- Maria J. Yzuel, Univ. Automoma de Barcelona, Spain
- Jurgen Jahns, Fern Univ., Germany
- Barry Johnson, Optical ETC Inc., USA
- David Kessler, Eastman Kodak Co., USA
- Tina Kidger, Kidger Optics Ltd., UK
- David Knapp, Raytheon Missile Systems Co., USA
- Kashiko Kodate, Japan Women's Univ., Japan
- Carmina Londono, NIST, USA
- Virendra Mahajan, Aerospace Corp., USA
- Daniel Malacara, Centro de Investigaciones en Optica, Mexico
- Hiroshi Miyamae, Konica Corp., Japan
- Kenneth E. Moore, Focus Software, Inc., USA
- Robert Pagano, Breault Res. Organization, Inc., USA
- Jannick Rolland, School of Optics/CREOL, USA
- Masato Shibuya, Nikon Corp., Japan
- Bryan Stone, Optical Res. Assoc., USA
- Akiyoshi Suzuki, Canon Inc., Japan

- Kevin Thompson, Optical Res. Assoc., USA
- Valerie Vance-Goff, Arizona Optics Industry Assoc., USA
- Zhicheng Weng, Changchun Inst. of Optics and Fine Mechanics, China
- David Williamson, Nikon Res. Corp., USA
- Kimiaki Yamamoto, Olympus Optical Co. Ltd., Japan

Lens Design Division

- Richard Youngworth, Univ. of Rochester, USA
- Joseph Howard, NASA Goddard Space Flight Ctr, USA
- Barry Johnson, Optical ETC Inc., USA
- Richard Juergens, Raytheon Systems Co., USA
- Richard Pfisterer, Photon Engineering, LLC, USA
- Yongtian Wang, Beijing Inst. of Tech., China

About Diffractive Optics & Micro-Optics

June 3-6, 2002

The aim of this meeting is to bring together scientists and engineers with diverse backgrounds to discuss new developments in the various aspects of diffractive and refractive micro-optics. These discussions will include new applications and products, fabrication, integration, and replication technology, as well as modeling and design.

Diffractive optics and micro-optics continue to find new and interesting applications. These optical elements provide the potential to significantly reduce the size, weight, and cost of a variety of optical systems. In addition, diffractive and refractive micro-optics can be combined to provide unique system properties.

Topics to be Presented

Fabrication

- Fabrication, integration, and replication of diffractive and micro-optical elements
- Pattern generation, photolithography, diamond turning, and single point laser writers
- Direct laser and electron beam write techniques
- Interferometric methods, ion milling
- Photopolymer and photochromic materials
- Fabrication by nanotechnology
- Fabrication by self-assembly
- Plastic embossing, molding and casting
- Element characterization and performance evaluation
- Assembly and packaging technology

Applications and New Products

- Optical interconnects
- Optical switching
- Imagers and image processing
- Sensors, micro-optics for spectral analysis, miniature spectrometers
- Heads-up and helmet-mounted displays

- Integration of DOEs/MOEs and MEMS
- Diffractive optics in communications
- DOEs for WDM applications
- Nonlinear waveguide-grating devices
- Beam forming and beam steering
- Telecom applications

Nanostructured Diffractive/Micro-Optical Elements

- Subwavelength diffractive elements
- Photonic crystals
- Microsphere resonators

Dynamic Diffractive/Micro-Optical Elements

- Spatial light modulators
- Optical MEMS
- Acousto-optic and electro-optic devices
- Integration with active elements such as VCSELs and photo-detectors
- Optically switched elements
- Novel techniques exploiting microdisplays and other COTS optical technologies

Design and Analysis of Diffractive and Micro-Optical Elements

- Elements for IR, visible, UV, and x-ray operation
- Optical and computer generated kinoforms
- Blazed, discrete-step, and continuous surface profiles
- Gratings, lenses, lens arrays, spatial and spectral filters
- Resonant devices, polarization elements, antireflective surfaces
- Diffractive elements exploiting nonlinear effects
- Multi-layer structures, multiplexed optical elements.
- Diffractive-refractive elements and systems
- Achromatization, aberration correction
- Computer-aided design and evaluation

About Optical Fabrication and Testing

June 3-5, 2002

The focus of this meeting is on the recent advances and trends affecting the area of optical manufacturing. The emphasis on practical and applied research is crucial to our manufacturing constituent and shall be revitalized at the 2002 meeting. Research topics will also be discussed as a preview of future technologies.

Topics to be Presented

- Polishing and grinding process science
- Automated fabrication and computer integrated manufacturing (CIM)
- Large optics
- Figure and finish metrology
- Diamond turning
- Optics for projection lithography
- Micro-optics
- Education and training in optics fabrication
- Surface finishing of optical crystals
- Optics for high energy lasers
- Aspheric fabrication and metrology
- Subsurface damage metrology
- Ion figuring and other vacuum removal processes
- Novel fabrication techniques
- Laser damage threshold
- Optical accomplishments
- Cost reduction / flow optimization accomplishments and techniques
- Asphere fabrication equipment
- Software aids to the optical industry - estimating, design, etc.
- Interface information between fabrication/ metrology and coating, design, etc.
- Workforce retention techniques
- Telescopes
- Space & cryogenic optics
- Light-weight & flexible substrates

- Water-jet cutting and removal processes
- Injection molding
- Stress lap technology
- Rapid fabrication techniques
- Sub-aperture lap polishing
- Metrology - interferometry, holography, speckle, phase-measuring, spatial heterodyne & static fringe analysis
- Absolute calibration - flats, spheres, windows, etc.
- Diffractive null correctors

About the International Optical Design Conference

June 3–5, 2002

During the past few years, many areas of optical design have seen rapid development driven by a combination of increased demands on system performance, significant advances in both computing power and design software, and by new manufacturing technologies that offer entirely new engineering options. With such a flourish of activity occurring throughout the optics industry, it becomes imperative for designers, engineers, and scientists to keep up to date with the latest state of the art.

The International Optical Design Conference (IODC) occurs every 4 years and provides the opportunity for attendees from around the world to interact on a structured and informal basis. The IODC will cover a wide range of applications and developments throughout the industry, and the conference is conveniently co-located with two other timely topical meetings. There will be hands-on software demonstrations and a design problem will be proposed in advance of the meeting so that attendee solutions can be covered during one of the sessions.

Topics to be Presented

- Adaptive optics in optical systems
- Advances in optical design software
- Astronomical optics
- Asymmetric optics
- Coherence detection modeling and optical system design
- Conformal optics
- Diffractive and holographic optics
- Education in optics, optical design, and optical system modeling
- Fabrication and testing developments that expand the design horizon
- Laser diode couplers
- Gradient index optics
- High power laser systems
- History of optics and optical design
- Illumination optics design and modeling
- Instrument design
- Integration of design and manufacturing
- IR systems

- LCD and laser display and virtual reality optics
- Lithographic optics
- Materials (glass and other) and material characterization
- Medical/Bio-optics
- Micro-electro-mechanical systems (MEMS)
- Micro-optics
- New lens designs
- Non-imaging optics
- Ophthalmic optics and instruments
- Optical data storage systems
- Optimization - developments in local and global methods
- Photonic and optical interconnect systems
- Physical optics modeling and design methods
- Plastic optics
- Polarization considerations
- Space-borne optics
- Telecommunications optics
- Theory and mathematical methods applied to optical design including new optical surface descriptions
- Thin film coatings in optical designs
- Testing and alignment of optical surfaces and systems
- Tolerance generation and application
- Vision testing and enhancement optics
- X-ray systems
- Zoom optics and multi-configuration optics

DOMO Speakers

>> Invited Speakers

- Diffractive optics and micro-optics production technology in Europe
  Michael T. Gale, *Centre Suisse d'Electronique et de Microtechnique, Switzerland*

- Moving diffractive optical elements from stand-alone components into micro-optical systems
  Shanalyn A. Kemme, *Sandia National Labs, USA*

- Fabrication and applications of subwavelength gratings
  Hiroshi Toyota, *Osaka Science and Technology Center, Japan*

- Imaging with blazed binary diffractive elements
  Philippe Lalanne, *Institut d'Optique, France*

- Fabrication of 2D opal-based photonic crystals
  Fotios Papadimitrakopoulos, *University of Connecticut, USA*

- Progress in diffractive integrated optics
  Jorgen Bengtsson, *Chalmers University of Technology, Sweden*

- Calcitic microlenses as part of the photoreceptor system in brittle stars
  Joanna Aizenberg, *Lucent Technologies, USA*

- Hybrid integration of micro-optical sub-assemblies
  Thomas J. Suleski, *Digital Optics Corp., USA*

- Differential theory amelioration using Fourier factorisation rules
  Evgeny G. Popov, *Domaine Universitaire de St. Jerome, France*

- Spectral and spatial filtering using waveguide grating mirror
  Ivan Avrutsky, *Wayne State Univ., USA*

- Micro-optical modules fabricated by high-precision replication processes
  Markus Rossi, *Heptagon, Switzerland*

- Modeling of focusing in diffractive optics and micro-optics
  Colin Sheppard, *Univ. of Sydney, Australia*

OF & T Speakers

>> Invited Speakers

- Novel approach in magnetorheological finishing(MRF) system configuration
  William I. Kordonski, *QED Tech., USA.*

- Lightweight mirror technology development for NGST
  H. Philip Stahl, *NASA Marshall Space Flight Ctr., USA.*

- Giant segmented mirror telescope
  Larry Stepp, *Gemini Observatory and AURA New Initiatives Office, USA.*

- Manufacture of large-aperture diffractive optics and ultrathin refractive optics for high-power laser and space applications
  Jerald Britten, *Lawrence Livermore Natl. Labs., USA.*

- Breaking barriers to Moore's Law
  Gerald T. Marcyk, *Intel Corp., USA.*

- Future requirements on optics for lithography in the sub 100 nm range
  Reiner Garreis, *Carl Zeiss, Inc., Germany.*

- Intrinsic birefringence in 193nm and 157nm lithography crystalline optics
  John Burnett, *NIST, USA.*

- Fabrication and metrology of high NA imaging optics for EUV-lithography
  Udo Dinger, *Carl Zeiss, Inc., Germany.*

- Characterization of optical components used in fiber communication
  Anmin Zheng, *JDS Uniphase Corp., USA.*

- Advances in interferometric metrology
  James Wyant, *Univ. of Arizona, USA.*

- Subaperture stitching interferometer for versatile and accurate surface metrology
  Gregory W. Forbes, *QED Tech., USA.*

IODC Speakers

>> Invited Speakers

- Superconic and subconic surface descriptions in optical design
  Alan W., Greynolds, *Breault Research Organization, Inc., USA*

- Practical considerations for simulating beam propogation: A comparison of three approaches
  Bryan Stone, *Thomas Bruegge, Optical Research Associates, USA*

- Fundamentals of conformal missile dome design
  David Knapp, *Raytheon Missile Systems Co., USA*

- Optical design of laser beam shaping systems
  David Shealy, *University of Alabama-Birmingham, USA*

- The Holy Grail of ray-based optical modeling
  Greg Forbes, *Macquarie University, Australia; Miguel Alonso, UNAM, Mexico*

- Let's reconsider scalar diffraction theory
  Hiroshi Ooki, *Sony Corporation, Japan*

- NURBS surface description in optical design
  Holden Chase, *Raytheon Electronic Systems, USA*
- Optical design issues for giant telescopes
  Jim Burge, *University of Arizona, USA*
- Stress birefringence modeling in lens design and photonics
  Keith Doyle, *Optical Research Associates, USA*
- Beyond spot diagrams: End-user oriented optical design
  Pantazis Mouroulis, *California Institute of Technology, USA*
- Fifty years of lens design: What do we know now that we did not know then?
  Robert Shannon, *University of Arizona, USA*
- The pleasure of creation
  Roland Shack, *University of Arizona, USA*
- An overview of optical systems for 30 nm lithography at EUV wavelengths
  Russ Hudyma, *Paragon Optical Company, USA*
- Inhomogeneously polarized illumination in optical imaging
  Tom Brown, *University of Rochester, USA*
- The development of dioptric projection lenses for DUV lithography
  Wilhelm Ulrich, *Hans-Jurgen Rostalski, Carl Zeiss Inc., Germany*
- Illumination optimization: The revolution has started
  William J Cassarly, *Optical Research Associates, USA*
- Optical design and fabrication in China
  Yongtian Wang, *Beijing Institute of Technology, China*

DOMO Beauty Contest

>> Purpose

The purpose of the Diffractive Beauty Contest is to promote the development of diffractive optical technology in a light-hearted competitive manner by challenging the community to be creatively artistic. The contest will be held prior to the conference reception on Tuesday, June 4 from 3:45 pm - 5:30pm, and the winners will be announced during the reception.

>> Ground Rules

Two contests will be held at this conference, the Beauty Contest, and the Design Race.

Beauty Contest

Beauty contestants must demonstrate their diffractive elements at the conference and will be judged on the basis of technical merit and artistic qualities. Contestants may compete in either the amateur or professional category. The professional category includes companies that fabricate and sell diffractive elements in the course of their business. Amateurs would include universities and also groups that would be first-time entrants at this contest. Contestants will be allotted tabletop space to display their entries continuously throughout the contest time. As such, contestants should bring a laser source and any opto-mechanical mounts required to display their entries. The particular visible wavelength used to project the diffractive image is left to the discretion of the contestant. Entrants should bring hardcopy of slides containing pictures of the image projected as well as information regarding their diffractive elements, such as diffraction efficiency, fidelity, and computing time should be provided. As room permits, these will be posted next to the displays.

Design Race

The design race will pit contestant's algorithms against each other in designing common images with predetermined quality tolerances. Entrants to the design race are asked to submit the design times and image quality metrics that they achieve. The seed for the design must be randomly generated.

Publications

>> Advance Programs

Authors appearing on the contributed paper form automatically receive a program. Check back soon to review the Advance Program.

For additional information on the technical program or a copy of the Advance Program, please contact:

DOMO, OF & T, IODC 2002
OSA Meetings and Exhibits Department
2010 Massachusetts Ave., NW
Washington, DC 20036-1023
Tel: 202.416.1907 or 800.723.4632
Fax: 202.416.6140
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>> Technical Digests

The Diffractive Optics and Micro-Optics Technical Digest, International Optical Design Conference, and Optical Fabrication and Testing are comprised of the camera-ready summaries of papers being presented during the meeting. At the meeting, each registrant receives a copy of the technical digest. Extra copies can be purchased at the meeting for a special price of $60 US.

>> International Optical Design Conference Proceedings

SPIE, in conjunction with OSA, will be publishing the IODC proceedings. The IODC Proceedings order form will be available on-site and the actual proceedings will be available after the meeting.

Exhibitor List

As of May 29, 2002

>> DOMO Exhibitors

- Photonics Spectra
- Springer-Verlag New York, Inc.
- Thorlabs, Inc.

>> OF & T Exhibitors

- Photonics Spectra
- Thorlabs, Inc.
- Universal Photonics, Inc.
- 4D Technology Corporation
- Zygo Corporation

>> IODC Exhibitors

- Breault Research Organization
- Focus Software, Inc.
- Lambda Research Corp.
- Ohara Corporation
- Optical Research Associates
- Photon Engineering LLC
- Photonics Spectra
- Thorlabs, Inc.
- University of Arizona Optical Science Center

Collocated Agenda of Sessions

Sunday, June 2, 2002		
4:00PM - 6:00PM	Registration	Double Tree Ballroom Foyer

Monday, June 3, 2002		
7:00AM - 5:00PM	Registration	Double Tree Ballroom Foyer
10:00AM-4:00PM	Exhibit Hours	Double Tree Ballroom
DOMO Boojum Room	**IODC** West Grand Ballroom	**OF & T** East Grand Ballroom
	8:00AM-8:30AM Opening Remarks	
8:30AM - 10:00AM DMA, Applications	8:30AM - 10:10AM IMA, Modeling Optical Surfaced Systems	8:45AM - 9:00AM Opening Remarks 9:00AM - 9:30AM OMA, Magnetorheological Finishing (MRF) 9:30AM - 10:00AM OMB, Magnetorheological Finishing (MRF) Poster Briefings
10:00AM-10:30AM, Coffee Break		
10:30AM - 12:00PM DMB, Fabrication	10:30AM - 11:50AM IMB, Head Mounted Displays	10:30AM - NOON OMA & OMB, Monday Poster Presentation I
12:00PM - 1:30PM, Lunch Break, On Your Own		
1:30PM - 3:00PM	1:30PM - 3:40PM	1:30PM - 2:30PM OMC, Astronomical

DMC, Theory	IMC, Lens Design	Optics 2:30PM - 3:00PM OMD, Astronomical Optics Poster Briefings
3:00PM - 3:30PM Coffee Break	3:40PM - 4:00PM Coffee Break	3:00PM - 3:30PM Coffee Break
3:30PM - 5:00PM DMD, Scalar Methods and Applications	4:00PM - 6:00PM IMD, Lithography Systems	3:30PM - 5:00PM OMC & OMD Monday Poster Presentation II
	6:00PM - 7:30PM IME, Poster Session	6:30PM - 8:00PM Conference Banquet with Duncan Moore

Tuesday, June 4, 2002		
7:30AM - 5:30PM	Registration	
10:00AM - 7:30PM	Exhibit Hours	
DOMO Boojum Room	**IODC** West Grand Ballroom	**OF & T** East Grand Ballroom
8:30AM - 10:00AM DTuA, Applications: II	8:00AM - 10:10AM ITuA, Optical Design Theory	8:45AM - 9:00AM Announcements 9:00AM - 9:30AM, OTuA, Optical Fabrication 9:30AM - 10:00AM, OTuB, Optical Fabrication Poster Briefings
10:00AM-10:30AM, Coffee Break		
10:30AM - 12:00PM DTuB, Testing	10:30AM - 12:20PM ITuB, Large Telescope Technology	10:00AM - NOON OTuA & OTuB, Tuesday Poster Presentation I

12:00PM - 1:30PM, Lunch Break, On Your Own		
1:30PM - 3:15PM DTuC, Micro-optical Systems	1:30PM - 3:20PM ITuC, Illumination Systems	1:30PM - 3:30PM OTuC, Lithography
3:15PM - 3:45PM Coffee Break	3:20PM - 4:00PM Coffee Break	3:30PM - 4:00PM Coffee Break
3:45PM - 5:30PM DTuD, Poster Session and Beauty Contest	4:00PM - 5:40P ITuD, NIF & IR Optical Systems	4:00PM - 4:10PM OTuD, Lithography Poster Presentation 4:10PM - 5:30PM OTuC & OTuD, Tuesday Poster Presentation II
6:00PM - 7:30PM Joint Conference Reception, Double Tree Ballroom		
	7:30PM - 10:00PM ITuE, IODC Problem & Awards Session	

Wednesday, June 5, 2002		
8:00AM-5:00PM	Registration	Double Tree Foyer
10:00AM -4:00PM	Exhibit Hours	Double Tree Ballroom
DOMO Boojum Room	**IODC** West Grand Ballroom	**OF & T** East Grand Ballroom
	8:00AM - 10:20AM IWA, Diffraction & Beam Propagation	8:45AM - 9:00AM Announcements 9:00AM - 9:30AM WA, Thin Films 9:30AM - 10:00AM

		WB, Thin Films Poster Briefings
	10:20AM - 10:30AM Coffee Break	10:00AM - 10:30AM Coffee Break
10:30AM - 12:00PM DWA, Modeling & Characterization	10:30AM - 12:00PM IWB, Conformal Optics, PAW and Eye Modeling	10:30AM - NOON WA & WB, Wednesday Poster Presentation I
12:00PM - 1:30PM, Lunch Break, On Your Own		
1:30PM - 3:15PM DWB, Subwavelength Elements & Photonic Crystals	1:30PM - 3:20PM IWC , Photonics Systems	1:30PM - 2:30PM WC, Metrology 2:30PM - 3:10PM WD, Metrology Poster Briefing
3:15PM - 4:00PM Coffee Break	3:20PM - 4:00PM Coffee Break	3:10PM - 3:40PM Coffee Break
4:00PM - 5:15PM JWA, Micro Optics - Joint Session with DOMO & IODC, Boojum Room		3:40PM - 5:30PM WC & WD, Wednesday Poster Presentation II
		6:30PM - 8:30PM Conference Banquet with John Wood

Thursday, June 6, 2002		
8:00AM - 12:00PM	Registration	Double Tree Foyer
DOMO Boojum Room	**IODC** West Grand Ballroom	**OF & T** East Grand Ballroom
8:30AM - 10:15AM DThA, Subwavelength Structures		
10:15AM - 10:45AM		

Coffee Break		
10:45AM - 12:00PM DTh B, Telecommunications		

Abstracts

■ Monday
■ June 3, 2002

Room: West Grand Ballroom
8:00am–8:30am
Opening Remarks
Jose Sasian, Univ. of Arizona, USA;Paul Manhart, Raytheon Missile Systems Co., USA; Jim Wyant, Univ. of Arizona, USA. Presider

Room: West Grand Ballroom
8:30am–10:10am
IMA ■ Modeling Optical Surfaces and Systems
William Cassarly, Optical Res. Assoc., USA, Presider

IMA1 8:30am Invited
Superconic and subconic surface descriptions in optical design, *Alan W. Greynolds, Breault Res. Organization, Inc., USA.*
The superconic surface description has been around since 1986 and more recently implemented in commercial design software. A simpler version dubbed the 'subconic' is proposed and appears to work well in applications requiring steep aspherics.

IMA2 9:00am Invited
NURBS surface description in optical design, *Holden Chase, Raytheon Electronic Sys., USA.*
A very brief explanation of NURBS curve mathematics is presented followed by a number of the optical performance comparisons between rotationally symmetric NURBS surfaces and standard optical surfaces.

IMA3 9:30am
Nonanamorphic imaging with three conic mirrors, *Joseph M. Howard, NASA Goddard Space Flight Ctr, USA; Bryan D. Stone, Optical Res. Associates, USA.*
Design methods are described for unobstructed, plane-symmetric systems composed of three conic mirrors. Low order imaging constraints (including the requirement of nonanamorphism) are used to reduce the dimensionality of the configuration space. Examples are presented.

IMA4 9:50am
Unobscured mirror designs, *J. Michael Rodgers, Optical Res. Assoc., USA.*
This paper reviews multiple-mirror imaging designs ranging from two to many mirrors, the ranges of operating conditions of each configuration, their strengths and limitations, and areas of application.

Room: West Grand Ballroom
10:10am–10:30am
Coffee Break

Room: West Grand Ballroom
10:30am–12:10pm
IMB ■ Head Mounted Displays
Thomas P. Caudell, Univ. of New Mexico, USA, Presider

Presider

IMB1 10:30am
Wide field of view, wide spectral band off-axis helmet-mounted display optical design, *C. Bill Chen, Raytheon Electronic Systems Co., USA.*
This paper describes some design principles associated with the design of an ultra-wide field of view, wide spectral band off-axis helmet-mounted display. Several design examples are given to illustrate the design principles.

IMB2 10:50am
Design of a wearable wide-angle projective color display, *Yonggang Ha, Ricardo Martins, Jannick Rolland, CREOL, USA; Hong Hua, Univ. of Illinois-Urbana-Champaign, USA.*
Purpose: We investigate the design and fabrication of ultra-light weight projection lenses for color wearable displays. Methods: Plastic, glass, and diffractive optics are combined to yield <15g per eye. Results: We completed the design and fabrication of an 8g, 52 degree lens. The polychromatic MTF holds well over the entire field of view with a 20% modulation at 56cycles/arcmin. The lens performance will be demonstrated in an augmented reality application.

IMB3 11:10am
Hybrid diffractive-refractive eyepiece, *Donald Janeczko, ITT Night Vision, USA.*
A visible hybrid diffractive-refractive eyepiece magnifier with highly reduced forward protrusion from the eye for a sensor system has been designed, manufactured and evaluated. The design methods, trade studies and results will be presented.

IMB4 11:30am
Compact relay lenses using microlenslet arrays, *Vesselin Shaoulov, Jannick Rolland, Univ. of Central Florida, USA.*
Motivated by the need for compactness in relaying images, the idea of using microlenslet arrays is investigated. Microlenslet arrays have been quite extensively used in scanning devices, and not in forming images. Various possible arrangements of microlenslet arrays and associated baflles are considered and their role on image quality presented. Findings through software simulations clearly demonstrate the trade-offs between image quality and compactness.

IMB5 11:50am
Optical design of a monocentric autostereoscopic immersive display, *Josh Cobb, Eastman Kodak, USA.*
This paper discusses the optical design of a wide field, 3D,large aperture, and high resolution display for immersive imaging. The system presents an autostereoscopic virtual image to the observer of HDTV resolution liquid crystal displays.

Room: West Grand Ballroom
1:30pm–3:40pm
IMC ■ Lens Design
John Rogers, Optical Res. Assoc., USA, Presider
Presider

IMC1 1:30pm Invited
Fifty years of lens design: What do we know now that we did not know then?, *Robert Shannon, Univ. of Arizona, USA.*
This presentation examines the extent to which the knowledge of how lenses function has (or has not) kept pace with the computational ability developed over the past five decades, and how this has influenced progress in the field of optical design.

IMC2 2:00pm
Index inhomogeneity effects on imaging systems, *Brian Stamper, James Burge, Univ. of Arizona, USA.*
Large field of view, high power, lithography, and laser fusion systems are all limited by refractive index variations of their constituent glass elements. To estimate how the image degrades, a model of the bulk index inhomogeneity must be formed.

IMC3 2:20pm
Zoom lens with "electronic" curves, *Eckhard Langenbach, Hans-Joerg Heimbeck, Eckhard List, Fisba Optik, Switzerland.*
A zoom lens with two independently driven lens groups is presented. In contrast to conventional zooms, each lens has its own individual and temperature dependent zoom curves, which are determined with an interferometric test setup.

IMC4 2:40pm
Reduced manufacturing sensitivity in multi-element lens systems, *Mark Jeffs, Thales Optics Ltd., UK.*
Maximizing the as-built system performance is the real task of the lens designer. Tolerance sensitivity is always an issue. A range of techniques for de-sensitisation are presented with illustrative examples from recent design projects.

IMC5 3:00pm
Novel method for precise focal length measurement, *Brian DeBoo, Jose Sasian, Univ. of Arizona, USA.*
A new technique for precise focal length measurements using a hologram is presented. The hologram is used in first order diffraction to emulate reflective properties of a spherical mirror when performing interferometric null tests

IMC6 3:20pm
Method of determining Gaussian parameters for zoom systems with multiple moving lens groups, *Yongtian Wang, Liqin Zhang, Lin Li, Beijing Inst. of Tech., China.*
To determine Gaussian parameters of zoom systems with multiple moving lens groups, displacements and focal lengths of all the groups are optimized for all the zoom positions simultaneously, with their F-numbers constrained to rational values.

Room: West Grand Ballroom
4:00pm–6:00pm

IMD ■ Lithography Systems

David Williamson, Nikon Res. Corp. of America, UK, Presider

Presider

IMD1 4:00pm Invited

An overview of optical systems for 30 nm lithography at EUV wavelengths, *Russ Hudyma, Paragon Optics, Inc., USA.*

Using examples taken from the patent literature, this presentation provides an overview of contemporary all-reflective projection systems designed for EUV lithography at 13.4 nm.

IMD2 4:30pm

Designing extreme ultraviolet projection systems without obstruction and with multilayers, *Matthieu F. Bal, Florian Bociort, Joseph J.M. Braat, Delft Univ. of Tech., The Netherlands.*

The choice of the starting point of an EUV-projection system for optimization remains often based on existing experience. With our systematic-search method we identify all possible configurations. Incorporating the multilayers greatly affect the imaging properties.

IMD3 4:50pm Invited

The development of dioptric projection lenses for DUV lithography, *Wilhelm Ulrich, Hans-Jurgen Rostalski, Carl Zeiss AG, Germany.*

Most advanced refractive optical designs from Carl Zeiss are the basis of lenses for DUV microlithography. However, in the design process towards implementing maximum numerical apertures and increasingly short wavelengths, many design and technology advances achieved in many years design experience at Carl Zeiss have been incorporated.

IMD4 5:20pm

Microlithographic lens for DUV scanner, *Tomoyuki Matsuyama, Yuichi Shibazaki, Nikon Corp., Japan.*

This paper descirives several kinds of new technologies introduced into the latest microlithographic lens system for Nikon's DUV(Deep Ultra Violet) Scanner. Actual lens performance will be reviewed at the end of this paper.

IMD5 5:40pm
High NA projection lens designs for exposure tools, *Toshiro Ishiyama, Kotaro Yamaguchi, Nikon Corp., Japan.*
Enhancement of NA is required enthusiastically. This paper describes how to enhance NA without increasing lens diameter or deteriorating aberrations. One is using aspherical surfaces and the other is changing magnification of the optical system.

Room: Doubletree Ballroom
6:00pm–7:30pm

IME ■ Poster Session

IME1
Design and modeling of a dual-magnification Galilean IR telescope and associated focusing optics, *Nadeem M Akram, Royal Inst. of Tech., Sweden; Muhammad Hammad Asghar, Advanced Engineering Res. Organization, Pakistan.*
The complete design and modeling of a dual-magnification 8-12 ?m Galilean telescope along with the associated focusing optics and scanning mechanism is described. Initially, the telescope (narrow and wide-angle modes) and the focusing optics are designed as individual subsystems. Later, they are combined together and the complete optical system is modeled and optimized as one unit to get the required final performance.

IME2
Design and modeling of optical engine for LC rear projection display, *Weng Zhi-cheng, Zhang Zeng-Bao, Cong Xiao-Jie, Zhang Xin, Chinese Acad. of Sciences, China.*
In this paper, an optical engine for three penal LC projection display have been designed and analyzed, at the same time, have been optimized and evaluated using LightTools software.

IME3
Design, tolerance specification and stray analyzing of an unobscured, compact, high-resolution spacing system, *Weng Zhi-Cheng, Cong Xiao-Jie, Chinese Acad. of Sciences, China; Chang Jun, Jiang Hui-Lin, Changchun Inst. of Optics and Fine mechanics, China.*
This paper describes the results of the design effort for a three-mirror anastigmatic system (TMAS) and its tolerance exercise, also analysis the stray light for the system using the LightTools software.

IME4
Design of a wide-angle fast optical system with anamorphic mirrors, *Takayuki Nakano, Yasuhisa Tamagawa, Mitsubishi Electric Corp., Japan.*
We propose a design method for off-axis optical systems adapted to its asymmetry by use of anamorphic mirrors and an elliptic aperture, and show a design example reaching F/1.2 with 18x14 degrees field angle.

IME5
Nulling interferometry with a single-element phase-shifting interferometer, *Kuo-Hui Chang, A-Chuan Hsu, Jyh-Long Chern, Natl. Cheng Kung Univ., Taiwan.*
Nulling interferometry based on a single-element (liquid-crystal-phase-retarder) phase-shifting interferometer is proposed and analyzed with optical simulation. The geometric-phase-based nulling interferometry is also reinvestigated for comparison.

IME6
New lens design for infrared systems with micro-scanning, *Yi-chin Fang, ITRI, Taiwan; A.H. Lettington, Univ. of Reading, UK.*
Traditionally the image quality of the staring IR systems, is limited by the aliasing effects. A new micro-scanning system with newly developed optics are introduced. After comparison, its excellence was concluded.

IME7
The untold secret of MACRO language usage in optical design, *Shiyu Zhang, Ultratech Steppers, USA.*
MACRO language is included in optical design software to enable the designer to expand the functions of the software. This paper reveals the untold secret of MACRO language usage in optical design through several examples.

IME8
Mercado/Robb/Buchdahl coefficients - An update of 243 common glasses, *Michael Bolser, Unaffiliated, USA.*
The 1983 Mercado/Robb listing of Buchdahl chromatic coordinate coefficients is supplemented with glasses from the Schott and O'Hara catalogues. The coefficients were calculated by using Buchdahl's cubic model. Appropriately selected materials yield a superachromat.

IME9
New lens design for LCOS projector system with color selectors, *Yi-chin Fang, Ou Chung-Jen, Chung Shuang Chao, ITRI, Taiwan.*
A new lens design is presented for the special LCOS projector with color selector, dicromirror instead of the X cube and beamsplitter. The lens is characterized with the different optical path of the R,G,B color and inherent non-symmetric problem. This new design concluded the success of this compact LCOS design.

IME10
The research for uniform illumination aystems, *Yifan Huang, Lin Li, Liansheng An, Beijing Inst. of Tech., China.*
Methods of getting uniform illumination are introduced in this paper. Studies on a new optical components - Rod lens are carried out and rules of its uniformity changing with sizes are deduced.

IME11
Intersection measurement with CCD in detecting multi-targets, *Menghong Feng, Lin Li, Yifan Huang, Liansheng An, Beijing Inst. of Tech., China.*
To conquer the traditional measuring system's disadvantages that can only measure a simple target, a new intersection measuring system with CCD is established to detect multi-targets in real-time processing with their different gray levels.

IME12
Design of complex optical system for measuring vibrant track of cable crossing river, *Guangjun Gao, Lin Li, Yifan Huang, Liansheng An, Beijing Inst. of Tech., China.*
In order to measure the vibrant track of a cable crossing a river, a complex optical system is introduced to realize the image of a rectangle on a CCD plane. The quantitative diagnosis of the system's aberration reveals that the distortion is beyond the tolerance. A new and accurate method of digital correcting the distortion with asymmetrical distribution is proposed. An example shows that a good effect can be achieved with the correcting method.

IME13
Discretization effects on imaging quality of digital holographic systems, *Lei Xu, Xiaoyuan Peng, Jianmin Miao, Anand Asundi, Nanyang Tech. Univ., Singapore.*
The effects introduced by the discrete feature of a CCD sensor on the image formation and imaging quality of a digital holographic system are studied. The characteristics of the in-line and off-axis configurations are comparatively discussed.

IME14

Comparative study on thermal effects of diode-pumped Nd:YVO4 and Nd:YAG lasers, *Xiaoyuan Peng, Lei Xu, Anand Asundi, Nanyang Tech. Univ., Singapore.*
The thermal effects of diode-pumped Nd:YVO_4 and Nd:YAG lasers are analyzed by a one-dimensional model and a three-dimensional model, respectively. The characteristics of the Nd:YVO_4 and Nd:YAG rod are comparatively discussed.

IME15

Evaluation the effect of fine undulation on lens surface to the optical performance, *Masato Shibuya, Kouichi Aoyagi, Suezou Nakadate, Tokyo Inst. of Polytechnics, Japan; Hiroki Ono, CRC Solutions Corp., Japan.*
The effect of residual fine undulation on aspherical surface may not be always evaluated correctly. We make this problem clear both theoretically and numerically and proposed the simple and valuable equation for evaluating the fine undulation.

IME16

Rapid return loss computation, *Byron Taylor, Optical Res. Assoc., USA.*
Presented is a macro running in CODE V that automatically calculates the return loss from all surfaces in a lens system using a gaussian beam approach. Results are compared with output from a diffraction based approach.

IME17

FOCOIVA lens: Scanner in longitudinal direction, *Sergio Vazquez-Montiel, Inst. Nacional de Astrofisica-Optica y Electronica, Mexico; Tetsuya Suzuki, Morio Hosoya, Hoya Corp., Japan.*
We propose a novel optical system that can scan in longitudinal directions to the optical axis, which we have named the FOCOIVA lens system. We give the equations for the first order analysis and also the equations of motion for the lenses. Examples calculated with these equations are presented.

■ Tuesday
■ June 4, 2002

Room: West Grand Ballroom
8:00am–10:10am
ITuA ■ Optical Design Theory
Bryan D Stone, Optical Res. Assoc., USA, Presider

Presider

ITuA1 8:00am Invited
Beyond spot diagrams: End-user oriented optical design, *Pantazis Mouroulis, Jet Propulsion Lab., USA.*
End-user requirements are established and then translated into means of optimizing and assessing the performance of the optical design and the finished instrument for two different types of systems, visual instruments and imaging spectrometers.

ITuA2 8:30am Invited
The Holy Grail of ray-based optical modelling, *Greg Forbes, QED Tech., USA; M.A. Alonso, UNAM, Mexico.*
Our new method for optical modeling puts ray optics on a more solid foundation. This method not only delivers higher accuracy, but also offers estimates of its own errors. The conceptual framework is fully consistent with intuitive interpretations of rays and resolves many of the ad hoc steps in standard ray-based modeling. This includes problems in such areas as propagation, refraction, reflection, and diffraction. The model's higher accuracy also means that more applications now fall within the scope of ray-based system analysis.

ITuA3 9:00am Invited
Inhomogeneously polarized illumination in optical imaging, *Tom Brown, Univ. of Rochester, USA.*
This paper will describe experiments demonstrating this type of illumination in imaging and discuss the creative use of inhomogeneous polarization in optical system design, emphasizing applications in microscopy/ inspection and lithography.

ITuA4 9:30am
MTF optimization by automatic adjustment of aberration merit function, *Akira Yabe, Fuji Photo Optical Co., Ltd., Japan.*
In this MTF optimization the aberration merit function is optimized. The basic concept of this MTF optimization is to connect the improvement of the aberration merit function to the improvement of the MTF merit function.

ITuA5 9:50am
Local optimization strategies to escape from poor local minima, *Florian Bociort, Alexander Serebriakov, Joseph Braat, Delft Univ. of Tech., The Netherlands.*
Radically modifying the error function may help local optimization to escape from poor local minima. The old and new error function should both tend to zero for ideal systems but must differ sufficiently from another.

Room: West Grand Ballroom
10:30am–12:20pm

ITuB ■ Large Telescope Technology

K Doyle, Optical Res. Assoc., USA, Presider Presider

ITuB1 10:30am Invited
Optical design issues for giant telescopes, *Jim Burge, Univ. of Arizona, USA.*
A new generation of ground based optical telescopes is now being proposed with diameters up to 100 meters. It is not practical to simply scale up the current successful designs, as this would result in unwieldy structures, extremely high manufacturing costs, and poor performance. This paper summarizes design issues for these giant telescopes.

ITuB2 11:00am
Criteria for correction of all aberrations with quadratic field dependence, *Chunyu Zhao, Jim Burge, Univ. of Arizona, USA.*
A new set of relations is presented that give the criteria for correction of quadratic field aberrations, in the same way as the Abbe sine condition is used for linear field aberrations.

ITuB3 11:20am
Stretched Membrane with Electrostatic Curvature (SMEC) mirrors: Demonstration of a new technology for large lightweight space telescopes, *Simona Errico, Brian Stamper, Roger Angel, James Burge, Tom Connors, Brian Duffy, Neville Woolf, Univ. of Arizona, USA.*
A new type of lightweight space-telescope mirrors has been developed and tested using a 6 inch stretched membrane with electrostatic curvature (SMEC). New results showing active control of mirror shape and astronomical images will be presented.

ITuB4 11:40am
Basic principles of combining beams in imaging multiple aperture systems, *E.M. Sabatke, J.H. Burge, Univ. of Arizona, USA.*
We discuss the basic concepts that have been useful in our work designing multiple aperture telescopes with wide fields of view. We apply these concepts to several types of systems and discuss the results.

ITuB5 12:00pm
OSIRIS optical design, *Francisco J. Cobos, J. Jesús González, Carlos Tejada, UNAM, Mexico; Jordi Cepa, Inst. de Astrofísica de Canarias and Univ. de la Laguna, Spain; José Luis Rasilla, Inst. de Astrofísica de Canarias, Spain.*
OSIRIS, a versatile imager/spectrograph, is the optical Day One instrument for GTC, the 10.4m Spanish-telescope. Here the optical design is summarized, explaining how the evolution of the OSIRIS concept forced it to successfully respond to ever-harder challenges.

Room: West Grand Ballroom
1:30pm–3:20pm
ITuC ■ Illumination Systems
Jose M. Sasian, Univ. of Arizona, USA, Presider Presider

ITuC1 1:30pm Invited
Illumination optimization: The revolution has started, *William J. Cassarly, Optical Res. Assoc., USA.*
Over the last 25 years, optimization of imaging systems has become commonplace. With the advent of powerful illumination software design packages, the industry is poised for illumination optimization. Trends and examples will be provided.

ITuC2 2:00pm
Enhancement of the downhill simplex method of optimization, *R. John Koshel, Breault Res. Org., Inc., USA.*
Simplex optimization uses arbitrary values for factors that describe the "simplex movement" within merit space. These control factors are optimized for arbitrary-order parabolic wells (i.e., optimization end game). Results show up to a 20% improvement in convergence.

ITuC3 2:20pm
Source modeling and calculation of mask irradiance during EUV lithography condenser design, *Lenny Laughlin, Jose Sasian, Univ. of Arizona, USA.*
EUV lithography condenser design requires a precise and efficient method for determining uniformity of irradiance on the mask plane. A new methodology is described and results for the method are compared to calculated values.

ITuC4 2:40pm
3D NURBS representation of surfaces for illumination, *Thomas Davenport, Univ. of Arizona, USA.*
Use of NURBS surfaces to create facets on a reflecting surface will be considered. Specifically, the design of a reflector that generates a circular illuminance pattern will be investigated. Important considerations are: choice of variables used to represent a NURBS surface, total number of variables, parameterization and/or knot vector specification, and where to use algorithmic vs. optimization approaches.

ITuC5 3:00pm
A fly's eye condenser system for uniform illumination, *Blake Crowther, Donald Koch, Joseph Kunick, James McGuire, Optical Res. Assoc., USA; Robert Harned, Rich Gontin, ASM Lithography, USA.*
We recently completed a preliminary design of a novel illumination system. The concept of this design is to integrate the incident irradiance from a small source such that an otherwise non-uniformly illuminated target is uniformly illuminated, while maintaining high radiometric throughput. Our design incorporates a collector to efficiently gather flux from the source, two multi-element faceted arrays, and a flux relay. We explore the concept behind our design and show a preferred embodiment and its predicted performance.

Room: West Grand Ballroom
4:00pm–5:40pm
ITuD ■ NIF and IR Optical Systems
Robert Pagano, Breault Res. Organization, Inc., USA, Presider

Presider

ITuD1 4:00pm
National Ignition Facility end-to-end beamline optical model, *Ronald J. Korniski, SAIC, USA; Janice K. Lawson, Lawrence Livermore Natl. Lab., USA.*
The optical model of a National Ignition Facility beamline will be described and illustrated. The complexity of the optical design will be evident. The benefits of having an End-to-End optical model will be presented.

ITuD2 4:20pm
Infrared optic using polymer layered lens, *Del Vicker, Lockheed Martin, USA.*
A midwave infrared (IR) imager with silicon lenses and a laminated plastic surface has been made. It has a focal length of 50 mm and f/# of 2.6.

ITuD3 4:40pm
Optical design of CPAPIR, a cryogenic IR camera for OMM, *Simon Thibault, Jean Lacoursière, INO, Canada; P. Vallée, René Doyon, Univ. of Montreal, Canada.*
We present the final design of a wide-field infrared camera to be installed at the Cassegrain focus of the Ritchey-Chretien telescope at the Mont Mégnantic Observatory in southern Québec city. We discussed the cryogenic design technique and the ghost analysis based on Zemax Non-Sequential raytracing.

ITuD4 5:00pm
Design of a step-zoom dual field-of-view infrared telescope, *Nadeem M. Akram, Royal Inst. of Tech., Sweden.*
A dual field-of-view 8-12 um IR telescope based on the axial motion of a single lens group is described. A total of 6 lenses with one conic surface is used. Near diffraction-limited MTF is achieved for both magnifications. A wide range of magnification change is possible using this concept.

ITuD5 5:20pm
National Ignition Facility beamline pupil relay plane locations and imaging, *Ronald Korniski, SAIC, USA; Janice Lawson, Lawrence Livermore Natl. Lab., USA.*
Axial astigmatism can be introduced into the nominal design of an optical system by tilted and tilted-wedged plates. The pupil images in the National Ignition Facility experience many such components. Some ramifications will be explored.

Room: West Grand Ballroom
7:30pm–10:00pm

ITuE ■ IODC Problem Session

Jose M. Sasian, Univ. of Arizona, USA, Presider Presider

7:30pm–8:00pm
The pleasure of creation, *Roland Shack, Univ. of Arizona, USA*

8:00pm–8:30pm
20-20 vision: New telescopes for the 21st century, *Roger Angel, Univ. of Arizona, USA*

8:30pm–8:45pm
Awards Presentation, *Jose Sasian, Univ. of Arizona, USA*

8:45pm–10:00pm
IODC Design Problem Discussion

Room: West Grand Ballroom
8:00am–10:20am

IWA ■ Diffraction and Beam Propagation

Alan W. Greynolds, Breault Res. Organization, Inc., USA, Presider

Presider

IWA1 8:00am Invited
Optical design and fabrication in China, *Yongtian Wang, Lin Li, Qiming Xin, Beijing Inst. of Tech., China.*
Optical design programs commonly used in China are described. Fabrication capacities are given for typical companies producing optical glasses, lens elements and commercial products. Efforts are made to promote closer international cooperation in optical industry.

IWA2 8:30am Invited
Optical design of laser beam shaping systems, *David Shealy, Univ. of Alabama-Birmingham, USA.*
Geometrical methods (ray tracing, conservation of energy, and constant optical path length condition) have been used to determine system configurations, including aspheric elements and spherical-surface GRIN lenses, for shaping rotationally symmetric and asymmetric laser beams.

IWA3 9:00am Invited
Practical considerations for simulating beam propagation: A comparison of three approaches, *Bryan Stone, T. Bruegge, Optical Res. Assoc., USA.*
Conventional ray tracing cannot always adequately model propagation of optical beams. We compare three approaches for modeling diffraction effects throughout an optical system: i) FFT-based, ii) Gaussian beam decomposition and iii) the SAFE method of Forbes and Alonso.

IWA4 9:30am
General beam propagation through non-orthogonal optical systems, *Michael Harrigan, Eastman Kodak, USA.*
The capability to propagate non-Gaussian two-dimensional beams through non-rotationally symmetric optical systems is not available in all commercial lens design software. A review of the detailed theoretical methods will be presented along with examples.

IWA5 9:50am Invited

Some thoughts on scalar diffraction theory, *Hiroshi Ooki, Nikon Corp., Japan.*

Scalar diffraction theory is widely used for optical design and evaluation. However, since the theory assumes the light to be a scalar wave, it is sometimes necessary to be careful how to understand the meaning of the result. This paper will discuss the vector nature of optical imaging and its effect on the optical design.

Room: West Grand Ballroom

10:30am–12:00pm

IWB ■ Conformal Optics, PALs, and Eye Modeling

Jannick P. Rolland, CREOL,USA, Presider Presider

IWB1 10:30am Invited

Fundamentals of conformal missile dome design, *David Knapp, Raytheon Missile Systems Co., USA.*

This paper reviews the fundamentals of conformal optical design and shares some of the latest developments.

IWB2 11:00am

I like your GRIN: Design methods for gradient-index progressive addition lenses, *David Fischer, Duncan Moore, Univ. of Rochester, USA.*

Gradient-Index designs of Progressive Addition Lenses are examined. B-Spline curves are used for GRIN representation. Design methods and simulation results are presented. Other applications, such as unifocal lenses and axicons, are also discussed.

IWB3 11:20am

Designing a perfect cornea: Computational aspects, *J. Rubinstein, Indiana Univ., USA; G. Wolansky, Technion, Israel.*

An algorithm for the design of a perfect cornea that exactly focuses an object on the retina is analyzed. We consider the stability of the design to errors in the input and in the ablation process.

IWB4 11:40am

Eye rotation and vignetting in visual instruments, *M. Rosete-Aguilar, UNAM, Mexico; J.L. Rayces, J.L. Rayces Consulting Inc., USA.*

In this paper we discussed how the specification of vignetting has a different interpretation in the design of a visual instrument, if we assume that the eye remains static when looking at objects located off-axis, or if we take into account the rotation of the eye.

Room: West Grand Ballroom
1:30pm–3:20pm

IWC ■ Photonics Systems

Michael R. Descour, Univ. of Arizona, United States, Presider

Presider

IWC1 1:30pm Invited

Stress birefringence modeling for lens design and photonics, *Keith Doyle, Jeffrey Hoffman, Optical Res. Assoc., USA; Victor Genberg, Gregory Michels, Sigmadyne, Inc., USA.*

Modeling the effects of mechanical-induced stress birefringence is critical for wavefront error and polarization sensitive optical systems. Optical design and optomechanical interface software tools to model stress birefringence are discussed and demonstrated for two examples. The first example compares the magnitude of birefringence as a function of lens shape parameters. The second example computes the stress-induced cross-talk in a wavelength selective switch used in the telecommunication industry.

IWC2 2:00pm

Tolerantly designed optical clock distribution system, *Jurgen Jahns, Markus Stölzle, Univ. of Hagen, Germany; Barbara Lunitz, Daimler-Chrysler AG, Germany.*

The influence of process parameters in the design and fabrication of a clock distribution system using integrated free-space optics is considered based on ray-tracing simulations and experiments.

IWC3 2:20pm

Analysis of near field characteristics of a diffractive optical laser beam profile shaper using a high accuracy finite difference time domain method, *S. Banerjee, J.B. Cole, Univ. of Tsukuba, Japan.*

The authors use a new high accuracy version of finite difference time domain algorithm to study the near field characteristics of a binary phase grating, capable of generating a far field flattop profile from a Gaussian laser beam.

IWC4 2:40pm

High-efficiency, low-cost fiber-optic links via carrier-interferometry pulse shaping, *Fang Zhu, Carl R. Nassar, Colorado State Univ., USA.*

We propose a far-reaching, inexpensive solution to counter the many dispersion effects introduced by the fiber-optic link. Our signal-processing-based solution employs novel transmit and receive technology based on Carrier Interferometry (CI) ultrashort pulse shaping.

IWC5 3:00pm
Perro's achromatic polarization-preserving beam displacer, *A-Chuan Hsu, Cheng-Fang Ho, Jyh-Long Chern, Natl. Cheng Kung Univ., Taiwan.*
A new achromatic polarization-preserving beam displacer is found in the simple Perro's two-prism image erector system. Full analyses of mechanism (compensating-phase-shifting principle), tilting tolerance and the influence of material are presented.

Room: Boojum
4:00pm–5:30pm
JWA ■ Micro Optics - Joint Session with DOMO
Daniel W. Wilson, Jet Propulsion Lab., USA, Presider
Presider

JWA1 4:00pm Invited
Calcitic microlenses as part of the photoreceptor system in brittle stars, *Joanna Aizenberg, Lucent Tech., USA.*
This presentation describes biologically-formed array of crystalline microlenses that demonstrate unique optical and mechanical properties. The microlenses are birefringence- and aberration-free and are individually-addressed. They exhibit exceptional signal enhancement, angular selectivity, photochromic activity and intensity adjustment.

JWA2 4:30pm Invited
Fabrication of micro-optical systems with deep x-ray lithography, *W.C. Sweatt, T.R. Christenson, Sandia Natl. Lab., USA.*
Preassembled, prealigned microlens systems have been fabricated in PMMA using Deep X-ray Lithography (DXRL). These systems consist of crossed cylindrical lenses with ≈0.3-mm apertures. Lithographically defined masks and two exposures from a synchrotron beam can produce arrays of micro-imagers, micro-spectrometers, etc.

JWA3 5:00pm
Aberration measurement of photolithographic lenses using hybrid diffractive photo-masks, *Eric Johnson, Jinwon Sung, Mahesh Pitchumani, Univ. of Central Florida, USA.*
In this paper, we present a method for incorporating diffractive optics on a photomask for aberration characterization. This allows for a manipulation of the incident illumination to the amplitude mask for estimating the aberration coefficients.

JWA4 5:15pm

Design and construction of disposable high NA miniature microscope objective for laser confocal microscopy, *Matthew Chidley, Chen Liang, Michael Descour, Univ. of Arizona, USA; Kung-Bin Sung, Rebecca Richard-Kortum, Univ. Texas-Austin, USA.*

In this paper we present the design and construction of a NA=1.0 water-immersion microscope objective 5mm in diameter and 17mm in length. Proposed design can be fabricated by injection molding using plastic materials.

Key to Authors and Presiders

Abstracts

■ Monday
■ June 3, 2002

Room: East Grand Ballroom
8:45am–9:00am
Opening Remarks
Lisa Rich, Corning Tropel Corp., USA.

Room: East Grand Ballroom
9:00am–9:30am
OMA ■ Magnetorheological Finishing (MRF)
Steven A. Jacobs, OmniGuide Comm., USA, Presider

Presider

OMA1 9:00am Invited
Novel approach in magnetorheological finishing(MRF) system configuration, *William Kordonski, Don Golini, Stephan Hogan, Andy Price, QED Tech., USA.*
New magnetorheological elements of MRF machine "circulatory system" are developed. The use of these elements in conjunction with a new configuration of the MR polishing unit results in significant improvement in machine performance and maintenance.

Room: East Grand Ballroom
9:30am–10:00am
OMB ■ Magnetorheological Finishing (MRF) Poster Preview
Steven A. Jacobs, OmniGuide Comm., USA, Presider

Presider

OMB1 9:30am
Experiments on magnetorheological finishing of optical polymers, *Jessica E. DeGroote, Stephen D. Jacobs, John M. Schoen, Univ. of Rochester, USA.*
We report the application of magnetorheological finishing (MRF) to the polishing of optical polymers. MR fluids with moderated removal rates were evaluated for acrylic, polystyrene, and polycarbonate, with emphasis on pre-polished and diamond-turned cyclic olefin copolymer (COC).

OMB2 9:33am
MR finishing of 220mm diameter aspheric lenses with the QED's Q22 machine, *John Johnson, Gary Ginter, Zygo Corp., USA.*
Presentation of recent experience with the limited production of a 220 mm diameter fused silica aspheric collimator lens. Discussion of the null test set-up and the use of the Q22 MRF platform for figuring. Will cover evolution of production process and typical results.

OMB3 9:36am
Raster mode MRF polishing of phase correction plates, *John Johnson, Zygo Corp., USA.*
Early experiences in polishing 1/2-meter class fused silica windows having substantial departure from best-fit plane. Description of a meter class MRF platform and provisions made for processing large optics.

OMB4 9:39am
Combined advanced finishing and UV-laser conditioning for producing UV-damage-resistant fused silica optics, *Joseph Menapace, Bernie Penetrante, Phil Miller, Tom Parham, Mike Nichols, John Peterson, Lawrence Livermore Natl. Lab., USA; Don Golini, QED Tech., USA; Al Slomba, Zygo Corp., USA.*
During the past year, we have focused on optimizing the laser damage performance for fused silica optics at 355-nm, 3-nsec pulse length, via application of magnetorheological finishing (MRF), wet chemical etching, and UV laser conditioning.

OMB5 9:42am
Shaping weak aspheres with MRF, *Paul E. Murphy, QED Tech., USA.*
The Q22 MRF system has the capability to fabricate weak aspheres from best-fit spheres. This powerful feature, however, has subtleties in its operation. Process considerations are outlined, particularly those associated with non-null interferometric testing.

OMB6 9:45am
Leica aspheric optic manufacturing process with MRF, *Michael Thomas, Leica Camera AG, Germany.*
We have integrated the MRF-Technology in our aspherical production. We will explain furthermore the advantage we have with our products containing aspheres, and also how the development relating to products with aspherical lenses will grow in the future by Leica Camera AG.

OMB7 9:48am
Polishing high aspect ratio substrates for optics, telecommunications, and microelectronics applications using magnetorheological finishing (MRF), *Marc Tricard, Mike DeMarco, Don Golini, QED Tech., USA.*
Precise flatness or thickness control is extremely difficult to achieve for substrates with a high diameter to thickness ratio. MRF is able to polish high aspect ratio substrates for telecommunications and microelectronic applications to the nanometer level.

OMB8 9:51am
MRF as a complimentary tool to conventional optical fabrication processes, *Steven VanKerkhove, Corning Tropel Corp., USA.*
MRF has shown to be an excellent complimentary tool to conventional optical fabrication processes that are unable to achieve desired surface figure characteristics due to material type, part shape or surface figure difficulty. This paper will examine some of the short-comings of conventional fabrication processes for polishing Calcium Fluoride crystals, prisms, and windows to name a few. MRF results will be presented showing clear improvements to surface figure without compromises to other surface characteristics.

Room: East Grand Ballroom
10:00am–10:30am
Coffee Break

Room: East Grand Ballroom
10:30am–12:00pm
Monday Poster Presentation I
Steven A. Jacobs, OmniGuide Comm., USA, Presider Presider
This poster presentation includes all papers from sessions OMA and OMB.

12:00pm–1:30pm
Lunch on Your Own

Room: East Grand Ballroom
1:30pm–2:30pm

OMC ■ Astronomical Optics

Hubert M. Martin, Univ. of Arizona, USA, Presider

Presider

OMC1 1:30pm Invited
Lightweight mirror technology development for NGST, *H. Philip Stahl, NASA Marshall Space Flight Ctr., USA.*
Lightweight mirror technology is critical to the success of the next generation space telescope. This paper reviews mirror requirements and provides status on recent development efforts.

OMC2 2:00pm Invited
Giant segmented mirror telescope, *Larry Stepp, Natl. Optical Astronomy Observatories, USA.*
Abstract not available.

Room: East Grand Ballroom
2:30pm–3:00pm

OMD ■ Astronomical Optics Poster Preview

Hubert M. Martin, Univ. of Arizona, USA, Presider

Presider

OMD1 2:30pm
Initial operation of the University of Arizona NGST mirror system demonstrator, *Dave Baiocchi, Jim Burge, Brian Cuerden, Scott DeRigne, Univ. of Arizona, USA.*
We present an update on the University of Arizona NGST (Next Generation Space Telescope) Mirror System Demonstrator (NMSD). We discuss the mirror's design and present the initial measurements of the surface figure.

OMD2 2:33pm
Optics for the large binocular telescope, *H.M. Martin, R.G. Allen, J.H. Burge, L.R. Dettmann, J.M. Hill, D.A. Ketelsen, S.M. Miller, J.M. Sasian, Univ. of Arizona, USA.*
The two primary mirrors for the Large Binocular Telescope are the largest mirrors ever made. Lightweight honeycomb mirrors 8.4 m in diameter and f/1.14, they present a number of challenges in fabrication and testing. Both mirrors have been cast in a spinning furnace at the Steward Observatory Mirror Lab. The first has been generated, and is currently being polished with a 1.2 m diameter stressed lap that bends to match the varying curvature of the mirror surface. The primary mirrors are matched with adaptive secondary mirrors to provide diffraction-limited imaging.

OMD3 2:36pm
Error in vertex radius of curvature extrapolation via least-squares fit, *Brian Robinson, Joseph Geary, Univ. of Alabama-Huntsville, USA; H. Philip Stahl, NASA Marshall Space Flight Ctr., USA.*
We connect uncertainty in locations of points on a paraboloidal mirror to uncertainty in radius of curvature of best-fit surface. The analysis is based on least-squares fitting and is applicable to mirrors without physical vertex.

OMD4 2:39pm
Paraboloid vertex radius of curvature extrapolation from simultaneos measurement of tangential and sagittal radius of curvature, *Brian Robinson, Patrick Reardon, James Hadaway, Univ. of Alabama-Huntsville, USA.*
We analyze fundamental sources of uncertainty in three methods for extrapolating vertex radius of curvature of off-axis paraboloids from sagittal and/or tangential radii of curvature. The errors inherent in these and other methods are discussed.

OMD5 2:42pm
Surface figure determination of vibrating optical membrane, *Ted Rogers, Joseph Geary, Univ. of Alabama-Huntsville, USA.*
A synchronized, phase adjustable CCD camera trigger coupled to an audio frequency signal allows for surface figure determination of vibrating optical membrane to support NGST proof of concept.

Room: East Grand Ballroom
3:00pm–3:30pm
Coffee Break

Room: East Grand Ballroom
3:30pm–5:00pm
Monday Poster Presentation II
Hubert M. Martin, Univ. of Arizona, USA, Presider
Presider
This poster presentation includes all papers from sessions OMC and OMD.

Room: Cottonwood
6:30pm–8:00pm
Monday Dinner Speaker
Duncan Moore, Univ. of Rochester, USA.

■ Tuesday
■ June 4, 2002

Room: East Grand Ballroom
8:45am–9:00am
Announcements
Lisa Rich, Corning Tropel Corp., USA.

Room: East Grand Ballroom
9:00am–9:30am
OTuA ■ Optical Fabrication
Oliver Fahnle, Fisba Optics, Switzerland, Presider

Presider

OTuA1 9:00am Invited
Manufacture of large-aperture diffractive optics and ultrathin refractive optics for high-power laser and space applications, *Jerald A. Britten, Lawrence Livermore Natl. Lab., USA.*
We have developed equipment and technology for fabricating submicron pitch, high- efficiency diffraction gratings over meter-scale apertures that are used for pulse compression in ultrafast systems around the world. We have also developed wet-etch figuring (WEF) to generate arbitrary continuous contours on ultrathin glass substrates in a closed loop process. The current and future states of these technologies will be discussed.

Room: East Grand Ballroom
9:30am–10:00am
OTuB ■ Optical Fabrication Poster Preview
Oliver Fahnle, Fisba Optics, Switzerland, Presider

Presider

OTuB1 9:30am
Computational model for prediction of shaping with FJP and experimental validation, *Silvia M. Booij, Indro Partosoebroto, Joseph J.M. Braat, Delft Univ. of Tech., The Netherlands; Hedser van Brug, TNO Inst. of Applied Physics, The Netherlands; Oliver W. Fähnle, FISBA-Optik, Switzerland.*
A computer program is presented for computing material removal from spot-footprints, which is used to design a nozzle ideal for shape corrections, and to predict large-area removal. This removal can be in the ductile regime.

OTuB2 9:33am
A data base for the physical properties of optical polishing pitch, *Jessica E. DeGroote, Stephen D. Jacobs, Leslie L. Gregg, Anne E. Marino, Jennifer C. Hayes, Rupal Varshneya, Univ. of Rochester, USA.*
This presentation will discuss three quantitative methods for determining the hardness, softening point and viscosity of optical polishing pitch and the data acquired to date for each of the tests.

OTuB3 9:36am
Effects of in process adjustment of process speeds on the figure and surface quality of contour ground optical surfaces, *Derek Rollins, Paul Funkenbusch, Sheryl Gracewski, Jeff Ruckman, University of Rochester, USA.*
By adjusting the crossfeed speed and workpiece rotation rates as functions of position, geometrically induced variations in contour grinding can be reduced. The effects of this approach in improving process quality and consistency are described.

OTuB4 9:39am
Determination of subsurface damage in optical materials using a non-invasive technique, *J.A. Randi, J.C. Lambropoulos, S.D. Jacobs, Univ. of Rochester, USA.*
A non-destructive method for determining SSD depth has been developed using the relationship between the surface roughness (PV) and SSD of optical glasses. This relationship is being expanded to optical single crystal materials and checked with a destructive technique.

OTuB5 9:42am
Ion beam finishing technology for high precision optics production, *Axel Schindler, Thomas Hänsel, Frank Frost, Renate Fechner, Andreas Nickel, Hans-Jürgen Thomas, Horst Neumann, Dietmar Hirsch, Inst. für Oberflächenmodifizierung, Germany; Gerhard Seidenkranz, Reinhard Schwabe, Nanotechnologie Leipzig GmbH, Germany; Karl Barucki, Innovative Oberflächentechnologien GmbH, Germany.*
A new company - Nanotechnologie Leipzig GmbH - NTGL - is now offering customized ion beam figuring production equipment including the technology for high precision optics. The talk presents the system and its performance.

OTuB6 9:45am
Status of optical finishing for the National Ignition Facility, *Christopher Stolz, Joseph Menapace, Michael Borden, Lawrence Livermore Natl. Lab., USA; Albert Slomba, Zygo Corp., USA; Craig Kiikka, Tinsley Labs., Inc, USA; Sonia Gelman, Eastman Kodax Co., USA.*
Roughly 14% of the 7,500 meter-scale optics required for the National Ignition Facility have been fabricated to specification utilizing deterministic processes that were developed for efficient optical finishing of laser glass, BK7, and fused silica.

Room: East Grand Ballroom
10:00am–10:30am
Coffee Break

Room: East Grand Ballroom
10:30am–12:00pm
Tuesday Poster Presentation I
Oliver Fahnle, Fisba Optics, Switzerland, Presider
Presider
This poster presentation includes all papers from sessions OTuA and OTuB.

12:00pm–1:30pm
Lunch on Your Own

Room: East Grand Ballroom
1:30pm–3:30pm
OTuC ■ Lithography
Roland Loercher, Carl Zeiss, Inc., Germany, Presider
Presider

OTuC1 1:30pm Invited
Breaking barriers to Moore's Law, *Gerald Marcyk, Intel Corp., USA.*
The semiconductor industry faces an environment that includes increasing chip complexity, continued cost pressures, increasing environmental regulations, and growing concern about energy consumption. New materials and technologies are needed to support the continuation of Moore's Law.

OTuC2 2:00pm Invited

Future requirements on optics for lithography in the sub 100 nm range, *Reiner Garreis, Carl Zeiss Semiconductor Manufacturing Tech. AG, Germany.*

As the semiconductor industry follows the trend to higher integration of functionalities on a chip while increasing the speed of the operations the feature sizes on a chip continue to shrink at a rate of 30 % every two years. The imaging capabilities of optical lithography tools are the key enablers to support this trend. In this talk I will give an overview on the knobs the optical tool manufacturer has at his hands to increase the resolution of the optical systems: Starting from wavelength reduction and NA increase different illumination modes and other resolution enhancement methods will be described. It will be shown what implication the turning of these knobs will have on the requirements on optical manufacturing be it for optics in wavelength regions between 248 nm and 157 nm as well as for EUV Wavelengths of 13 nm. The current status of optical manufacturing for lithography systems will be described on component and system level and an outlook will be given what has to be achieved within the next technology changes.

OTuC3 2:30pm Invited

Intrinsic birefringence in 193nm and 157nm lithography crystalline optics, *John H. Burnett, NIST, USA.*

I discuss measurements and characterization of our recently reported intrinsic birefringence in cubic crystalline materials, e.g., CaF_2, required for VUV optics. I discuss the implications for 193nm and 157nm lithography system design, fabrication, and performance.

OTuC4 3:00pm Invited

Fabrication and metrology of high NA imaging optics for EUV-lithography, *Udo Dinger, Carl Zeiss Semiconductor Manufacturing Tech. AG, Germany.*
EUVL, i.e. microlithography, at 13nm is one of the most likely technologies to satisfy the requirements of the 50nm-node and below of the IC-manufacturing roadmap The development of the first step and scan machines meeting production requirements of field size and resolution is in progress. A key component of these machines will be a diffraction limited, off-axis mirror system with aspherical surfaces. The optical surfaces of these mirrors have to be fabricated and measured with unprecedented accuracies. In recent years, technology development at Carl Zeiss was focussed on the on-axis aspheres of the NA=0.30 micro exposure tool (MET). The next step is to transfer these processes to the surfaces of a NA=0.25 off-axis, large field system. The current status of the fabrication and metrology of both on-axis and off-axis mirrors will be presented.

Room: East Grand Ballroom
3:30pm–4:00pm
Coffee Break

Room: East Grand Ballroom
4:00pm–4:10pm
OTuD ■ Lithography Poster Presentation
Roland Loercher, Carl Zeiss, Inc., Germany, Presider Presider

OTuD1 4:00pm

Technology development for DUV-DOE fabrication – Results and problems, *A. Schindler, R. Fechner, Inst. für Oberflächenmodifizierung, Germany; R. Steiner, B. Dobschal, K. Rudolf, M. Burkhardt, R. Brunner, Carl Zeiss Jena GmbH, Germany.*
A fabrication technology for DUV Fresnel zone lenses has been developed using laser holography for the photo lithographic patterning and reactive ion beam etching for the 3D resist mask proportional transfer into fused silica.

OTuD2 4:03pm
Characterizing the polarization dependence of system-wavefronts at 157nm induced by intrinsically birefringent material, *Horst Schreiber, Paul G. Dewa, Keith E. Hanford, Steve K. Mack, Lisa. R. Rich, Paul J. Tompkins, Corning Tropel Corp., USA.*
Smaller semiconductor feature sizes demands lens systems with higher numerical apertures that operate at shorter wavelengths. 157nm materials exhibit properties that depend strongly on wavelength. We will present results obtained for characterizing the quantitative impact of this effects measured with high NA lens systems.

Room: East Grand Ballroom
4:10pm–5:30pm
Tuesday Poster Presentation II
Roland Loercher, Carl Zeiss, Inc., Germany, Presider Presider
This poster presentation includes all papers from sessions OTuC and OTuD.

Room: Double Tree Ballroom
6:00pm–7:30pm
Conference Reception

■ Wednesday
■ June 5, 2002

Room: East Grand Ballroom
8:45am–9:00am
Announcements
Lisa Rich, Corning Tropel Corp., USA.

Room: East Grand Ballroom
9:00am–9:30am
OWA ■ Thin Films
Birgit E. Gillman, Zygo Corp., USA, Presider Presider

OWA1 9:00am Invited
Characterization of optical components used in fiber communication, *Anmin Zheng, JDS Uniphase Corp., USA.*
Optical interference filters and coatings, of being able to alter the spectral distribution of an incident light, are playing a vital role in today's fiber communication. Based on the altered spectral response, filters and coatings are classified as narrow and wide bandpass filter, longpass and lowpass filter, high reflection coating, gain flattening filter, tunable filter notch filter and anti-reflection coating etc. When used as Gain flattening filters, 50GHz, 200GHz, and100GHz Mux/de-multiplexing, add-drop filters, and others etc, they can offer significant advantages, which include no requirement on any additional thermal compensation (absolutely passive device), easy integration with many other components, and easy-upgrade when needed. This talk will address some of the basic issues with characterizing the performance of optical filters and coatings. This includes the preparation and inspection of substrate, grin lenses and fiber before deposition, and measurement and testing of filters and coatings' spectral and environment properties after deposition. It will be also presented how substrate and coating quality affects the performance of the final devices and modules etc.

Room: East Grand Ballroom

9:30am–10:00am
OWB ■ Thin Films Poster Preview

Birgit E. Gillman, Zygo Corp., USA, Presider Presider

OWB1 9:30am
Multispectral slit filter developed for the remote sensing instrument of the ROCSAT-2 satellite, *Jean-Jacques Arnoux, Astrium SAS, France; Ting-Ming Huang, Precision Instrument Development Ctr., Taiwan.*
We describe the optimization of the Multispectral Slit Filter developed for ROCSAT-2 satellite with high transmittance, rejection of the solar flux and low level of ghost images in the detector package. Technological choices are examined.

OWB2 9:33am
Local thickness correction of nanometer thin films by means of ion beam etching, *T. Hänsel, A. Nickel, H.J. Thomas, A. Schindler, Inst. für Oberflächenmodifizierung, Germany.*
An ion beam figuring technology for local thickness correction of thin films has been developed. The thickness uniformity achieved over 6 inch substrate diameter for production like conditions is 5 nm.

OWB3 9:36am

Study of laser conditioning process for optical films, *Ren Huan, Jiang Xiao-dong, Huang Zu-xin, Gan Rong-bing, Zhong Wei, CAEP, China.*

The limit of the damage threshold of optics is one of the most important factors which affect the foundation of high power laser system. Under the actual level of technique, it is hardly to increase the laser system's loading capacity by improving the process technics or increasing the caliber. For some optics, laser conditioning is an effective way to improve their damage threshold. Related study show that the damage threshold of optics would improve to two times more than before after laser conditioning. It is feasible that the damage threshold could be improved safely and the power density of the laser system could be stepped up by studying the mechanism and technology of laser conditioning systematically. Since the limit of coating technical, the laser conditioning mechanism must be understood and comprehended. So experiments in two aspects were done to find the changes of several sol-gel films and PVD films during laser conditioning. First, studied the infection which damage did to decide the effective size and appearance. Secondly, studied the stability of different damages under consecutive irradiation. At the same time, some factors that affect the conditioning effect were analysed in order to discuss the techniques and methods of laser conditioning scientifically.

Room: East Grand Ballroom
10:00am–10:30am
Coffee Break

Room: East Grand Ballroom
10:30am–12:00pm
Wednesday Poster Presentation I

Birgit E. Gillman, Zygo Corp., USA, Presider Presider

This poster presentation includes all papers from sessions OWA and OWB.

12:00pm–1:30pm
Lunch on Your Own

Room: East Grand Ballroom
1:30pm–2:30pm

OWC ■ Metrology

H. Philip Stahl, NASA Marshall Space Flight Ctr., USA, Presider

Presider

OWC1 1:30pm Invited

Advances in interferometric metrology, *James Wyant, Univ. of Arizona, USA.*

Modern electronics, computers, and software have made interferometry an extremely powerful tool in many fields including the testing of optical components and optical systems. This talk will discuss some of the recent advances in interferometric metrology stressing advances in reducing the sensitivity to vibration.

OWC2 2:00pm Invited

Subaperture stitching interferometer for versatile and accurate surface metrology, *G.W. Forbes, P.R. Dumas, J.F. Fleig, P.E. Murphy, QED Tech., USA.*

We have incorporated system calibration within the familiar stitching process. Stitching inherently extends the testable aspheric departure and aperture sizes (both NA and CA), and we now show that it can also boost accuracy.

Room: East Grand Ballroom
2:30pm–3:03pm

OWD ■ Metrology Poster Preview

H. Philip Stahl, NASA Marshall Space Flight Ctr., USA, Presider

Presider

OWD1 2:30pm

Surface and particle characterization with cylindrical vector beams, *Thomas Brown, Univ. of Rochester, USA.*

Cylindrical vector beams possess an inhomogeneous linear polarization, which has cylindrical symmetry about the optical axis. Two members of this family exist: the azimuthally-polarized beam possesses an electric field which is always transverse, even under high numerical aperture focusing. The radially- polarized beam exhibits, in the focal region, a strong longitudinal component to the electric field. We have employed these beams in surface and particle metrology, with attention to micropolarimetry of particles, imaging of surface gradients, and single- molecule microscopy. Of particular interest is the use of longitudinal field imaging for the characterization of surfaces; fundamental questions are raised about what, exactly, is being probed on the surface in question. We present the results of recent experiments and discuss the prospects for using linear and nonlinear optical techniques for surface and particle metrology.

OWD2 2:33pm
Optical test alignment using computer generated holograms, *Jim Burge, Peter Koudelka, Univ. of Arizona, USA.*
Measurement systems for optical surfaces that lack axisymmetry are notoriously difficult to align and have limited accuracy. This paper describes a technique that uses a single CGH to act as null lens for measuring the aspheric surface, at the same time as it projects alignment marks into space that can be used for aligning the test. By providing reference features and the surface shape on the same hologram, we ensure accurate alignment. This method can also be used for aligning systems with multiple surfaces.

OWD3 2:36pm
Advances in laser Fizeau interferometry for optical testing, *C. Evans, L. Deck, D. Stephenson, M. Kuchel, Zygo Corp., USA.*
We summarize three development efforts in view of improving the state of the art for laser Fizeau interferometers for testing optical components. The first is a novel ring-shaped geometry for the laser source resulting in significantly reduced coherent artifacts without loss of fringe contrast over a wide measurement range. We then outline a commercial product designed to resolve much higher slopes than normal, which incorporates this novel ring-shaped source geometry. The third is a new approach, incorporating wavelength tuning with novel analysis techniques capable of simultaneous measurement of multiple surfaces and optical characteristics of sample parts, including homogeneity, without surface treatments that are normally needed to defeat unwanted internal Fizeau interference. These developments are intended to improve the functionality, precision and usefulness of this very important metrology tool.

OWD4 2:39pm
Null testing at 1nm accuracy for sub-mm asphericity, *Takashi Gemma, Shigeru Nakayama, Yuichi Takigawa, Hajime Ichikawa, Takahiro Yamamoto, Yusuke Fukuda, Tetsuji Onuki, Toshiro Umeda, Nikon Corp., Japan.*
We have developed the interferometry at 1nm accuracy for testing aspherical surfaces of sub-mm deviation from the sphere. Two null tests, with a null lens and a zone plate were compared with a CMM measurement and the differences were smaller than 1.8nm rms.

OWD5 2:42pm
White light diffractive common-path interferometer, *V. Koronkevich, G. Lenkova, A. Matochkin, Russian Acad. of Sciences, Russia.*
The diffractive interferometer with common–path beams was developed on the basis of synthetic test glass (zone plate). The interferograms agree well with results obtained using Zygo interferometer (accuracy < ?/20).

OWD6 2:45pm
Background subtraction for NIF large optics interferometry measurements, *Michael McBurney, Will House, Gary Stone, Wade Williams, Lawrence Livermore Natl. Lab., USA.*
Direct and statistical background subtraction were tested for Fourier bandpass filtered Brewster's angle transmitted wavefront measurements. An inference has alos been made about statistical subtraction for reflected wavefront measurements.

OWD7 2:48pm
Measurement of aspherical surfaces using test plate and computer generated hologram (CGH), *F. Pan, J. Burge, Univ. of Arizona, USA; D. Anderson, Rayleigh Optical Corp., USA.*
We present a new method for measuring off-axis aspheres that uses a test plate with spherical reference surface and a small CGH to compensate the aspheric departure. Design trade-offs and experimental results are also given.

OWD8 2:51pm
Focal length measurements for the National Ignition Facility large lenses, *T.G. Parham, T.J. McCarville, M.A. Johnson, Lawrence Livermore Natl. Lab., USA; C. Kiikka Tinsley Labs., Inc., USA.*
The focal length of the spatial filter and final focus lenses for the National Ignition Facility are measured to < +/- 0.01% using a combination of master lenses and production-oriented techniques for relative focal length

OWD9 2:54pm
Self-calibrating white-light interferometry techniques for shape measurement, *Joanna Schmit, Shawn McDermed, Artur Olszak, Veeco Metrology, USA.*
In order to obtain high precision shape measurements using white-light interferometry, it is necessary to accurately measure the rate of change of scanner motion. Presented here are two methods to account and correct for scanner non-linearity.

OWD10 2:57pm
Considerations for metrology of aspheric optical components, *Randall Wilson, Randy Brost, David Strip, Ronald Sudol, Richard Youngworth, Paul McLaughlin, Eastman Kodak Co., USA.*
In metrology for optical systems with aspheres, much emphasis has been placed on assessment of surface errors. In practice, however, there are important component-related considerations that must also be taken into account. In this paper, we discuss these considerations and raise several difficult issues that must be resolved. We conclude with a strong recommendation for an effort - on the part of the optics community - to standardize an interpretation method for aspheric component metrology.

OWD11 3:00pm
High-resolution micromeasurement with digital holography, *Lei Xu, Xiaoyuan Peng, Jianmin Miao, Anand Asundi, Nanyang Tech. Univ., Singapore.*
Digital holography is studied on system configuration and microscopic scheme for realizing high-resolution micromeasurement. The proposed system is examined experimentally in lateral resolution, measurement sensitivity and microscopic resolution respectively with application to microstructure testing.

Room: East Grand Ballroom
3:03pm–3:40pm
Coffee Break

Room: East Grand Ballroom
3:40pm–5:30pm
Wednesday Poster Presentation II
H. Philip Stahl, NASA Marshall Space Flight Ctr.., USA, Presider Presider
This poster presentation includes all papers from sessions OWC and OWD.

Room: Cottonwood
6:30pm–8:30pm
Wednesday Dinner Speaker
H. John Wood, NASA Goddard Space Flight Ctr., USA.

Key to Authors and Presiders

Abstracts

■ Monday
■ June 3, 2002

Room: Boojum
8:30am–10:00am
DMA ■ Applications: I
Gregory P. Nordin, Univ. of Alabama–Huntsville, USA, Presider

Presider

DMA1 8:30am Invited
Progress in diffractive integrated optics, *Jorgen Bengtsson, Peter Modh, Johan Backlund, Hans Lindberg, Anders Larsson, Chalmers Univ. of Tech., Sweden.*
Exploiting the wave nature of light to create new compact components is the goal of Diffractive Integrated Optics (DIO). So far DIOs have been only partly successful and in the next generation DIOs the diffractive, coupling, and waveguiding functions will be more indistinguishable.

DMA2 9:00am
Research on multi-layer diffractive optical elements and their application to camera lenses, *Takehiro Nakai, Hideki Ogawa, Canon Inc., Japan.*
We developed the multi-layer diffractive optical elements to operate with visible wavelength region. The principle of the multi-layer diffractive optical elements and application to photographic lens system, EF400mm F4 DO IS USM, is reported.

DMA3 9:15am
Shaping and homogenization of illumination with random microlens arrays, *G. Gretton, G.M. Morris, D.H. Raguin, Tasso R.M. Sales, Corning Rochester Photonics Corp., USA.*
We describe the use of random microlens arrays for beam shaping and homogenization. applications to light diffusion and display are discussed.

DMA4 9:30am
Diffractive optics for particle velocimetry and sizing, *Daniel W. Wilson, Pawan K. Gogna, Rebecca J. Chacon, Richard E. Muller, Jet Propulsion Lab., USA; Dominique Fourguette, Darius Modarress, Frederic Taugwalder, Pavel Svitek, VioSense Corp., USA; Morteza Gharib, California Inst. of Tech., USA.*
Beam-shaping diffractive optical elements are used to create structured light patterns in fluid flows. Particle scattering results in detected signals that can be used to determine the particle velocity and size.

DMA5 9:45am
Beam steering with four level phase modulating SLM, *David Engström, Sverker Hård, Chalmers Univ. of Tech., Sweden; Emil Hällstig, Swedish Defense Res. Agency, Sweden.*
We have studied beam steering with four-level phase modulation. Problems with angular dependent intensity, uncontrolled diffraction spots, and steering inaccuracy have been observed and investigated.

Room: Double Tree Ballroom
10:00am-10:30am
Coffee Break

Room: Boojum
10:30am–12:00pm
DMB ■ Fabrication
Dennis W. Prather, Univ. of Delaware, USA, Presider

Presider

DMB1 10:30am Invited
Diffractive optics and micro-optics production technology in Europe, *Michael Gale, CSEM, Switzerland.*
Following a period of intensive R&D in the 1990s, supported in part by national and EU funding programs, new technology and commercial services in micro-optics and diffractive optics have become available in Europe. A number of new companies offering commercial products and services have been established. This paper summarises the status and outlook of this technology.

DMB2 11:00am
Fabrication of refractive and diffractive micro-optical structures in diamond, *Mikael Karlsson, Fredrik Nikolajeff, Uppsala Univ., Sweden.*
Fabrication of refractive microlenses, blazed gratings and diffractive Fresnel lenses in diamond is demonstrated. In the fabrication process we have used photolithography, electron-beam lithography and plasma etching. The micro-optical elements have been optically evaluated.

DMB3 11:15am

GaN diffractive microlens fabricated with gray-level mask, *Chii-Chang Chen, Ming-Hung Li, Chih-Yang Chang, Gou-Chung Chi, Jenq-Yang Chang, Natl. Central Univ., Taiwan; Wei-Tai Cheng, Jui-Hung Yeh, Nano-Architect Res. Corp., Taiwan; Chuck Wu, Canyon Materials Inc., USA.*

We present the design and the fabrication of the GaN diffractive mcirolens by gray-level mask and inductively coupled plasma etching. The microlens was designed for the application of high-density optical data storage. The calculation results show that the high-numerical-aperture GaN diffractive microlens could be achieved by using the gray-level mask. The fabrication of the GaN diffractive microlens has been demonstrated for the first time. The advantage of using GaN as the material of the diffractive microlens is discussed.

DMB4 11:30am

Single step fabrication of blazed grating on sol-gel glass with high-energy beam-sensitive grey scale mask, *X-C. Yuan, W.X. Yu, W.C. Cheong, H.J. Jiang, Nanyang Tech. Univ., Singapore.*

We report the single-step fabrication technique using the hybrid sol-gel material with high-energy beam sensitive (HEBS) grey scale mask for low-cost mass production of continuous surface relief micro-optical components.

DMB5 11:45am

One-step fabrication of hybrid micro-diffractive-refractive lens with continuous relief using focused ion beam milling, *Yong-Qi Fu, Ngoi Kok Ann Bryan, Nanyang Tech. Univ., Singapore.*

The design, microfabrication and testing of hybrid micro-diffractive-refractive lens with continuous relief, which is used on laser diode for monomode fiber coupling, is discussed. The hybrid microlens with diameter as small as 65 mm and numerical aperture (N.A.) of 0.25 is fabricated directly onto a spherical surface using focused ion beam milling (FIBM) technology. Focused Ga+ ion beam is used to mill the continuous relief microstructure at an acceleration voltage of 50 kV. Measurement result shows that the one-step micromachining method is valid for practical use.

12:00pm–1:30pm

Lunch on Your Own

Room: Boojum
1:30pm–3:00pm
DMC ■ Theory
Philippe Lalanne, Ctr. Natl. de la Recherche Scientifique, France, Presider

Presider

DMC1 1:30pm Invited
Differential theory amelioration using Fourier factorisation rules, *Evgeny Popov, Michel Nevière, Nicolas Bonod, Inst. Fresnel, France.*
Classical differential theory is based on wrong propagation equations in the truncated Fourier space and shows a poor convergence in TM polarization. We present a new formulation of these equations applying the correct rules for truncated Fourier factorisation.

DMC2 2:00pm
Analytical model for the focusing of pinhole photon sieve, *Qing Cao, Jurgen Jahns, Univ. Hagen, Germany.*
We present a simple yet accurate analytical model for determining the focusing ability of the pinhole photon sieve. The validity of this model is demonstrated by comparing it with the exact numerical results. Some related problems are discussed.

DMC3 2:15pm
Numerical modelling of nonconformal gratings by the modified integral method, *Leonid I. Goray, Intl. Intellectual Group Inc., USA; Sergey Y. Sadov, Russian Acad. of Sciences, Russia.*
Numerical study of coated gratings of general nonconformal geometry in various parameter ranges is presented. Effects of an integral algorithm's characteristics (mesh parameters, Green series cutoff) are explored. Applications to industrial oxidized and covered gratings are demonstrated.

DMC4 2:30pm
Approximate diffraction theories: Efficient modeling of diffractive optical elements, *Markus Testorf, Univ. of Massachusetts-Lowell, USA.*
A new formulation of the generalized Kirchhoff approximation is presented which provides improved accuracy and a higher flexibility to model surface relief structures. The predicted diffraction amplitude is compared with rigorous coupled wave theory.

DMC5 2:45pm
Pseudoperiodic phase quantization approach, *Matthias Gruber, Univ. Hagen, Germany.*
A design approach for multilevel phase elements is presented. It is based on a modified IFTA and a pseudoperiodic phase quantization scheme. Optimal suppression of quantization noise is achieved.

Room: Double Tree Ballroom
3:00pm-3:30pm
Coffee Break

Room: Boojum
3:30pm–5:00pm
DMD ■ Scalar Methods and Applications
Markus E. Testorf, Univ. of Massachusetts-Lowell, USA, Presider

Presider

DMD1 3:30pm
Hybrid (diffractive-refractive) optical processor for space-variant color pattern recognition, *J. Lancis, G. Mínguez-Vega, E. Tajahuerce, V. Climent, Univ. Jaume I, Spain; J. Caraquitena, P. Andrés, Univ. de València, Spain.*
We report a hybrid chromatically-compensated Fresnel processor to perform space-variant color pattern recognition operations in a single step.

DMD2 3:45pm
Multiplexing of arbitrary-shaped polygonal apertures with discrete phase levels to design computer-generated holograms, *Jean-Numa Gillet, Yunlong Sheng, Univ. Laval, Canada.*
The iterative Fourier-transform algorithm (IFTA) has been widely used in the design of computer-generated holograms (CGHs) and diffractive optical elements. However, the IFTA becomes computationally expensive when the size of the CGH to design is larger than 512x512 pixels per period. On the other hand, modern lithographic techniques as electron-beam (e-beam) lithography provide to the CGH an extremely large number of degrees of freedom whose exploitation during the numerical design is of great importance.

DMD3 4:00pm

Diffractive elements designed to suppress unwanted zero order due to surface depth error, *Ville Kettunen, Heptagon, Switzerland; Janne Simonen, Markku Kuittinen, Univ. of Joensuu, Finland; Olivier Ripoll, Hans Peter Herzig, Univ. of Neuchatel, Switzerland.*

We consider design approach where unwanted zero order intensity due to profile depth error in binary diffractive elements is reduced by introducing third phase level thus relaxing the fabrication tolerances. The method is demonstrated numerically and experimentally.

DMD4 4:15pm

Comparison of diffractive optical element types for far-field beam shaping, *Olivier Ripoll, Hans Peter Herzig, Univ. of Neuchatel, Switzerland; Ville Kettunen, Heptagon, Switzerland.*

We compare the performance of grating type and remapping type diffractive optical elements for far-field beam shaping applications. Tolerances to fabrication errors, especially mask misalignment and etch depth error, are investigated.

DMD5 4:30pm

Diffractive optical elements displayed on a ferroelectric gray-scale spatial light modulator, *Laurent Bigue, Pierre Ambs, Univ. de Haute Alsace, France.*

We propose the optical implementation of diffractive optical elements onto a gray-scale ferroelectric liquid crystal spatial light modulator. The modulator is first characterized and multilevel amplitude elements are implemented. Optical results are provided.

DMD6 4:45pm

Methods for certification of CGH fabrication, *J. Burge, Univ. of Arizona, USA; A.G. Poleshchuk, V.P. Korolkov, V.V. Cherkashin, Inst. of Automation and Electrometry, Russia.*

A method for certifying the direct writing process for computer generated holograms is offered and experimentally validated. This method effectively reveals both random errors and slow drift during writing process. The techniques are demonstrated with a 64 mm diameter, f/1 binary zone plate.

Room: Boojum
8:30am–10:00am

DTuA ■ Applications: II

Sverker Hård, Chalmers Univ. of Tech., Sweden, Presider

Presider

DTuA1 8:30am Invited
Hybrid integration of micro-optical sub-assemblies, *Thomas J. Suleski, Alan D. Kathman, John B. Hammond, Hongtao Han, Michael R. Feldman, Digital Optics Corp., USA.*
Hybrid integration techniques provide powerful tools for fabrication of micro-optical sub-assemblies. In this paper, technologies for fabricating hybrid optical sub-assemblies are discussed, and multiple examples of devices are presented.

DTuA2 9:00am
Silicon diffractive optics at THz frequencies, *E.D. Walsby, R. Blaikie, S.M. Durbin, Univ. of Canterbury, New Zealand; T. Yuan, S. Wang, J. Xu, X.C. Zhang, Rensselaer Polytechnic Inst., USA; D.R.S. Cumming, Univ. of Glasgow, UK.*
Multilevel silicon diffractive lenses have been fabricated and tested in the frequency range 0.5-2THz. Efficient focusing occurs at the design frequency of 1THz with 4-level and 8-level lenses significantly outperforming zone plates and 2-level lenses.

DTuA3 9:15am
Optical vortex diffractive optical element-scattering application, *David Palacios, Grover Swartzlander Jr., Univ. of Arizona, USA.*
An optical vortex diffractive element was constructed by etching a plate of glass in a spiral staircase shape, such that the thickness of the glass increased in the azimuthal direction of the glass plate. The phase mask was then used to detect the light forward scattered through a colloidal solution. In the center of the optical vortex, the bright coherent laser beam was darkened owing to destructive interference allowing the detection of the incoherent scattered light.

DTuA4 9:30am
Nonvolatile holographic gratings in doubly doped $LiNbO_3$, *Liren Liu, Dean Liu, Liyong Ren, Changhe Zhou, Ye Liu, Chinese Acad. of Sciences, China.*
By using a two-step and a three-step recording/fixing schemes the nonvolatile holographic gratings are formed in $LiNbO_3$ crystals doped with Fe:Mn, Ce:Mn, Ce:Cu and Fe:Cu of the photochromic, bleaching or no-sensitization effect observed.

DTuA5 9:45am
A statistical model of noise grating selectivity in volume holographic recording materials, *Jesse A. Frantz, Raymond K. Kostuk, Univ. of Arizona, USA; David A. Waldman, Aprilis Inc., USA.*
A statistical model that describes noise gratings in volume holographic recording materials is presented. The model accounts for material properties and polarization effects. Results are compared to experimental data obtained using a cationic ring-opening photopolymer.

Room: Double Tree Ballroom
10:00am–10:30am
Coffee Break

Room: Boojum
10:30am–12:00pm
DTuB ■ Testing
Eric G. Johnson, Univ. of Central Florida, USA, Presider
Presider

DTuB1 10:30am
Planar grating lens for compact spectral imaging system, *Shogo Ura, Fumikazu Okayama, Koichi Shiroshita, Kenzo Nishio, Kyoto Inst. of Tech., Japan; Takahiro Sasaki, Hiroshi Nishihara, Osaka Univ., Japan; Tsutom Yotsuya, Masato Okano, Osaka Science and Tech. Ctr., Japan; Kazuo Satoh, Tech. Res. Inst. of Osaka Prefecture, Japan.*
Planar grating lens was designed and fabricated for compact spectroscopic imaging system. Spectral resolution of 5nm and spatial resolution of 0.25mm were experimentally confirmed with optical fiber array and two-dimensional image sensor.

DTuB2 10:45am

A new, sensitive diffractive optic angle meter, *Anders Magnusson, Kamyar Kazemi Moud, Sverker Hård, Chalmers Univ. of Tech., Sweden.*

A sensitive diffractive optic angle meter scheme, based on coherent imaging of two laterally shifted phase gratings onto a third, their periods matched, is presented and experimentally investigated. An angle less than 0.5 μrad was readily measured.

DTuB3 11:00am

CGHs as Fizeau reference for interferometric null testing, *A.G. Poleshchuk, Russian Acad. of Sciences, Russia; Jean-Michel Asfour, DIOPTIC GmbH, Germany.*

We present a new interferometric design for testing aspherical surfaces. The Fizeau type interferometer consists of an diffractive objective, which is generating reference beam and aspherical wavefront simulatanously on one single optical surface.

DTuB4 11:15am

New pulse-width measurement for ultrashort laser pulse, *Peng Xi, Changhe Zhou, Enwen Dai, Liren Liu, Chinese Acad. of Sciences, China.*

A new ultrashort pulse-width measurement based on Talbot effect is presented. As it is a linear method, it avoids all the drawbacks relating to nonlinear effect. Three techniques are brought forward to make it applicable.

DTuB5 11:30am

Measuring unresolved surface features using imaging ellipsometric polarization signatures, *Qiwen Zhan, James R. Leger, Univ. of Minnesota, USA.*

Imaging ellipsometric polarization signatures diffracted from unresolved structures are investigated using vector diffraction theory and utilized as sensitive measure to the linewidth. A 10-nanometer accuracy is obtained for 100-nanometer lines using an imaging system with 500-nanometer resolution.

DTuB6 11:45am

A novel DOE design for spectroscopy, *Odd Løvhaugen, Stephane Nicolas, Ib-Rune Johansen, Britta Grennberg Fismen, SINTEF, Norway.*

A DOE allows the function of beamsplitters, bandpassfilters and lenses to be integrated into a single optical surface. Scanning spectrometers constructed with DOE technology will have a built-in wavelength reference for the scanning, relaxing the demand for a scan angle control.

12:00pm-1:30pm
Lunch on Your Own

Room: Boojum
1:30pm–3:15pm
DTuC ■ Micro-optical Systems
Michael T. Gale, CSEM S.A., Switzerland, Presider

Presider

DTuC1 1:30pm Invited
Micro-optical modules fabricated by high-precision replication processes, *Markus Rossi, Ilkka Kallioniemi, Heptagon, Switzerland.*
Double-sided optical modules are fabricated by precision replication in environmentally resistant polymers and sol-gel materials. Due to their competitive prices they are of remarkable interest for datacom applications. Wafer scale processes and injection molding are addressed.

DTuC2 2:00pm Invited
Moving diffractive optical elements from stand-alone components into micro-optical systems, *S.A. Kemme, M.E. Warren, W.C. Sweatt, J.R. Wendt, D.W. Peters, T.R. Carter, S. Samora, O.B. Spahn, G.R. Hadley, G.A. Vawter, S.Y. Lin, D.W. Peterson, Sandia Natl. Labs., USA.*
The evolution of a diffractive optical element (DOE) from a stand-alone component into a micro-optical system can be a significant challenge. Design, fabrication, assembly, environmental and packaging constraints of micro-optical systems should be intimately coupled.

DTuC3 2:30pm
Optical microelectromechanical systems (OMEMS) based on silicon-on-insulator (SOI) technology, *Wilfried Noell, Pierre-André Clerc, Urs Staufer, Nico de Rooij, Hans Peter Herzig, Omar Manzardo, René Dändliker, Univ. of Neuchatel, Switzerland; Benedikt Guldimann, Univ. of California-Berkeley, USA; Gregor Schürmann, Harvard Univ., USA; Cornel Marxer, Sercalo Microtechnology Ltd., Liechtenstein.*
Microelectromechanical systems (MEMS) combined with optical components have additional optical functionality. The underlying technology of many of our devices is the silicon-on-insulator (SOI) technology. Switches, attenuators, and optomechanical and near-field sensors can be batch fabricated.

DTuC4 2:45pm
Fabrication and assembly of miniature imaging systems using lithographically patterned micro-optics and silicon microstructures, *Jeremy D. Rogers, Michael R. Descour, Ari H.O. Kärkkäinen, Randy J. Shul, C.G. Willison, C.P. Tigges, Univ. of Arizona, USA.*
A miniature imaging system is constructed by precision assembly of lithographically patterned hybrid-glass micro-optics on a micro-machined silicon substrate or MicroOptical Table (MOT).

DTuC5 3:00pm
Micro-sized Fourier spectrometer, *Omar Manzardo, Yves Petremand, Hans Peter Herzig, Wilfried Noell, Nico De Rooij, Univ. of Neuchatel, Switzerland.*
We present a miniaturized Michelson interferometer based on optical micro-electro-mechanical system (OMEMS) technology and we propose a possible method to obtain micro-optical elements that are suitable for integration in silicon chips.

Room: Double Tree Ballroom
3:15pm–3:45pm
Coffee Break

Room: Double Tree Ballroom
3:45pm–5:30pm
DTuD ■ Poster Session and Beauty Contest

DTuD1
Wavelength dispersion of 1D photonic crystals, *Shigeo Kittaka, Masatoshi Nara, Tatsuhiro Nakazawa, Takahiro Asai, Tadashi Koyama, Nippon Sheet Glass Co., Ltd., Japan.*
Propagations of plural photonic bands in one dimensional photonic crystals along spreading direction were examined with photonic band calculations and finite element method simulations. Large wavelength dispersion of Tiania-Silica multilayer film was also observed.

DTuD2
Polarization-selective subwavelength size hologram with rigorous coupled-wave analysis, *S.H. Tao, X-C. Yuan, W.C. Cheong, Nanyang Tech. Univ., Singapore.*
A subwavelength size computer generated hologram is designed with rigorous coupled-wave analysis, the simulation reconstruction results of the hologram are given with different polarization incident beams.

DTuD3
Polarization independent resonant grating reflection filters with broad angular selectivities, *Donald Jacob, Georgios Siganakis, M.G. Moharam, Univ. of Central Florida, USA.*
The design of polarization independent resonant grating reflection filters with broad angular selectivities will be discussed. The structures under consideration incorporate single 2-D and dual 1-D grating regions.

DTuD4
Diffraction grating modeling by RCWA and CM methods: Diffraction efficiency synchronism studies, *Ivan Richter, Petr Honsa, Pavel Fiala, Czech Tech. Univ.-Prague, Czech Republic.*
This contribution concentrates on modeling of diffraction processes in diffraction gratings by using RCWA and CM methods. Different situations are analyzed and compared (grating types, refractive index/relief modulation profiles, modulation strengths, and incident wave polarization, conical and Littrow mounts).

DTuD5
Digital modulation of light based on collinear acousto-optical weakly coupled states, *Alexandre S. Shcherbakov, A. Aguirre Lopez, INAOE, Mexico.*
Temporal solitons in the form of acousto-optical coupled states are studied theoretically and experimentally for digital modulation of light. Weakly-coupled states based conversion of multi-bit electronic signals into binary encoded optical pulse trains is demonstrated.

DTuD6
A three-order diffraction of light by acoustic grating with direct coupling of all the optical modes in a crystal, *Alexandre S. Shcherbakov, E. Tepichin Rodriguez, A. Aguirre Lopez, INAOE, Mexico.*
Specially designed regime of a three-order diffraction, when direct transitions between all the light modes are allowed and electronically controlled, is investigated both analytically and numerically. A set of scopes for all-optical switching is revealed.

DTuD7
Dynamic computer generated holograms displayed on a digital micromirror device, *Pierre Ambs, Laurent Bigue, Univ. de Haute Alsace, France; Yeshayahu Fainman, Univ. of California, USA.*
Dynamic binary amplitude Fourier and Fresnel Computer Generated Holograms were displayed on a Digital Micromirror Device. Using its speed, temporal multiplexing allowed speckle reduction and 3-D images reconstructions.

DTuD8
Analysis and design of diffractive optics in Wigner space, *Patrick Ghogomu, Markus Testorf, Univ. of Massachusetts-Lowell, USA.*
The Wigner Distribution function is applied to the analysis and the design of diffractive optical elements. This provides insight into how the space-bandwidth product is distributed and a measure of the wavelength dependence of diffraction.

DTuD9
Diffractive beam shaping for partially coherent UV-laser beams, *Dirk Schaefer, Juergen Ihlemann, Laser-Laboratorium Goettingen, Germany; Frank Simon, MicroLas Lasersystem GmbH, Germany.*
Based on a recently developed design algorithm a multifaceted diffractive phase element (DPE) has been realized for an excimer laser beam shaping application. The optical reconstruction is presented and the influence of corrections concerning wavefront distortion and coherence is demonstrated.

DTuD10
Optimization of diffraction grating profiles in fabrication by the electron-beam lithography, *Masato Okano, Tsutom Yotsuya, Osaka Science and Tech. Ctr., Japan; Hisao Kikuta, Yoshihiko Hirai, Osaka Prefecture Univ., Japan; Kazuya Yamamoto, NALUX Co., Ltd., Japan.*
We propose a new automatic design method of diffraction gratings with the rigorous electromagnetic grating analysis and the electron-beam lithography simulator. By using the simulator, the design method yields grating profiles to ease the fabrication.

DTuD11
Performance of beam energy sampling gratings fabricated with E-Beam direct writing, *Jingqin Su, Xiaofeng Wei, Chi Ma, Feng Jing, CAEP, China; Fuhua Gao, Feng Gao, Yongkang Guo, Sicuan Univ., China.*
In this paper, a method to fabricate beam energy sampling grating is presented. We also fabricated the sample of the gratings and corresponding experiment was carried out, the results agreed with what we designed well.

DTuD12
Additive lithography for micro-optics fabrication, *Mahesh Pitchumani, Heidi Hockel, Jinwon Sung, Waleed Mohammed, Laurent Vaissie, Eric G. Johnson, Univ. of Central Florida, USA.*
An innovative fabrication technique is introduced that is based on multiple exposure techniques for micro-optics fabrication. This method utilizes varying exposure times and masks to combine binary and analog photo-masks to sculpt complex photoresist profiles.

DTuD13
Fabrication of polymer diffractive elements for mid-infrared radiation, *Manuel Ornelas-Rodriguez, Sergio Calixto, Ctr. de Investigaciones en Optica, Mexico.*
Transmissive diffractive elements have been fabricated for the mid-infrared wavelength region by using polymeric substrates. The fabrication method is described. The influence of some fabrication variables related with the performance of the elements is analyzed.

DTuD14
Paper withdrawn.

DTuD15
Combination gratings for visual security applications, *C. Weiteneder, H.P. Herzig, Univ. Neuchâtel, Switzerland; A. Schilling, W.R. Tompkin, OVD Kinegram AG, Switzerland.*
We present the results of multiple gratings for visual security applications. The gratings are combinations of zero-order gratings and gratings with large periods with novel diffractive properties. Theoretical and experimental results are shown.

DTuD16
Demonstration of integrated electrical and free-space optical interconnects on a glass wafer, *Matthias Gruber, Stefan Sinzinger, Jurgen Jahns, Univ. of Hagen, Germany.*
We report about the planar integration of electrical lines and dense free-space optical interconnects between flip-chip bonded optoelectronic VLSI chips on a fused silica substrate.

Room: Double Tree Ballroom
6:00pm–7:30pm
Conference Reception with OF&T and IODC

Room: Boojum
10:30am–12:00pm
DWA ■ Modeling & Characterization
Thomas J. Suleski, Digital Optics Corp., USA, Presider

Presider

DWA1 10:30am
Color rendering techniques applied to the study of butterflies wings, *Boris Gralak, Gérard Tayeb, Stefan Enoch, Evgueni Popov, Inst. Fresnel, France.*
We use simultaneously color vision rendering techniques and rigorous lamellar electromagnetic grating theory in order to study the reflection properties of Morpho rhetenor butterflies wings

DWA2 10:45am
Total external reflection at optical wavelengths, *Rafael Piestun, Brian Schwartz, Univ. of Colorado-Boulder, USA.*
Total external reflection can occur at the interface between vacuum and a medium with refractive index less than unitiy. Here, analytical and numerical models predict such reflection at optical wavelengths for a metal-dielectric composite material.

DWA3 11:00am
Characterization of zone plates for lithography and imaging, *Rajesh Menon, Dario Gil, D.J.D. Carter, Xudong Tang, Henry I. Smith, MIT, USA.*
We characterize zone plates used for lithography and imaging. Experimental and simulation study of the spatial structure of the zone-plate point-spread functions (PSFs) are conducted.

DWA4 11:15am
Full complex amplitude modulation proximity printing mask fabricated on DLC and SiO_2 substrates, *L.G. Neto, G.A. Cirino, R.D. Mansano, P.S.P. Cardona, P. Verdonck, Univ. of São Paulo, Brazil.*
Proximity printing is a lithographic technique for microelectronic fabrication. A full complex-amplitude modulation proximity printing mask fabricated using a diamond like carbon (DLC) thin film on top of a patterned fused silica (SiO_2) substrate is proposed.

DWA5 11:30am
Study of blazed surface-relief transmission grating, *Jianru Shi, Chuck Titus, Philip J. Bos, Kent State Univ., USA; Bruce Winker, Rockwell Scientific Co., USA.*
The diffraction efficiency of a blazed surface relief transmission grating is reduced by geometrical (shadowing) and wavefront distortions associated with the relief. By means of FDTD (finite-difference time-domain) method, phase and efficiency conditions are obtained.

DWA6 11:45am
Modes of optical radiation from coated microsphere with active core, *Gennadiy Burlak, A. Zamudio-Lara, J. Sanchez-Mondragon, P. Marques-Aguilar, Autonomous State Univ. of Morelos, Mexico.*
Transmittance of compound system: spherical stack deposited on active substrate are calculated and analyzed. The Q factor of the eigenfrequencies becomes negative in the gain band when number of layers in stack is large enough.

12:00pm-1:30pm
Lunch on Your Own

Room: Boojum
1:30pm–3:15pm
DWB ■ Subwavelength Elements & Photonic Crystals
Shogo Ura, Kyoto Inst. of Tech., Japan, Presider Presider

DWB1 1:30pm Invited
Spectral and spatial filtering using waveguide grating mirror, *I. Avrutsky, Rabi Rabady, Kirill Zinoviev, Wayne State Univ., USA.*
Excitation and re-emission of guided modes in a planar waveguide grating structure is known to result in sharp features in wavelength and angular reflectance spectra. Being a part of a laser resonator, the waveguide grating mirror provides both spectral and spatial filtering, resulting in a single-mode operation of a large volume laser resonator.

DWB2 2:00pm
Low-sideband resonant subwavelength grating array design, *D.W. Peters, S.A. Kemme, G.R. Hadley, Sandia Natl. Lab., USA.*
A systematic method for the design of arrayed resonant subwavelength gratings is described. Design goals are peak reflectance of unity, narrow spectral bandwidth, and low sideband reflectivity for use in an arrayed grating structure.

DWB3 2:15pm
Brewster-angle resonant filters with absentee layers, *D. Shin, Z.S. Liu, Univ. of Texas-Arlington, USA; R. Magnusson, Univ. of Connecticut, USA.*
A method for sideband suppression applicable to resonant filters based on the Brewster effect and half-wavelength layers is presented. The spectral linewidth is controllable via grating thickness without affecting the sidebands. Experimental results confirm the predictions.

DWB4 2:30pm Invited
Laterally compressive drying of colloidal microspheres into highly-ordered 2-dimensional crystalline arrays, *Fotios Papadimitrakopoulos, Shifeng Hou, Eric Geiss, Baocheng Yang, Harris Marcus, Univ. of Connecticut, USA.*
A novel approach for fabricating uniform two-dimensional (2D) ordered arrays of colloidal particles on a variety of substrates was developed. The combination of confining the colloid evaporation local along with applying a compressive hydrostatic force while drying, has led to the formation of highly-ordered 2D crystalline arrays of polystyrene or silica particles organized into areas up to 1 cm^2.

DWB5 3:00pm
Fabrication of three-dimensional photonic crystals by holographic lithography, *Yuzo Ono, Kiyokatsu Ikemoto, Ritsumeikan Univ., Japan.*
Three-dimensional photonic crystals have been successfully fabricated in a photoresist by four-wave interference, where incident wave directions were set by considering the equation for interference fringe and that between lattice and reciprocal lattice vectors.

Room: Double Tree Ballroom
3:15pm–4:00pm
Coffee Break

Room: Boojum
4:00pm–5:15pm

JWA ■ Micro Optics - Joint Session with IODC

Daniel W. Wilson, Jet Propulsion Lab., USA, Presider

Presider

JWA1 4:00pm Invited
Calcitic microlenses as part of the photoreceptor system in brittle stars, *Joanna Aizenberg, Lucent Tech., USA.*
This presentation describes biologically-formed array of crystalline microlenses that demonstrate unique optical and mechanical properties. The microlenses are birefringence- and aberration-free and are individually-addressed. They exhibit exceptional signal enhancement, angular selectivity, photochromic activity and intensity adjustment.

JWA2 4:30m
Fabrication of micro-optical systems with deep x-ray lithography, *W.C. Sweatt, T.R. Christenson, Sandia Natl. Lab., USA.*
Preassembled, prealigned microlens systems have been fabricated in PMMA using Deep X-ray Lithography (DXRL). These systems consist of crossed cylindrical lenses with ≈0.3-mm apertures. Lithographically defined masks and two exposures from a synchrotron beam can produce arrays of micro-imagers, micro-spectrometers, etc.

JWA3 4:45pm
Aberration measurement of photolithographic lenses using hybrid diffractive photo-masks, *Eric Johnson, Jinwon Sung, Mahesh Pitchumani, Univ. of Central Florida, USA.*
In this paper, we present a method for incorporating diffractive optics on a photomask for aberration characterization. This allows for a manipulation of the incident illumination to the amplitude mask for estimating the aberration coefficients.

JWA4 5:00pm
Design and construction of disposable high NA miniature microscope objective for laser confocal microscopy, *Matthew Chidley, Chen Liang, Michael Descour, Univ. of Arizona, USA; Kung-Bin Sung, Rebecca Richard-Kortum, Univ. Texas-Austin, USA.*
In this paper we present the design and construction of a NA=1.0 water-immersion microscope objective 5mm in diameter and 17mm in length. Proposed design can be fabricated by injection molding using plastic materials.

Room: Boojum
8:30am–10:15am

DThA ■ Subwavelength Structures

Jyrki Saarinen, Heptagon, Finland, Presider Presider

DThA1 8:30am Invited
Fabrication and applications of subwavelength gratings, *H. Toyota, W. Yu, M. Okano, S. Omori, T. Yotsuya, Osaka Science and Tech. Ctr., Japan; H. Kikuta, Osaka Prefecture Univ., Japan; Y. Ichioka, Nara Natl. Col. of Tech., Japan.*
We have developed several kinds of diffractive optical elements with submicron structures. A key technology of fabrication of them is a high-density plasma etching. The profiles of subwavelength structures are controlled by etching conditions.

DThA2 9:00am Invited
Imaging with blazed binary diffractive elements, *P. Lalanne, M.S.L. Lee, J.C. Rodier, P. Chavel, E. Cambril, Y. Chen, Ctr. Natl. de la Recherche Scientifique, France.*
Blazed binary gratings are recent diffractive elements which implement continuous phase delays through a gradient index artificial material with subwavelength binary etches. Their performance in the resonance domain opens up new perspectives for manufacturing fast lenses.

DThA3 9:30am
Applications and fabrication of subwavelength gratings, *Marc Schnieper, Michael T. Gale, Christian Zschokke, CSEM, Switzerland; Christian David, Paul Scherrer Inst., Switzerland.*
Subwavelength gratings are being developed for commercial applications, in particular polarisers, antireflection surfaces and resonant filters for the visible and NIR. Prototyping, production and design using experimentally realistic profiles will be discussed.

DThA4 9:45am
Design of two dimensional polarization selective computer generated holograms using form-birefringence, *Mark S. Mirotznik, Catholic Univ., USA; Joseph N. Mait, US Army Res. Lab., USA; Dennis W. Prather, Univ. of Delaware, USA.*
We introduce a new design methodology for synthesizing two-dimensional polarization sensitive computer generated holograms. Our method uses the form-birefringence of a single binary two-dimensional grating to produce different phase profiles for the two orthogonal linear polarizations. We validated the method numerically using the finite-difference-time- domain method. We fabricated a single element but have not yet characterized its performance.

DThA5 10:00am
Tunable optical nanocavity based on modulation of near-field coupling between subwavelength periodic nanostructures, *Wataru Nakagawa, Yeshaiahu Fainman, Univ. of California-San Diego, USA.*
We design and analyze resonant optical nanocavities tuned by modulating via relative position the near-field coupling between periodic subwavelength nanostructures embedded within the nanocavity, and describe its potential application as an optical switching device.

Room: Double Tree Ballroom
10:15am–10:45am
Coffee Break

Room: Boojum
10:45am–12:00pm
DThB ■ Telecommunications
Joseph N. Mait, National Defense Univ., USA, Presider

Presider

DThB1 10:45am
Volume holographic filters for 1550 nm dense wavelength division multiplexing applications, *Raymond K. Kostuk, Univ. of Arizona, USA; Atsushi Sato, Univ. of Arizona, USA and Tech. Res. Inst., Japan; David A. Waldman, Aprilis Inc., USA.*
We review the performance requirements on spectral filters for dense wavelength division multiplexing applications. The design of holographic filters in cationic ring opening photopolymers is presented. Diffraction efficiency of 80% at 1550 nm is achieved.

DThB2 11:00am
Photopolymer characterization and grating playback at telecommunication wavelengths, *Daniel M. Sykora, Univ. of Rochester, USA; G. Michael Morris, Corning Rochester Photonics Corp., USA.*
The viability of holographic photopolymers for use at telecommunication wavelengths is studied. Parameters including absorption and transmission are determined, and the formation of large period gratings designed for high efficiency and infrared playback is discussed.

DThB3 11:15am
Design of a resonant grating filter for a tunable add-drop device at oblique incidence, *Guido Niederer, Hans Peter Herzig, Wilfried Noell, Thomas Overstolz, Ville Kettunen, Martin Salt, Univ. of Neuchatel, Switzerland; Michael Thomas Gale, Hans Thiele, Ctr. Suisse d'Electronique et de Microtechnique, Switzerland.*
A reflective resonant grating filter with a full width at half maximum of 0.5nm at 1545nm for a MOEMS tunable add-drop device was investigated. The minimal filter size and the fabrication tolerances were analyzed.

DThB4 11:30am
Diffractive optics in a parallel fiber transmitter module, *Christopher Coleman, Ye Christine Chen, Xu Wang, Agilent Tech., USA; Hudson Welch, Bob TeKolste, Digital Optics Corp., USA.*
A diffractive/refractive lens is described as the optical design for a high-speed fiber optic communications module. The diffractive element solves problems related to shaping light that is launched into the fiber, frustrating reflected feedback, and attenuating the laser power.

DThB5 11:45am
Paper withdrawn.

Key to Authors and Presiders