OSA
Optical Society of America

DOMO

Diffractive Optics and Micro-Optics

October 10-13, 2004
Rochester, New York

Collocated with:

Optical Fabrication & Testing (OF&T), and
Frontiers In Optics / Laser Science XX

The DOMO topical meeting would like to acknowledge the generous support of:

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Frank Wyrowski, *Friedrich Schiller Univ., Germany*

About DOMO

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

Diffractive optics, micro-optics and nanotechnology 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 as well as nanophotonic components can be combined and integrated into electro-opto-mechanical systems to provide unique system properties.

Meeting Topics

Topics to be covered:

Applications and New Products

- Bio and chemical sensors with DOEs
- Imagers and image processing
- Micro-optics for spectral analysis, miniature spectrometers
- Holographic data storage
- Heads-up and helmet-mounted displays
- Integration of DOEs/MOEs and MEMS
- Communication/telecom applications using micro-optics/DOEs
- Optical interconnects and switching
- DOEs for WDM applications
- Nonlinear waveguide-grating devices
- Beam forming and beam steering
- Terahertz periodic elements

Fabrication

- Packaging and assembly of DOMO devices and systems
- Fabrication of 1D, 2D periodic elements and 3D photonic crystals
- MEMS fabrication
- Fabrication by nanotechnology
- Fabrication by self-assembly

- 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, and other etching processes
- Holographic optical elements
- Photopolymer and photochromic materials
- Plastic embossing, molding and casting
- Element characterization and performance evaluation

Nanostructured Diffractive/Micro-Optical Elements

- Subwavelength diffractive elements
- Polarization elements, antireflective surfaces, spectral filters
- Integrated optics with periodic light guides
- Laser sources with periodic reflectors
- 2D and 3D photonic crystals waveguides and devices
- Microsphere resonators

Dynamic Diffractive/Micro-Optical Elements

- Optical MEMS
- Spatial light modulators
- 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
- Analysis of wave propagation in periodic-index lattices

Invited Speakers

The preliminary list of invited speakers includes:

- DMB1, **Wave-optical design and its relation to diffractive optics**, *Frank Wyrowski; Friedrich Schiller, Univ., Germany.*
- DSuA1, **Diffractive and micro-optical components (20 years later)**, *Hans Peter Herzig; Inst. of Microtechnology, Univ. of Neuchâtel, Switzerland.*
- DSuA2, **Large-aperture diffractive optical elements for high power laser and space applications**, *Sham Dixit, Joe Menapace, June Yu, Jerry Britten, Rod Hyde; LLNL, USA.*
- DSuB1, **Dispersion in photonic crystals - Who cares?**, Thomas Krauss; Univ. of St. Andrews, UK.
- DSuC1, **Diffractive optics solution for phakic intraocular lenses**, *Mike Morris, Dale Buralli; Apollo Optical Systems, USA.*
- DTuA1, **Diffractive/refractive hybrids for blue LD optical storage**, *Yuichiro Ori[1], Kyu Takada[2], Junji Hashimura[1], Nobuo Mushiake[2]; [1]Optical Component Operations, Development Group, Konica-Minolta Opto Inc., Japan, [2]Optical R&D Ctr., Konica-Minolta Opto Inc., Japan.*
- DTuA2, **LED beam shaping with micro-optics**, *Markus Rossi, Ville Kettunen, Hartmut Rudmann; Heptagon, Switzerland.*
- DTuB1, **Effects of symmetry and defects on the extraordinary transmission of light through plasmonic films,** *John Ballato, Jeff DiMaio; Clemson Univ., USA.*
- DTuC1, **Photonic structures in biology**, *Peter Vukusic; Exeter Univ., UK.*
- DTuD1, **Holographic data storage - Photopolymer material and drive technology**, *David Waldman, C. J. Butler, D. H. Raguin, J. Joseph; Aprilis, Inc., USA.*
- DTuD3, **On the suitability of diffractive optical elements in solar applications**, *Andreas Gombert; Fraunhofer Inst. for Solar Energy Systems, Germany.*
- DWA1, **Sub-wavelength optical elements and nanofabrication - A path to integration of optical components on chip**, *Stephen Chou; Princeton Univ., USA.*

- DWA2, **3D microstructuring using ultrafast lasers - A new approach for integrated optics**, *Stefan Nolte, Matthias Will, Jonas Burghoff, Elodie Wikszak, Andreas Tünnermann; Friedrich Schiller Univ. Jena, Inst. of Applied Physics, Germany.*
- XWA2, **Measurement advances for micro-refractive fabrication**, *Angela Davies, Brent Bergner, Neil Gardner; Univ. of North Carolina at Charlotte, USA.*

Agenda of Sessions

On This Page:

Sunday, October 10, 2004

Time	Event/Location
10:00 AM - 12:00 PM	**DSuA**, Applications I *Hyatt Grand Ballroom ABC*
12:00 PM - 1:30 PM	Lunch Break
1:30 PM - 3:15 PM	**DSuB,** Waveguide Devices *Hyatt Grand Ballroom ABC*
3:15 PM - 3:45 PM	Coffee Break *Hyatt Grand Ballroom D*
3:45 PM - 5:30 PM	**DSuC**, Applications II *Hyatt Grand Ballroom ABC*

Monday, October 11, 2004

Time	Event/Location
8:15 AM - 10:00 AM	**OMA**, Advances in Optical Fabrication and Testing *Hyatt Grand Ballroom EFG*
9:45 AM - 10:30 AM	Coffee Break *Hyatt Grand Ballroom D*
10:30 AM - 12:15 PM	**DMA**, Design and Fabrication *Hyatt Grand Ballroom ABC*
10:30 AM - 12:00 PM	**OMB**, Thin Films *Hyatt Grand Ballroom EFG*
12:00 PM - 1:30 PM	Lunch Break
1:30 PM - 3:30 PM	**DMB**, Design *Hyatt Grand Ballroom ABC*

1:30 PM - 3:30 PM	**OMC**, Grinding and Polishing *Hyatt Grand Ballroom EFG*
3:30 PM - 4:00 PM	Coffee Break *Hyatt Grand Ballroom D*
4:00 PM - 5:30 PM	**DMC**, DOMO Poster Session *Hyatt Grand Ballroom D*
4:00 PM - 5:45 PM	**OMD**, Finishing *Hyatt Grand Ballroom EFG*
7:30 PM - 9:30 PM	**OME**, OF&T Glass Art Contest *Hyatt Grand Ballroom EFG*

Tuesday, October 12, 2004

Time	Event/Location
8:00 AM - 10:00 AM	**OTuA**, Materials Science *Hyatt Grand Ballroom EFG*
8:15 AM - 10:00 AM	**DTuA**, Applications III *Hyatt Grand Ballroom ABC*
10:00 AM - 10:30 AM	Coffee Break *Hyatt Grand Ballroom D*
10:30 AM - 12:00 PM	**OTuB**, Interferometry *Hyatt Grand Ballroom EFG*
10:30 AM - 12:00 PM	**DTuB**, Subwavelength Optics I *Hyatt Grand Ballroom ABC*
12:00 PM - 1:30 PM	Lunch Break
1:30 PM - 3:15 PM	**OTuC**, Fabrication and Testing *Hyatt Grand Ballroom EFG*
1:30 PM - 3:30 PM	**DTuC**, Subwavelength Optics II *Hyatt Grand Ballroom ABC*
3:15 PM - 4:00 PM	Coffee Break *Hyatt Grand Ballroom D*
4:00 PM - 6:00 PM	**DTuD**, Applications IV *Hyatt Grand Ballroom ABC*
4:00 PM - 5:45 PM	**OTuD**, Testing *Hyatt Grand Ballroom EFG*
5:00 PM - 8:30 PM	FiO/LS/DOMO/OF&T Joint Reception *Clarion*

Wednesday, October 13, 2004

Time	Event/Location
8:00 AM - 10:00 AM	**DWA**, Fabrication *Hyatt Grand Ballroom ABC*
8:00 AM - 10:00 AM	**OWA**, Large Optics *Hyatt Grand Ballroom EFG*
10:00 AM - 10:30 AM	Coffee Break *Hyatt Grand Ballroom D*
10:30 AM - 12:00 PM	**XWA**, Joint DOMO/OF&T Session *Hyatt Grand Ballroom ABC*

Diffractive Optics And Micro-Optics 2004

Hyatt Grand Ballroom ABC
10:00 a.m.–12:00 p.m.
DSuA • Applications I
Daniel Wilson; JPL, USA, Presider

DSuA1 • 10:00 a.m. (Invited)
Diffractive and micro-optical components (20 years later),
Hans Peter Herzig; Inst. of Microtechnology, Univ. of Neuchâtel, Switzerland.
Micro-optics includes optical components that are fabricated by modern micromachining. The paper presents the development of micro-optics since the introduction of microfabrication techniques. We discuss what we have learned and present recent developments.

DSuA2 • 10:30 a.m. (Invited)
Large-aperture diffractive optical elements for high-power laser and space applications,
Sham Dixit, Joe Menapace, June Yu, Jerry Britten, Rod Hyde; LLNL, USA.
We discuss the design, fabrication and performance of large aperture diffractive optical elements for high-power laser (NIF) and space applications. Examples include diffraction gratings, continuous phase plates and Fresnel lenses.

DSuA3 • 11:00 a.m.
High-efficient optical manipulation of microparticles using micro-optical elements,
Woei Ming Lee, Wai Chye Cheong, Jing Bu, Hong Wang, Xiao-Cong Yuan; Nanyang Technological Univ., Singapore.
We demonstrate that by using an assortment of microfabricated optical elements, a variety of high and low intensity optical traps are realized with high power efficiency.

DSuA4 • 11:15 a.m.
High-resolution optical fiber-integrated resonant biosensors,
Debra D. Wawro[1], Purnomo S. Priambodo[2], Robert Magnusson[3]; [1]UTSW Medical Ctr. at Dallas, USA, [2]Univ. of Texas at Arlington, USA, [3]Univ. of Connecticut, USA.
Optical sensors based on resonating periodic waveguides are presented. Spectral shifts of 6.4nm are measured as protein chemically binds to a sensor surface. Measured transmission notches agree with theory for a double-layer fibertip device.

DSuA5 • 11:30 a.m.
Selective coupling to higher order modes dual mode step index fiber,
Waleed Mohammed, Alok Mehta, Heidi Hockel, Mahesh Pitchumani, Eric Johnson; CREOL, USA.
We introduce a novel coupling scheme for selectively exciting the LP_{11} mode in a step index fiber. This scheme can be utilized for optical pumping for fiber lasers and amplifiers.

DSuA6 • 11:45 a.m.
Synthetical diffractive elements for security applications realized on enhanced integral dot-matrix system,
Marek Škereň, Ivan Richter, Pavel Fiala; Czech Technical Univ., Czech Republic.
Several methods of security enhancement of diffractive elements for security applications are presented, high carrier frequency cryptograms, Fresnel multi-focal cryptograms, and noise covered elements are introduced. Designed structures are realized on special integral dot-matrix system.

Hyatt Grand Ballroom ABC
1:30 p.m.–3:15 p.m.
DSuB • Waveguide Devices
Philippe Lalanne; Inst. d'Optique Théorique et Appliquée, France, Presider

DSuB1 • 1:30 p.m. (Invited)
Dispersion in photonic crystals–Who cares?
Thomas Krauss; Univ. of St. Andrews, UK.
The dispersive properties of planar photonic crystals and their use in photonic devices is discussed. Applications include dispersion compensation as well as phase matching for nonlinear processes and short pulse generation.

DSuB2 • 2:00 p.m.
Oxidized AlGaAs angle reflector and waveguide for optical interconnects,
Alan Y. Hsu, Michael J. Cich, Gregory A. Vawter, Gregory M. Peake;
Sandia Natl. Labs, USA. A novel oxidized AlGaAs angle reflector and waveguide for optical interconnects has been designed and fabricated. Successful transmission of the fundamental mode at 1.55 µm from in-plane to out-of-plane has been demonstrated.

DSuB3 • 2:15 p.m.
A leaky-mode directional coupler for a blue laser waveguide lens,
Yongwoo Park, Dongwoo Suh; Electronics and Telecommunications Res. Inst., Republic of Korea.
A leaky-mode directional coupler (LMDC) consisting of two slab waveguides was designed for the sake of high efficient focusing waveguide grating coupler (FWGC) using reflection pole method (RPM) and finite difference beam propagation method (FDBPM).

DSuB4 • 2:30 p.m.
Integrated optical devices with nanoscale guiding layers,
De-Kui Qing, Philip Hemmer; Texas A&M Univ., USA.
The waveguides with negative dielectric cladding are investigated. For TM1 modes the thickness of guiding layer can be ten times smaller than the working wavelength. The band-passing, wavelength-response, and transmission loss properties are analyzed.

DSuB5 • 2:45 p.m.
Amplitude apodization in lithographically-scribed planar waveguide holograms via correlated line set displacement,
Thomas W. Mossberg, Dmitri Iazikov, Christoph M. Greiner; LightSmyth Technologies Inc., USA.
Flexibility in the design of slab waveguide holograms demands an amplitude apodization means compatible with binary-etch-depth photolithographic fabrication. We discuss principles and implementation of one such amplitude apodization means based on correlated diffractive line sets.

DSuB6 • 3:00 p.m.
Split of phase-shifts in phase mask and its impact to fiber Bragg gratings,
Yunlong Sheng[1], Joshua E. Rothenberg[2], Hongpu Li[3], Ying Wang[4], Jason Zweiback[5]; [1]Univ. Laval, Canada, [2]Northrop Grumman, USA, [3]Shizuoka Univ., Japan, [4]Kiara Networks, USA, [5]General Atomics, USA.
A phase shift in phase mask is split into two half-magnitude phase-shifts in near field, resulting in FBG spectral asymmetry. The errors are removed using new pre-compensating phase mask for binary-phase Dammann sampled multi-channel FBGs.

Hyatt Grand Ballroom D
3:15 p.m.–3:45 p.m.
Coffee Break

Hyatt Grand Ballroom ABC
3:45 p.m.–5:30 p.m.
DSuC • Applications II
Jyrki Saarinen; Heptagon, Finland, Presider

DSuC1 • 3:45 p.m. **(Invited)**
Diffractive optics solution for phakic intraocular lenses,
Mike Morris, Dale Buralli; Apollo Optical Systems, USA.
A single polychromatic diffractive lens that brings a multiplicity of wavelengths to a common focus is used as a phakic intraocular lens (IOLs) to provide excellent vision correction for both myopia (near-sightedness) and hyperopia (far-sightedness).

DSuC2 • 4:15 p.m.
Replicated diffractive optical elements in consumer products,
Michael T. Gale, Markus Rossi, Hartmut Rudmann, Jyrki Saarinen; Heptagon, Switzerland.
Replication technology enables DOEs to be mass produced at low cost and is a major factor in their use in consumer products. The paper will discuss their advantages and give examples of applications in products.

DSuC3 • 4:30 p.m.
Deep-UV microscopy based on a hybrid diffractive/refractive lens system,
Robert Brunner[1], Reinhard Steiner[1], Klaus Rudolf[1], Hans-Jürgen Dobschal[1], Renate Fechner[2], Axel Schindler[2]; [1]Carl Zeiss Jena GmbH, Germany, [2]Leibniz-Inst. for Surface Modification, Germany.
A hybrid microscope system was developed and used to inspect lithography-masks at 193 nm. The realization of the DOE as most critical element involves both, high frequency lithography and an additional ion etching process.

DSuC4 • 4:45 p.m.
Imaging with a miniature microscope constructed from grayscale lithographically patterned refractive microlenses,
Jeremy D. Rogers[1], Tomasz S. Tkaczyk[1], Michael R. Descour[1], Ari H. O. Kärkkäinen[2], Mohammed S. Rahman[3], Rebecca Richards-Kortum[3]; [1]Optical Sciences Ctr., USA, [2]Chemtone, Oy., Finland, [3]Univ. of Texas, USA.
A miniature microscope objective is fabricated and assembled using refractive microoptics patterned directly in hybrid sol-gel glass. Imaging performance is assessed and design considerations for future improvements including tilted elements for stray-light reduction are discussed.

DSuC5 • 5:00 p.m.
Orthoscopic and pseudoscopic white-light imaging by means of symmetrical diffractive optical elements,
Jose J. Lunazzi, Noemí I. Rodriguez Rivera, Daniel S. Ferreira Magalhães; Campinas State Univ., UNICAMP, Brazil.
White-light imaging by means of two diffractive elements symmetrically located to an aperture is a new result that makes the technique useful as a starting point to understand other composite double diffraction systems.

DSuC6 • 5:15 p.m.
Dispersion-compensated Lau-like processor,
Gladys Minguez-Vega[1], Vicent Climent[1], Enrique Tajahuerce[1], Jesus Lancis[1], Pedro Andrés[2], Zbigniew Jaroszewicz[3]; [1]Univ. Jaume I, Spain, [2]Univ. de Valencia, Spain, [3]Inst. of Applied Optics, Poland.
We present a diffractive lens-based optical assembly with which to achieve high-contrast Lau-like interferential fringes with totally incoherent illumination.

Hyatt Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

Hyatt Grand Ballroom ABC
10:30 a.m.–12:15 p.m.
DMA • Design and Fabrication
Joseph Mait; Natl. Defense Univ., USA, Presider

DMA1 • 10:30 a.m.

Polarization-insensitive, high-dispersion TIR diffraction gratings,

John R. Marciante[1], Jeffrey I. Hirsh[2], Daniel H. Raguin[3], Eric T. Prince[4]; [1]Lab for Laser Energetics, Univ. of Rochester, USA, [2]Piezograph Ltd., USA, [3]Aprilis Inc., USA, [4]RPC Photonics, USA.

TIR diffraction gratings were fabricated with less than 0.6 dB IL and 0.2 dB PDL respectively across a 50-nm bandwidth. Littrow measurements resulted in low PDL across 100-nm bandwidth, with up to 100% diffraction efficiency.

DMA2 • 10:45 a.m.

An UV-replicated polymer focusing grating coupler for blue light,

Dongwoo Suh, Hojun Ryu, Yongwoo Park, Mun Cheol Paek; ETRI, Republic of Korea.

A polymer focusing grating coupler was implemented on a slab waveguide using nanoscale UV-replication process. Numerical aperture and spot size were measured at 0.85 and 347 nm, respectively. The out-coupling efficiency was 28%.

DMA3 • 11:00 a.m.

Rigorous contour integral equation study of optical properties of interacting arbitrary-shape nano-rods,

Svetlana V. Boriskina, Trevor M. Benson, Phillip Sewell, Alexander I. Nosich; George Green Inst. for Electromagnetics Res., Univ. of Nottingham, UK.

We apply an integral equations method to simulate the scattering of light from finite sets of arbitrary nano-rods. The effect of the rods shape and their electromagnetic interaction is studied with high and controllable accuracy.

DMA4 • 11:15 a.m.

The zero-order phase-contrast technique,

José Carlos Pizolato, Jr., Luiz Gonçalves Neto; Univ. of Sao Paulo, Brazil.

A new Phase-Contrast Technique without a phase-changing plate is proposed. The advantage of this method is the easy scheme to recover the gray level information encoded on a phase-only mask.

DMA5 • 11:30 a.m.

Phases of the diffracted waves and energy conservation,

Cristiano M. B. Cordeiro[1], Edson J. Carvalho[1], Agnaldo Freschi[2], Lifeng Li[3], Lucila Cescato[1]; [1]IFGW/UNICAMP, Brazil, [2]DF/UNESP, Brazil, [3]Dept. of Precision Instruments, Tsinghua Univ., China.

The energy conservation is used in an experiment in which two incident waves reach the grating at the symmetrical Littrow condition, to analyze the phases of the waves diffracted by a non-absorbing relief grating.

DMA6 • 11:45 a.m.

Micro-beam shaping to generate various non-diffracting modes,

Balpreet Singh Ahluwalia, Xiaocong Yuan, Shaohua Tao; Nanyang Technological Univ., Singapore.

In this paper we report the dynamic generation of various non-diffracting modes and complete set of its interference pattern. We also present review of our recent work on the novel optical beams by micro-beam shaping.

DMA7 • 12:00 p.m.

Experimental realization of nondiffracting Parabolic beams,

Carlos López-Mariscal[1], Miguel Bandrés-Motola[1], Julio C. Gutiérrez-Vega[1], Sabino Chávez-Cerda[2]; [1]Tecnologico de Monterrey, Mexico, [2]INAOE, Mexico.

We report the experimental realization of zero-order Parabolic nondiffracting beams. The observed transverse patterns have an inherent parabolic structure and exhibit the common features of general nondiffracting beams.

12:00 p.m.–1:30 p.m.

Lunch Break

Hyatt Grand Ballroom ABC
1:30 p.m.–3:30 p.m.
DMB • Design
Robert Magnusson; Univ. of Connecticut, USA, Presider

DMB1 • 1:30 p.m. **(Invited)**
Wave-optical design and its relation to diffractive optics,
Frank Wyrowski; Friedrich Schiller Univ., Germany.
Actually optical engineering experiences a generalization. Physical optics modelling and design methods enrich geometric optics based techniques which still dominate the design of optical systems. The role of diffractive optics in this process is discussed.

DMB2 • 2:00 p.m.
Implementation and analysis of binary optics for angular and wavelength multiplexing,
Markus E. Testorf, Ursula J. Gibson; Dartmouth College, USA.
The implementation of thick diffraction gratings with binary optics and thin film technology is proposed. Reciprocal space is used to analyze the grating properties and to design generalized color separation gratings.

DMB3 • 2:15 p.m.
Combination of focusing and apodization in one multilevel diffractive lens,
Qing Cao, Jürgen Jahns; Optische Nachrichtentechnik, Fern Univ. Hagen, Germany.
We show that both the functions of focusing and apodization can be simultaneously realized by one multilevel diffractive lens. As an example, we numerically design an 8-phase-level diffractive lens to produce a Gaussian focal spot.

DMB4 • 2:30 p.m.
Analytic solutions in design of resonance domain diffractive optical elements,
Michael A. Golub, A. A. Friesem; Weizmann Inst. of Science, Israel.
Analytical solutions for determining the optimum period, depth, detour and angular slant orientation of the grooves in diffractive elements in the resonance domain of light diffraction are developed. Computer simulations of specific gratings are presented.

DMB5 • 2:45 p.m.
The novel design of a polarization independent multi-layer grating with high diffraction efficiency,
Manabu Shiozaki[1], Masakazu Shigehara[2]; [1]Sumitomo Electric Industries Ltd., Japan, [2]Sumiden High Precision Co. Ltd., Japan.
To reduce polarization dependence in diffraction efficiency of first-order transmission gratings, we propose the novel design with multi-layer structure. High diffraction efficiency (>95%) and low polarization dependence (<2%) around C-band are obtained in our experiment.

DMB6 • 3:00 p.m.
Structured-groove phase gratings for control and optimization of the spectral efficiency,
Johan P. Backlund, Daniel W. Wilson, Richard E. Muller; JPL, USA.
We present a new design method that tailors and optimizes the spectral efficiency of a phase diffraction grating by introducing an arbitrary structure into the grating groove profile.

DMB7 • 3:15 p.m.
Adiabatic three-wave symmetric volume hologram,
Chang Ching Tsai, Leon B. Glebov, Vadim I. Smirnov, Boris Y. Zeldovich; CREOL, USA.
A transmission hologram with two volume gratings is considered for the diffraction of wave *A* into *B* via intermediate wave *C*. Adiabatic regime of efficient diffraction has the advantage of low sensitivity to gratings' strength.

Hyatt Grand Ballroom D
3:30 p.m.–4:00 p.m.
Coffee Break

Hyatt Grand Ballroom D
4:00 p.m.–5:30 p.m.
DMC • DOMO Poster Session

DMC1
Phase-space optics applied to the design of Talbot array illuminators,
Markus E. Testorf; Dartmouth College, USA.
The phase-space description of optical signals is used to design Talbot array illuminators. Array illuminators with arbitrary intensity compression ratio can be designed from simple geometrical transformations of a schematic phase-space diagram.

DMC2
Planar nonparaxial beams,
Gustavo Rodriguez-Morales[1], Julio C. Gutierrez-Vega[1], Sabino Chavez-Cerda[2]; [1]ITESM, Mexico, [2]Inst. Natl. de Astrofísica, Optica y Electronica, Mexico.
We present a study of nonparaxial modes in planar waveguides. We provide with exact analytical solutions for this kind of structures. These solutions are nonsingular and describe perfectly paraxial Hermite-Gauss beams in the corresponding limit.

DMC3
Enzimatic cleavage to enhance the surface relief on dichromated pullulan films,
Cristina Solano, Geminiano Martinez-Ponce; Ctr. de Investigaciones en Optica, Mexico.
Holographic gratings were recorded in dichromated pullulan films using a 532nm laser, which induced a cross-linking of the polysaccharide. A post-exposure enzymatic treatment is applied to the films in order to enhance the surface relief.

DMC4
Optical properties of a replicated polarizing holographic element,
Edson Carvalho[1], Edmundo Braga[2], Lucila Cescato[1]; [1]IFGW/UNICAMP, Brazil, [2]DEMIC/FEEC/UNICAMP, Brazil.
We described the replication of a polarizing holographic optical element by injection molding. The optical properties of the replicated structures were evaluated by measurements of the diffraction efficiency for the two orthogonal polarizations.

DMC5
Rigorous analysis of field distribution and power flow in grating coupler of finite length,
M. G. Moharam, Andrew B. Greenwell; School of Optics/CREOL - Univ. of Central Florida, USA.
We present an efficient rigorous vector electromagnetic analysis of field distribution and power flow in finite length grating couplers. Nanoscale field distribution at the waveguide/grating coupler discontuity is investigated.

DMC6
LED light coupling into a lightguide with gratings,
Samuli Siitonen[1], Pasi Laakkonen[1], Pasi Vahimaa[1], Markku Kuittinen[1], Marko Parikka[2], Kari Mönkkönen[3]; [1]Univ. of Joensuu, Finland, [2]Nokia Mobile Phones Ltd., Finland, [3]Perlos Ltd., Finland.
Two grating couplers are designed with rigorous diffraction theory to couple LED light into a thin lightguide through the bottom side. Designed couplers can be mass replicated with Ni-shim technology by injection molding.

DMC7

Collinear diffraction of light by short acoustic pulses and its application to coherent processing of UHF pulses,

Alexandre S. Shcherbakov, Eduardo Tepichin Rodriguez, Mauro Sanchez Sanchez; Natl. Inst. for Astrophysics, Optics & Electronics, Mexico.

We present analytical model for collinear diffraction of light by acoustic pulses in crystals, when attenuation and beam spreading are allowed. The algorithm for optical processing of UHF pulses for anti-radar applications is experimentally studied.

DMC8

Fabrication and testing of binary-phase Fourier gratings for nonuniform array generation,

Andrew S. Keys[1], Robert W. Crow[2], Paul R. Ashley[3], Thomas R. Nelson[4], Jack H. Parker[4], Elizabeth A. Beecher[4]; [1]NASA MSFC, USA, [2]Sensing Strategies Inc., USA, [3]US Army Aviation and Missile Command, USA, [4]AFRL, USA.

This effort describes the fabrication and testing of binary-phase Fourier gratings designed to generate an incoherent array of output source points with nonuniform user-defined intensities, symmetric about the zeroth order.

DMC9

Encoding diffractive optical elements onto liquid crystal displays,

Jeffrey A. Davis[1], Ignacio Moreno[2]; [1]San Diego State Univ., USA, [2]Univ. Miguel Hernandez de Elche, Spain.

Liquid crystal displays allow encoding of programmable diffractive optical elements. Various encoding schemes are possible including amplitude-only, phase-only, fully complex amplitude and phase, and a new technique for encoding polarization. Experimental results will be provided.

DMC10

Hartmann test of small F/# convex mirrors: cornea or aspherical contact lens,

Yobani Mejia-Barbosa; Univ. Natl. de Colombia, Colombia.

We present a Hartmann test for measuring aspherical convex mirrors of small F/#. We discuss the main differences with the usual Hartmann test for concave mirrors and show some experimental results for contact aspherical lenses.

Hyatt Grand Ballroom ABC

8:15 a.m.–10:00 a.m.

DTuA • Applications III

Shogo Ura; Kyoto Inst. of Technology, Japan, Presider

DTuA1 • 8:15 a.m. (Invited)

Diffractive/refractive hybrids for blue LD optical storage,

Yuichiro Ori[1], Kyu Takada[2], Junji Hashimura[1], Nobuo Mushiake[2]; [1]Optical Component Operations, Development Group, Konica-Minolta Opto Inc., Japan, [2]Optical R&D Ctr., Konica-Minolta Opto Inc., Japan.

We developed a BD/DVD compatible objective lens assembly using a diffractive optical element named WSE. This objective lens assembly has high efficiencies, fine tracking characteristics and low chromatic aberrations for both BD and DVD.

DTuA2 • 8:45 a.m. (Invited)

LED beam shaping with micro-optics,

Markus Rossi, Ville Kettunen, Hartmut Rudmann; Heptagon, Switzerland.

Many LED applications, such as in mobile phones and PDA’s, require compact and highly efficient beam shaping elements. Micro-optical elements fabricated by laser writing and UV-replication offer attractive solutions for white LED’s.

DTuA3 • 9:15 a.m.

Microlens diffusers and beam shapers for light-emitting diode (LED) sources,
Tasso Sales, Stephen Chakmakjian, Donald J. Schertler, G. Michael Morris; RPC Photonics Inc., USA.
We present a class of microlens-based diffusers and beam shapers designed to homogenize LED illumination and maximize the energy utilization from these sources. Diffuser design and fabrication are discussed.

DTuA4 • 9:30 a.m.
Engineered diffusers for UV litography,
Donald J. Schertler, Stephen Chakmakjian, G. Michael Morris, Tasso Sales; RPC Photonics Inc., USA.
Engineered diffusers are proposed for homogenization and shaping of pupil and field illumination distributions for UV lithography applications. Capabilities include arbitrary diffusion angle, spatial distribution, high transmission, and polarization conservation, without zero order or speckle.

DTuA5 • 9:45 a.m.
Correction of dispersion distorsion of femtosecond pulses by choosing the surface shape of THz diffractive optical elements,
Igor V. Minin, Oleg V. Minin; Novosibirsk State Technical Univ., Russian Federation.
Peculiarities of propagation of femtosecond pulses through a focusing diffractive optical element are considered. It is shown that the dispersion distorsion can be decreased by fabricating the diffractive optical element on the optimal curvilinear surface.

Hyatt Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

Hyatt Grand Ballroom ABC
10:30 a.m.–12:00 p.m.
DTuB • Subwavelength Optics I
Eric G. Johnson; Univ. of Central Florida, USA, Presider

DTuB1 • 10:30 a.m. (Invited)
Effects of symmetry and defects on the extraordinary transmission of light through plasmonic films,
John Ballato, Jeff DiMaio; Clemson Univ., USA.
Structure/property relationships of plasmonic films have been investigated through spectroscopy and electron imaging. Dominance of short range order allows for controlled emissions, and defects are found not to be detrimental to overall film performance.

DTuB2 • 11:00 a.m.
Surface plasmon-assisted transmission and emission from subwavelength patterned apertures,
David W. Peters, I. El-Kady, Shanalyn A. Kemme, G. R. Hadley; Sandia Natl. Labs, USA.
We optimize surfaces with patterned apertures for maximized transmission and emission by coupling into and out of surface plasmon modes. We shift transmission and emission peaks in the spectrum through control of device parameters.

DTuB3 • 11:15 a.m.
Accurate modelling of line-defect photonic crystal waveguides with the RCWA,
Christophe Sauvan, Philippe Lalanne, Jean Paul Hugonin; Inst. Optique, CNRS, France.
By using grating codes, and namely on the RCWA (also called Fourier modal method), we show that non-periodic photonic-crystal devices can be rigorously modelized.

DTuB4 • 11:30 a.m.
Arbitrary angle waveguiding applications of 2-D curvilinear-lattice photonic crystals, *Javad Zarbakhsh[1], Kurt Hingerl[1], Frank Hagmann[2], Sergei F. Mingaleev[2], Kurt Busch[3]; [1]Univ. Linz, Austria,*

[2]*Inst. für Theorie der Kondensierten Materie Univ. Karlsruhe, Germany,* [3]*Dept. of Physics and School of Optics/CREOL, Univ. of Central Florida, USA.*
Using stretching/shearing transformations on quadratic/hexagonal structures moves the dielectric rods/ holes and creates curvilinear photonic crystals, but keeps the bandgap effect. This design freedom leads to new resonator structures and arbitrary angle waveguides.

DTuB5 • 11:45 a.m.
Simulation of optical propagation in photonic crystals using a high accuracy FDTD model,
James B. Cole, Saswatee Banerjee; Univ. of Tsukuba, Japan.
We introduce a new high accuracy finite-difference time-domain (FDTD) algorithm, and a method to model complicated sub-wavelength structures on a coarse numerical grid. We used it to simulate light propagation in photonic crystals.

12:00 p.m.–1:30 p.m.
Lunch Break

Hyatt Grand Ballroom ABC
1:30 p.m.–3:30 p.m.
DTuC • Subwavelength Optics II
Philippe Lalanne; Inst. d'Optique Théorique et Appliquée, France, Presider

DTuC1 • 1:30 p.m. (Invited)
Photonic structures in biology,
Peter Vukusic; Exeter Univ., UK.
Diverse designs of naturally evolved nano-scale periodicity are known to generate optical functionality in the living world. While these systems have clearly evolved for biological purposes, they are increasingly offering inspiration and design protocols for applied optical technologies.

DTuC2 • 2:00 p.m.
Guided-mode resonance biosensors employing phase detection,
Robert Magnusson[1], K. J. Lee[1], D. Wawro[2]; [1]Univ. of Connecticut, USA, [2]Univ. of Texas Southwestern Medical Ctr., USA.
Example biosensors utilizing variations in guided-mode resonance phase are presented. It is shown that these phase changes can be appreciable so as to permit practical detection of ultra-thin biomolecular layers.

DTuC3 • 2:15 p.m.
High-frequent structures generated by interference lithography in the DUV,
Michael Helgert, Matthias Burkhardt, Klaus Rudolf, Reinhard Steiner, Robert Brunner; Carl Zeiss Jena GmbH, Germany.
We demonstrate the potential of interference lithography in the DUV by examples of two-dimensional patterns that have been obtained by multiple exposure techniques. Using immersion prisms we realized gratings with more than 10,000 lines/mm.

DTuC4 • 2:30 p.m.
Subwavelength diffractive optics for complete micropolarizer arrays in the short-wave and mid-wave IR,
Shanalyn A. Kemme[1], D. W. Peters[1], J. R. Wendt[1], T. R. Carter[2], S. Samora[2]; [1]Sandia Natl. Labs, USA, [2]L&M Technologies, USA.
Numerical and experimental results are presented on polarizers and waveplates, arrayed for snap-shot imaging polarimeter applications. Design, material, and fabrication issues are discussed as the wavelength moves from the mid-wave IR to the visible waveband.

DTuC5 • 2:45 p.m.

Polarization independent resonant bandstop filters using 1-D periodic layers with asymmetric profiles,
Yiwu Ding, Robert Magnusson; Univ. of Connecticut, USA.
We demonstrate polarization independent guided-mode resonance bandstop filters utilizing nondegenrate leaky modes excited with light at normal incidence. Narrowband and wideband filters are obtained by controlling the grating profile and modulation strength.

DTuC6 • 3:00 p.m.
Interaction between strongly focussed light and sub-λ-structures,
Henning Voellm, Manfred Eberler, Gerd Leuchs; Max-Planck-Res. Group, Germany.
We examine the interaction between strongly focussed light and sub-λ-structures by measuring the reflected and scattered intensities. Our results show that a scalar model is inadequate for high numerical aperture focussing.

DTuC7 • 3:15 p.m.
Combination of blazed and laterally blazed structures ,
Bernd H. Kleemann[1], Ralf Arnold[2], Johannes Ruoff[1]; [1]Carl Zeiss, Germany, [2]Carl Zeiss SMT AG, Germany.
We present the main properties of a new type of sub-wavelength blazed grating characterized by structures having a “pie-slice” form with sub-wavelength feature sizes in the direction lateral to the dispersion direction.

Hyatt Grand Ballroom D
3:30 p.m.–4:00 p.m.
Coffee Break

Hyatt Grand Ballroom ABC
4:00 p.m.–6:00 p.m.
DTuD • Applications IV
Eric G. Johnson; Univ. of Central Florida, USA, Presider

DTuD1 • 4:00 p.m. (Invited)
Holographic data storage–Photopolymer material and drive technology,
David Waldman, C. J. Butler, D. H. Raguin, J. Joseph; Aprilis Inc., USA.
Storage density (S_{2D}), dynamic range (υ_m), recording sensitivity, fidelity and data lifetimes will be discussed for angle and azimuthally multiplexed digital data pages recorded in Aprilis holographic media based upon low shrinkage Cationic Ring-Opening Polymerization.

DTuD2 • 4:30 p.m.
Four dimensional volume holographic imaging,
Wenyang Sun, George Barbastathis; Dept. of Mechanical Engineering, MIT, USA.
We present the use of volume holograms as depth-selective lenses with white light illumination. It demonstrated a spectral imaging with <250μm depth resolution over $\approx 15^0$ field of view, with angular selectivity <0.6 mrad.

DTuD3 • 4:45 p.m. (Invited)
On the suitability of diffractive optical elements in solar applications,
Andreas Gombert; Fraunhofer Inst. for Solar Energy Systems, Germany.
An overview of diffractive optical elements for radiation power management in solar applications is given. Design and manufacturing techniques of the proposed elements are described and the suitability of the elements is discussed.

DTuD4 • 5:15 p.m.
Large area microstructured optic applications,

Steve Scott; Reflexite Precision Technology Ctr., USA.
Applications where microstructured optics components are required over large areas are increasing. This paper describes optical microstructures, their applications, and the challenges involved in mastering, replicating and production of these microstructures over large areas.

DTuD5 • 5:30 p.m.
Photocontrolled micro-optical structures in azobenzene liquid crystals,
Nelson V. Tabiryan, Uladzimir A. Hrozhyk, Svetlana V. Serak; BEAM Co., USA.
Novel photosensitive liquid crystal material systems allow micro-optical applications such as beam steering. Photocontrolled reconfigurable integrated optical circuits can be created using low power LED sources.

DTuD6 • 5:45 p.m.
Polarization multiplexing of diffractive optical elements with liquid crystal displays,
Jeffrey A. Davis[1], Garrett H. Evans[1], Ignacio Moreno[2]; [1]San Diego State Univ., USA, [2]Univ. Miguel Hernández de Elche, Spain.
We show programmable polarization multiplexing of diffractive optical elements (DOE's) using two liquid crystal displays (LCD's). The first LCD encodes the two DOE's. The second LCD changes the polarization state for these two DOE's.

Clarion Hotel
5:00 p.m.–8:30 p.m.
FiO/LS/DOMO/OF&T Joint Reception

Hyatt Grand Ballroom ABC
8:00 a.m.–10:00 a.m.
DWA • Fabrication
Luiz G. Neto; Univ. of Sao Paulo, Brazil, Presider

DWA1 • 8:00 a.m. (Invited)
Sub-wavelength optical elements and nanofabrication: A path to integration of optical components on chip,
Stephen Chou; Princeton Univ., USA.
No abstract provided.

DWA2 • 8:30 a.m. (Invited)
3-D microstructuring using ultrafast lasers: A new approach for integrated optics,
Stefan Nolte, Matthias Will, Jonas Burghoff, Elodie Wikszak, Andreas Tünnermann; Friedrich Schiller Univ. Jena, Inst. of Applied Physics, Germany.
3-D photonic structures can be directly written into different glasses and crystalline media by using tightly focused ultrashort pulses. Using a high repetition-rate femtosecond fiber laser system we were able to produce low loss waveguides at writing speeds of up to 100 mm/s. We will review recent results.

DWA3 • 9:00 a.m.
Integrated-optic free-space-wave drop demultiplexer fabricated by using interference exposure method,
Shogo Ura[1], Mei Hamada[1], Junpei Ohmori[1], Kenzo Nishio[1], Kenji Kintaka[2]; [1]Kyoto Inst. of Technology, Japan, [2]Natl. Inst. of Advanced Industrial Science and Technology, Japan.
Compact interference optics and contact-type mask aligner were combined to integrate waveguide gratings for constructing intraboard WDM optical interconnects. Wavelength drop demultiplexing of free-space waves from guided waves was demonstrated.

DWA4 • 9:15 a.m.
Use of fractional Talbot images for fabrication of diffractive optical elements,

Thomas J. Suleski, Yi-Chen Chuang; Univ. of North Carolina at Charlotte, USA.
In this paper, we discuss the use of Fresnel-regime interference patterns as exposure mechanisms for the fabrication of diffractive optical elements. Design approaches are discussed, and both theoretical and experimental results are presented.

DWA5 • 9:30 a.m.
A novel technique for integration of optical elements onto silicon,
Karin Hedsten[1], Anders Magnusson[2], Jonas Melin[3], Henrik Rödjegård[4], Gert Andersson[4], Jörgen Bengtsson[2], Peter Enoksson[1], Fredrik Nikolajeff[3], David Karlén[1]; [1]Solid State Electronics Lab, Dept. of Microtechnology and Nanoscience, Chalmers Univ. of Technology, Sweden, [2]Photonics Lab, Dept. of Microtechnology and Nanoscience, Chalmers Univ. of Technology, Sweden, [3]Dept. of Engineering Sciences, Ångström Lab, Uppsala Univ., Sweden, [4]Imego AB, Sweden.
A novel technique is presented for integrating diffractive optical elements onto silicon. The processing is made in a reverse order as the diffractive lens is first embossed in a plastic layer on the silicon wafer.

DWA6 • 9:45 a.m.
Rod and spherical fused silica microlenses fabricated by the melting method,
Sergio Calixto[1], Lizbeth Castaneda-Escobar[2]; [1]Ctr. de Investigaciones en Optica, Mexico, [2]INAOE, Mexico.
It is shown that micro lenses with rod and spherical shape can be fabricated with the melting method. Size of the lenses ranges between tens of microns to about several millimeters.

Joint DOMO/OT&T Session

Hyatt Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

Hyatt Grand Ballroom ABC
10:30 a.m.–12:00 p.m.
XWA • Joint DOMO/OF&T Session
Thomas J. Suleski; Univ. of North Carolina at Charlotte, USA, Presider

XWA1 • 10:30 a.m. (Invited)
New technologies for aspherical grinding/polishing of micro/meso optics,
Tsunemoto Kuriyagawa, Nobuhito Yoshihara; Tohoku Univ., Japan.
New technologies for ultra-precision aspherical grinding and polishing of aspherical optical lenses and molding dies are introduced, which are “parallel grinding method,” “fluctuation-free grinding method” and “electrorheological fluid assisted micro-polishing.”

XWA2 • 11:00 a.m. (Invited)
Measurement advances for micro-refractive fabrication,
Angela Davies, Brent Bergner, Neil Gardner; Univ. of North Carolina at Charlotte, USA.
Micro-refractive lenses are critical components in many devices, yet characterization remains challenging. We have developed calibration methods for micro-interferometry to improve form error, transmitted wavefront, and radius of curvature measurements.

XWA3 • 11:30 a.m.
Test of aspherics in the NIR with a diffractive optical element as null lens,
Frank Simon, Norbert Lindlein, Johannes Schwider; Inst. of Optics, Information and Photonics, Max-Planck-Res. Group, Univ. of Erlangen-Nuremberg, Germany.
By the use of a Combo-DOE it is possible to get the absolute deviations of an aspherical surface. A light source of the NIR region is used to allow the measurement of steep aspherics.

XWA4 • 11:45 a.m.

Traceable radius measurements of micro-lenses,

Ayman M. Samara, Brent C. Bergner, Angela Davies, Kate Medicus, Neil Garner; Univ. of North Carolina at Charlotte, USA.

We have developed a method to measure the radius of curvature of micro-lenses. It is based on a coordinate transformation from known errors in the motion as the micro-lens is moved between the measurement positions.