Optical Interference Coatings Topical Meeting and Tabletop Exhibit

June 3–8, 2007

Loews Ventana Canyon Resort and Spa
Tucson, Arizona

Hotel Reservation Deadline: May 11, 2007
Pre-Registration Deadline: May 10, 2007

Technical Program Committee

Norbert Kaiser, *IOF Fraunhofer Inst., Germany*, **General Chair**
Christopher J. Stolz *, Lawrence Livermore Natl. Lab., USA,* ***Program Chair***

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Alexander V. Tikhonravov, *Moscow State Univ., Russian Federation*
Markus K. Tilsch, *JDS Uniphase Corp., USA*
Zhanshan Wang, *Tongji Univ., China*

Measurement Problem

Angela Duparré, *IOF Fraunhofer Inst., Germany*
Detlev Ristau, *Laser Zentrum Hannover eV, Germany*

Manufacturing Problem

Stephen D. Browning, *Ball Aerospace and Technologies Corp., USA*
J.A. Dobrowolski, *Natl. Res. Council, Canada*

Design Problem

Markus Tilsch, *JDS Uniphase Corp., USA*
Karen Hendrix, *JDS Uniphase Corp., USA*

About OIC

This meeting serves as a focal point for global technical interchange in the field of optical interference coatings. It will include papers on research, development and applications of optical coatings, such as fundamental and theoretical contributions in the field as well as practical techniques and applications.

This conference, like its predecessors, meets every three years to survey and capture advancements in the broad area of optical coatings. The format of the meeting includes invited papers by leaders in the field, short oral presentations of papers and poster sessions with ample discussion periods. There are no parallel sessions.

The International Society for Optical Engineering – SPIE, European Optical Society – EOS and the Society of Vacuum Coaters – SVC are cooperating societies for the OIC 2007 program.

Meeting Topics to Be Considered

Deposition Process Technologies

- New coating deposition technologies
- Low and high energy deposition techniques
- Process control for complex coatings
- Novel deposition methods
- Industrial sputtered metal and dielectric coatings
- Substrate cleaning techniques

Applications

- Coatings for fiber optic and telecommunication components
- Coatings for solar energy utilization
- Coatings on plastic
- Coatings for display applications
- Coatings for biological applications
- Coatings for astronomical and space applications
- Coatings for ultrafast applications
- Coatings for XUV, UV and IR spectral regions
- Thin film based polarizers

Coating and Substrate Materials

- Novel coating materials (Nonlinear, organic, electrochromic, electroluminescent,)
- Transparent conductive coatings
- Composite material coatings
- Unusual substrate materials

Characterization and Properties of Coatings

- Fundamentals of thin film growth
- Optical properties of thin films
- Scattering from multilayers
- Adhesion and stress
- Environmental stability
- Laser induced damage
- Optical thin film characterization techniques
- Non-optical thin film characterization techniques
- Computer-based thin film modeling

Design of Coatings

- Computer design techniques
- Computational Manufacturing
- Design of coatings for oblique angles of incidence
- Multilayers on gratings
- Structured and waveguide coatings

Invited Speakers

MA1, Charles Keith Carniglia (1944-2006): In Memoriam, *George Dobrowolski; Natl. Res. Council of Canada, Canada*

MA2, New Ideas and Developments in the Field of Optical Coatings, *H. Angus Macleod; Thin Film Ctr., USA*

MB1, 2007 OSA Topical Meeting on Optical Interference Coatings: Manufacturing Problem, *Stephen Browning[1], George Dobrowolski[2]; [1]Ball Aerospace & Technologies Corp., USA, [2]Natl. Res. Council of Canada, Canada*

MC1, Atomic Engineering with Multilayers, *Troy W. Barbee; Lawrence Livermore Natl. Lab, USA*

MC2, Micro-and Nanostructured Optical Thin Films: Potential and Applications, *François R. Flory[1], Ludovic Escoubas[2], Jean-Jacques Simon[2], Philippe Torchio[2]; [1]ENSPM, France, [2]EGIM, Technopole de Chateau-Gombert, France*

MD1, Chemically-Prepared Silica Films with Single Crystalline Mesoporous Structures, *Hirokatsu Miyata; Canon Res. Ctr., Leading-Edge Technology Development Headquarters, Canon INC., Japan*

TuA1, Nanoamorphous Optical Coatings, *Hans Pulker; Univ. of Innsbruck, Austria*

TuB1, Mechanical Properties of Thin Films, *Frank Richter[1], Thomas Chudoba[2], Norbert Schwarzer[3]; [1]Inst. für Physik, Chemnitz Univ. of Technology, Germany, [2]Advanced Surface Mechanics (ASMEC), Germany, [3]Saxonian Inst. of Surface Mechanics, Germany*

TuC1, Manufacture of High Performance Polarizing Beam Splitter for Projection Display Applications, *Penghui Ma, Li Li, Fengchen Lin, J. A. Dobrowolski; Natl. Res. Council of Canada, Canada*

TuD1, Narrowband Multi-Channel Filters and Integrated Optical Filter Arrays, *Zhanshan Wang[1], Yonggang Wu[1], Tian Sang[1], Li Wang[1], Hongfei Jiao[1], Jingtao Zhu[1], Lingyan Chen[1], Shaowei Wang[2], Xiaoshuang Chen[2], Wei Lu[2]; [1]Tongji Univ., China, [2]Chinese Acad. of Sciences, China*

WA1, Pre-Production Analysis of Optical Coating Manufacturability, *Alexander V. Tikhonravov, Michael K. Trubetskov; Res. Computing Ctr. of, Russian Federation*

WB1, OIC 2007: Design Problem Results, *Markus Tilsch, Karen Hendrix; JDSU, USA*

WC1, Optimization of Optical Monitoring of Non-Quarterwave Stacks Using Admittance, *Boo-Young Jung[1], Jang-Hoon Lee[1], Sung-Goo Jung[1], Byung Jin Chun[1], Chang Kwon Hwangbo[1], Young-Jin Song[2], Eung-Soon Kim[2], Jong Sup Kim[3]; [1]Inha Univ., Republic of Korea, [2]Intec Inc., Republic of Korea, [3]Korea Photonics Technology Inst., Republic of Korea*

WD1, Constructing Multilayers with Absorbing Materials, *Juan I. Larruquert, Mónica Fernández-Perea, Manuela Vidal, José A. Méndez, José A. Aznárez; Inst. de Fisica Aplicada, CSIC, Spain*

ThA1, Standardized Characterization of Optical Losses from the Ultraviolet to Near-Infrared Range, *Kai Starke, I. Balasa, H. Blaschke, L. Jensen, M. Jupé, D. Ristau; Laser Zentrum Hannover e.V., Germany*

ThB1, Measurement Problem, *Angela Duparré[1], Detlef Ristau[2]; [1]Fraunhofer Inst. Angewandte Optik und Feinmechanik, Germany, [2]Laser Zentrum Hannover e.V., Germany*

ThC1, Optical Coating Technology Developed for Flexible Concentrator Space Power Arrays, *Michael L. Fulton; Ion Beam Optics Inc., USA*

ThD1, Characterization of Low Level Losses in Optical Thin Films, *Ric Shimshock; MLD Technologies, LLC, USA*

FA1, High-Performance Optical Coatings for VUV Lithography Application, *Christoph Zaczek, Alexandra Pazidis, Horst Feldermann; Carl Zeiss SMT AG, Germany*

FB1, Femtosecond Pulse Laser Damage in Thin Films, *Mark Mero[1,2], Jianhua Liu[1], Ali J. Sabbah[1], Benjamin Clapp[1], Jayesh Jasapara[1], Wolfgang Rudolph[1]; [1]Univ. of New Mexico, USA, [2]Max Born Inst., Germany*

OIC 2007 Short Courses

Sunday, June 3, 2007
8:00 a.m. – 12:00 p.m.

SC295 Optical Coating on Polymers
Ulrike Schulz; Fraunhofer IOF, Germany

Course Description:
Modern optical applications need solutions for the coating of polymer surfaces. The focus of this course is on evaluating the state of the art in coating technologies applied to plastic optics today. The potential to produce optical interference coatings is shown for plasma enhanced physical and chemical vapor deposition methods including modern hybrid techniques as well as for sol-gel wet chemical processes. Basic properties of the most important transparent polymer materials used for optical applications will be communicated. The problems for vacuum coating comprise thermal limitations, incompatible mechanical properties of coating and substrate materials, and the interaction between polymers and plasma. These limitations make it necessary to follow special rules and strategies to find out suitable coating designs and process parameters.

The main optical function required on polymers is antireflection. The course will give an overview about the technologies and designs to achieve antireflection. Additional coating functions like improved hardness and scratch resistance, easy-to-clean, anti-fogging and anti-static also will be reviewed. As an alternative for coating, antireflective properties on polymers can also be obtained by surface structures. Several technological solutions to generate such artificial "moth eyes" will be discussed. The diversity of polymer materials, combined with the broad range of applications, makes it difficult to define generally applicable standards for coated plastics. Nevertheless, the course will teach the participants the most important procedures for testing adhesion, lifetime properties and mechanical properties of coated polymers.

Benefits and Learning Objectives:
This course should enable you to:

- Specify the best suitable polymer materials for a defined optical application.
- Explain the special behavior of polymers in plasma-enhanced vacuum coating processes.
- Evaluate different techniques and coating designs for antireflection of polymer surfaces.
- Define suitable characterization tools and testing procedure for coated plastic optics.

Intended Audience:
Physicists, chemists and engineers who needs to learn how to proceed with polymer materials in vacuum coating processes.

Instructor Biography:
Ulrike Schulz is research chemist and group manager at the optical coating department of Fraunhofer IOF in Jena, Germany. She has been involved in optical coating for 14 years and is responsible for the group coatings on polymers. Schulz has authored more than 20 papers, book articles and patents on processes for polymer coating and coating design. In 2003 she was awarded the Josef-von-Fraunhofer Prize for the development of a new type of antireflective coating design.

SC296 Design of Optical Coatings
Angus Macleod, Thin Films Center Inc., USA

Course Description:
Optical coatings alter the properties of optical surfaces in almost any desired way. They may increase or reduce reflectance, selectively transmit some wavelengths and reflect others, change the phase of reflected or transmitted light, shorten chirped pulses, separate the luminous and thermal portions of radiation, and change the color temperature of a source. They are necessary components of virtually every possible optical system. They consist of assemblies of thin layers of different materials and operate by a mixture of interference and the optical behavior of the material. Their structure is often complex with many different layers, and accurate calculation requires the use of a computer. Computers can also synthesize designs. The user enters a target performance, together with the preferred materials, and a design is automatically produced. Computers, however, do not contribute to any understanding of coating properties, and understanding is a necessary prerequisite for efficient, successful design.

This course will start with fundamentals and then introduce tools that will help in understanding optical coating designs. These tools do not replace the computer but supplement it. Many of these tools can be described as back-of-the-envelope techniques. They are useful not simply in coating design but in activities like reverse engineering when trying to answer the question of what could have gone wrong in production. The quarterwave rule allows rapid and accurate assessment of assemblies of quarterwaves. The admittance diagram is a powerful pictorial representation of multilayer calculations. The vector diagram helps in understanding inhomogeneous structures such as rugates. And there are many more. Comprehensive notes will be provided.

Benefits and Learning Objectives:
This course should enable you to:

- Explain the principles of optical coating operation.
- Design simple optical coatings.
- Perform simple order of magnitude calculations of coating performance without a computer.
- Produce good starting designs for subsequent computer refinement.
- Assess the degree of difficulty in achieving a stated performance.
- Recognize limitations of coating performance.
- Recognize likely mistakes in computer calculations.
- Suggest possible reasons for errors in coating production.

Intended Audience:
The course is aimed at those who wish familiarity with tools used in understanding optical coatings, which supplement the digital computer. They may include coating designers, coating manufacturers and coating users. The level of experience can range from someone entering the field for the first time to the experienced practitioner. Participants should have some familiarity with such optical concepts as wavelength, refractive index, Snell's Law, reflectance, transmittance and interference.

Instructor Biography:
Angus Macleod has more than 40 years of experience in optical coatings, both in manufacturing and in research. He was born and educated in Glasgow, Scotland, and worked both in industry and academia in Great Britain before joining the University of Arizona as Professor of Optical Sciences in 1979. Since 1995, he has been full time with Thin Film Center Inc., a software, training and consulting company in Tucson that he co-founded in 1986. He is the author of *Thin Film Optical Filters, 3rd Edition* (Institute of Physics Publishing, 2001).

SC227 Understanding the Optical Properties of Optical Coating Materials
Olaf Stenzel, Fraunhofer Inst., Germany

Course Description:
The course provides attendees with theoretical knowledge on the basic properties of linear optical constants. It consists of two main parts: In the first (more formal) part, both normal and anomalous dispersion of the optical constants will be extensively discussed. The basis is general principles of the interaction of light with matter, including causality and Kramers-Kronig-relations. The specifics of the optical properties in different spectral regions, ranging from the infrared up to the X-ray spectrum, will be derived. The second (and more applicative) part of the course concentrates on the derivation and application of classical and semi-classical dispersion models to describe the optical behavior of isotropic thin film optical materials. Examples include dielectrics as well as semiconductors and metals.

Benefits and Learning Objectives:
This course should enable you to:

- Discuss the optical constants of any material basing on fundamental physical principles.
- Identify the correct dispersion model applicable to the material under investigation in practice.
- Calculate the optical constants of material mixtures, among them porous layers and systems with metal island films.
- Discover the complicated relation between mass density and optical constants.
- Simulate linear optical constants at both classical and semi-classical levels.

Intended Audience:
This intermediate level course is intended for people who would like to become familiar with fundamentals of the optical properties of optical materials with emphasis on typical coating materials. It is of use to anyone who needs to compute thin film optical constants for either design or characterization tasks. It is addressed to newcomers and experts, to engineers and science students.

Instructor Biography:
Olaf Stenzel received his *Diplom Physiker* in 1986 from Moscow State University, and his *Dr. rer. nat.* in 1990 and *Dr. habil* in 1999, both from the University of Technology in Chemnitz, Germany. He has more than six years teaching experience as a university lecturer. In 2001, he joined the optical coating department at the Fraunhofer Institute of Applied Optics and Precision Engineering in Jena, Germany. At present he is the group manager for NIR- and VIS-Coatings at this department. The combination of university teaching until 2001 with more applicative research work at the Fraunhofer Institute defines the individual content and style of the offered Short Course. Olaf Stenzel has authored and co-authored more than 90 scientific papers, mainly in the field of thin film spectroscopy, and authored two textbooks on thin film optics.

Sunday, June 3, 2007
1:00 p.m.–5:00 p.m.

SC297 Mechanical (and Other Functional) Properties and Structural (Including Chemical) Characterization Methods for Optical Films
Ludvik Martinu, Ecole Polytec Montreal, Canada

Course Description:
Advances in optics, optoelectronics and photonics strongly depend on the development of new deposition processes and film materials for optical film systems such as optical filters, waveguides and optical microelectromechanical systems. Besides appropriate control of the optical constants, requirements include enhanced mechanical performance, long-term environmental stability and specific functional characteristics (electrical conductivity, gas or vapor permeation, hydrophobicity or hydrophilicity, etc.). Such film properties depend on the film composition and microstructure dictated by the physical and chemical surface reactions during film growth.

This course describes the energetic ion- and photon-induced reactions with the surface during the film growth by different complementary techniques including ion (beam) assisted deposition (IAD or IBAD), balanced and unbalanced magnetron sputtering (BMS and UMS), dual ion beam sputtering (DIBS), filtered cathodic arc deposition (FCAD), and plasma-enhanced chemical vapor deposition (PECVD), while concentrating on the more recent pulsed-discharge processes and time and spatially-resolved diagnostic methods. It also presents the principles and capabilities of the microstructural characterization microscopic and spectroscopic tools suitable for materials assessments and for process optimization and reverse engineering.

Mechanical properties such as adhesion, stress, hardness, scratch, abrasion and wear resistance are often the main limiting factors for the successful use of optical films. Numerous tests have been designed for the assessment of such mechanical properties, but in many cases they are only qualitative or they deal with optical systems with a specific application in mind. This course describes the metrology of the mechanical and tribological properties and the long term stability in various temperature, radiative and environmental conditions. It links mechanical, optical and other characteristics, the film microstructure and the film growth mechanisms, allowing one to better perform film system optimization.

Benefits and Learning Objectives:
This course should enable you to:

- Describe the principles of different complementary deposition techniques of optical films and discuss their advantages for specific applications.
- Explain the role surface reactions in the formation thin film microstructure.
- Determine and discuss the relationship between the microstructure and the film’s optical, mechanical and other functional properties.
- Summarize different testing methods for the assessment of the microstructure and of the optical and mechanical properties, and compare and explain their reliability.
- Determine and justify the choice of specific deposition methods, thin film materials and characterization techniques for particular optical applications including multilayer and graded layer optical filters.

Intended Audience:
This course is intended for technologists, students, researchers and managers who wish to obtain a condensed overview of the processes, materials and characterization techniques related to the fabrication of optical films systems and their optimization, illustrated by numerous examples from laboratory and industrial practice. Familiarity of the participants with basic concepts of physics and engineering would be helpful but not necessary.

Instructor Biography:
Ludvik Martinu is a professor at École Polytechnique de Montréal, head of its Department of Engineering Physics, past associate director of the Thin Film Research Center, founder and director of the Functional Coating and Surface Engineering Laboratory, and organizer of the annual symposia of the SVC and AVS. His main research interest is surface engineering and the physics and technology of thin films for optics, photonics, aerospace, biomedical and other applications. His activities resulted in more than 260 publications and 6 patents.

SC298 Manufacture of Precision Evaporative Coatings
James Oliver, Univ. of Rochester, USA

Course Description:
Evaporation is an ideal process for the deposition of optical coatings, providing flexibility in source materials, scalability for large-aperture substrates, relatively low film stress, and high laser damage resistance. While evaporation is a "well-understood" and "basic" deposition process, a deeper level of understanding provides the ability to produce coatings of significantly greater precision and performance. If the fundamental requirements of a coated optical component are spectral/photometric performance, sufficiently flat surface figure, environmental resistance and/or stability, and laser damage resistance, then it is important to control the process variables that influence these requirements. Through sufficient process control of layer endpoint determination, film thickness uniformity, thin-film material structure and vacuum chamber conditions, it is possible to produce extremely high performance evaporative coatings.

The goal of this course is to provide detailed information on how to establish and improve evaporative coating processes for precision optical coatings. Design considerations for coating chambers, such as source placement, substrate fixturing, control of film thickness uniformity, and thickness monitors will be discussed. Trade-offs in the selection of source materials, means of controlling film structure, and the influence on the performance of the coated component will be considered. Process details will be approached with a focus on practicality; film properties must be measurable and system designs must be practical and cost-effective. These process concepts are readily implemented in standard evaporation systems, providing significant improvements in existing coating facilities.

Benefits and Learning Objectives:
This course should enable you to:

- Determine proper evaporation source placement in a coating chamber.
- Evaluate different types of substrate fixturing and rotation systems.
- Understand how to calculate film thickness uniformity.
- Understand the impact of film stress and how to control it.
- Realize the importance of the deposited film structure and its influence on film properties.
- Better control evaporation processes for high-precision spectral or photometric performance.

Intended Audience:
This course is intended for engineers and scientists who develop or manufacture optical coatings using evaporation processes. Material will be presented at an intermediate to advanced level, though many topics will be well-suited for anyone establishing or refining evaporation deposition processes.

Instructor Biography:
James Oliver earned bachelor's and master's degrees in optics at the University of Rochester, and he has been working in optical thin films since 1992. He is currently a research engineer at the University of Rochester's Laboratory for Laser Energetics (LLE), where he develops and manufactures optical coatings for large aperture laser applications. Coatings are deposited on a daily basis for use on LLE's Omega laser system, the National Ignition Facility at Lawrence Livermore National Laboratory, and numerous other laser facilities throughout the world. He teaches optical interference coating design at the University's Institute of Optics and lectures on design and process issues in the thin film summer school.

SC299 Design, Pre-Production Analysis, Computational Manufacturing and Reverse Engineering of Optical Coatings
Alexander Tikhonoravov, Moscow State Univ., Russian Federation

Course Description:
The course will start with a discussion of the most fruitful ideas used in modern optical coating design techniques. Modern design approaches aimed at constructing sets of theoretical designs with different combinations of principle design parameters (merit function value, number of design layers, design total optical thickness) are considered. It will be demonstrated that these design approaches extend opportunities for choosing the most practical and manufacturable design.

The course will cover various aspects of the pre-production error analysis of optical coatings. It will be shown how this analysis helps to reveal the most critical coatings layers which deposition requires a special attention. The most recent results connected with the pre-production estimation of the cumulative effect of thickness errors associated with direct optical monitoring of coating production will be observed. It will be shown how effects caused by surface micro-roughness, bulk inhomogeneity and scattering may influence spectral characteristics of manufactured coatings.

The course will demonstrate the increasingly important role of computational manufacturing of optical coatings (computer simulation of deposition and monitoring processes). It will be shown how computational manufacturing experiments can be used for selecting optimal monitoring strategies and choosing designs with the best probability of high production yield. In connection with this topic, specification of various monochromatic monitoring strategies will be discussed. The course will present the most recent results on the reverse engineering and post-production characterization of manufactured optical coatings. The calibration of monitoring devices and elimination of systematic manufacturing errors will be discussed. Raising production yields with the help of the online correction of monitoring and deposition processes will be considered.

Benefits and Learning Objectives:
This course should enable you to:

- Determine modern design approaches that are most suitable for solving their specific design problems.
- Perform pre-production error analysis of optical coatings to reveal the most critical layers for special attention, estimate a cumulative effect of thickness errors, and evaluate effects connected to inhomogeneity, scattering and surface micro-roughness.
- Specify various monochromatic monitoring strategies and perform computational manufacturing experiments for selecting optimal monitoring strategies and choosing designs with the best probability of high production yield.
- Investigate main reasons for the degradation of the spectral performance of manufactured coatings and find ways to improve the production yield.

Intended Audience:
The intended audience includes designers of optical coatings, production engineers and technicians. The background required is a general understanding of what thin films and optical coatings are. Prior knowledge of design and evaluation techniques is not essential because the course will cover basic ideas and practical aspects of modern design approaches, and new topics related to choosing the most practical design and maximizing the production yield.

Instructor Biography:
Alexander Tikhonravov is a professor of theoretical physics and the director of the Research Computing Center of Moscow State University. He has received his PhD and Doctor of Sciences degree from Moscow State University. He has authored more than 260 publications, among them the book *Basics of Optics of Multilayer Systems*. Tikhonravov is the inventor of the needle optimization technique, a universal technique for the design of optical coatings. He was a course instructor at the OIC 1995, OIC 1998, OIC 2001 and OIC 2004 meetings.

AGENDA OF SESSIONS

Sunday, June 3, 2007		
7:00 a.m.–5:00 p.m.	**Registration Open**	*Grand Ballroom Foyer*
8:00 a.m.–12:00 p.m.	**SC295 • Optical Coating on Polymers**	*Rooms to be announced onsite*
8:00 a.m.–12:00 p.m.	**SC296 • Design of Optical Coatings**	
8:00 a.m.–12:00 p.m.	**SC227 • Understanding the Optical Properties of Optical Coating Materials**	
	Lunch (on your own)	
1:00 p.m.–5:00 p.m.	**SC297 • Mechanical (and Other Functional) Properties and Structural (Including Chemical) Characterization Methods for Optical Films**	
1:00 p.m.–5:00 p.m.	**SC298 • Manufacture of Precision Evaporative Coatings**	
1:00 p.m.–5:00 p.m.	**SC299 • Design, Pre-Production Analysis, Computational Manufacturing and Reverse Engineering of Optical Coatings**	
7:00p.m.-9:00p.m.	**Welcome Reception**	*Kiva Patio*
Monday, June 4, 2007		
7:30 a.m.–5:30 p.m.	**Registration Open**	*Grand Ballroom Foyer*
8:30 a.m.–8:35 a.m.	**Opening Remarks**	*Grand Ballroom Salon B & C*
8:35 a.m.–9:45 a.m.	**MA • Deposition of Optical Coatings I**	*Grand Ballroom Salon B & C*
9:45 a.m.–10:15 a.m.	**Coffee Break**	*Grand Ballroom Foyer*
9:45 a.m.–3:15 p.m.	**Exhibits Open**	*Grand Ballroom Foyer*
10:15 a.m.–11:15 a.m.	**MB • Manufacturing Problem / Deposition of Coatings II**	*Grand Ballroom Salon B & C*
11:15 a.m.–12:15 p.m.	**PMAB • Poster Session I**	*Grand Ballroom Salon A*
12:15 p.m.–1:30 p.m.	**Lunch**	*Kiva Ballroom*
1:30 p.m.–2:45 p.m.	**MC • Nanoscale Coatings**	*Grand Ballroom Salon B & C*
2:45 p.m.–3:15 p.m.	**Coffee Break**	*Grand Ballroom Foyer*
3:15 p.m.–4:30 p.m.	**MD • Photonic Structures/ Materials**	*Grand Ballroom Salon B & C*
4:30 p.m.–5:30 p.m.	**PMCD • Poster Session II**	*Grand Ballroom Salon A*
5:30 p.m.–6:30 p.m.	**Evening Session**	*Grand Ballroom Salon B & C*
Tuesday, June 5, 2007		
7:30 a.m.–5:30 p.m.	**Registration Open**	*Grand Ballroom Foyer*
8:30 a.m.–9:45 a.m.	**TuA • Coating Microstructure**	*Grand Ballroom Salon B & C*
9:45 a.m.–10:15 a.m.	**Coffee Break**	*Grand Ballroom Foyer*
9:45 a.m.–3:15 p.m.	**Exhibits Open**	*Grand Ballroom Foyer*
10:15 a.m.–11:20 a.m.	**TuB • Coating Stress**	*Grand Ballroom Salon B & C*
11:20 a.m.–12:20 p.m.	**PTuAB • Poster Session III**	*Grand Ballroom Salon A*
12:20 p.m.–1:35 p.m.	**Lunch**	*Kiva Ballroom*
1:35 p.m.–2:55 p.m.	**TuC • Birefringent Coatings / Polarizer Coatings**	*Grand Ballroom Salon B & C*
2:55 p.m.–3:25 p.m.	**Coffee Break**	*Grand Ballroom Foyer*
3:25 p.m.–4:40 p.m.	**TuD • Filters**	*Grand Ballroom Salon B & C*
4:40 p.m.–5:40 p.m.	**PTuCD • Poster Session IV**	*Grand Ballroom Salon A*
5:40 p.m.–6:05 p.m.	**TuE • Postdeadline Session**	*Grand Ballroom Salon B & C*
Wednesday, June 6, 2007		
8:00 a.m.–5:30 p.m.	**Registration Open**	*Grand Ballroom Foyer*
8:30 a.m.–9:45 a.m.	**WA • Design of Optical Coatings I**	*Grand Ballroom Salon B & C*
9:45 a.m.–10:15 a.m.	**Coffee Break**	*Grand Ballroom Foyer*
9:45 a.m.–3:15 p.m.	**Exhibits Open**	*Grand Ballroom Foyer*
10:15 a.m.–11:20 a.m.	**WB • Design Problem / Design of Optical Coatings II**	*Grand Ballroom Salon B & C*
11:20 a.m.–12:20 p.m.	**PWAB • Poster Session V**	*Grand Ballroom Salon A*
12:20 p.m.–1:35 p.m.	**Lunch**	*Kiva Ballroom*
1:35 p.m.–2:50 p.m.	**WC • Optical Monitoring**	*Grand Ballroom Salon B & C*
2:50 p.m.–3:20 p.m.	**Coffee Break**	*Grand Ballroom Foyer*
3:20 p.m.–4:35 p.m.	**WD • Thermal Properties**	*Grand Ballroom Salon B & C*
4:35 p.m.–5:35 p.m.	**PWCD • Poster Session VI**	*Grand Ballroom Salon A*
6:00 p.m.–7:30 p.m.	**Conference Reception**	*Poolside*

Thursday, June 7, 2007		
8:00 a.m.–5:30 p.m.	**Registration Open**	*Grand Ballroom Foyer*
8:30 a.m.–9:45 a.m.	**ThA • Measurements I**	*Grand Ballroom Salon B & C*
9:45 a.m.–10:15 a.m.	**Coffee Break**	*Grand Ballroom Foyer*
9:45 a.m.–3:15 p.m.	**Exhibits Open**	*Grand Ballroom Foyer*
10:15 a.m.–11:20 a.m.	**ThB • Measurement Problem / Measurements II**	*Grand Ballroom Salon B & C*
11:20 a.m.–12:20 p.m.	**PThAB • Poster Session VII**	*Grand Ballroom Salon A*
12:20 p.m.–1:35 p.m.	**Lunch**	*Kiva Ballroom*
1:35 p.m.–2:50 p.m.	**ThC • Applications I**	*Grand Ballroom Salon B & C*
2:50 p.m.–3:20 p.m.	**Coffee Break**	*Grand Ballroom Foyer*
3:20 p.m.–4:40 p.m.	**ThD • Applications II / Antireflection Coatings**	*Grand Ballroom Salon B & C*
4:40 p.m.–5:40 p.m.	**PThCD • Poster Session VIII**	*Grand Ballroom Salon A*
5:40 p.m.–6:40 p.m.	**Evening Session**	*Grand Ballroom Salon B & C*
Friday, June 8, 2007		
8:00 a.m.–12:00 p.m.	**Registration Open**	*Grand Ballroom Foyer*
8:30 a.m.–9:45 a.m.	**FA • Short and Intense Wavelength Coatings**	*Grand Ballroom Salon B & C*
9:45 a.m.–10:15 a.m.	**Coffee Break**	*Grand Ballroom Foyer*
10:15 a.m.–11:20 a.m.	**FB • Laser Damage**	*Grand Ballroom Salon B & C*
11:20 a.m.–11:25 a.m.	**Closing Remarks**	*Grand Ballroom Salon B & C*
11:25 a.m.–12:25 p.m.	**PFAB • Poster Session IX**	*Grand Ballroom Salon A*
12:25 p.m.–1:15 p.m.	**Lunch**	*Grand Ballroom Foyer*

NOTES

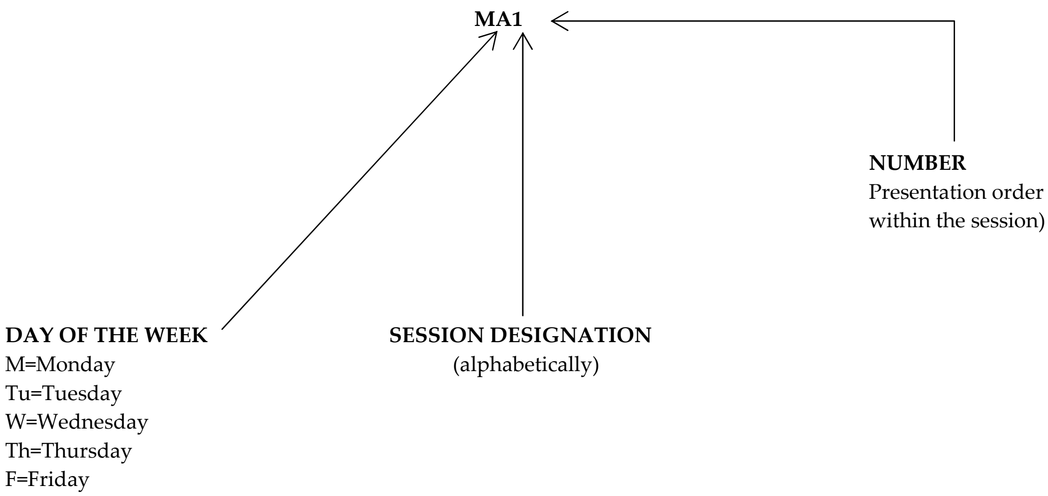
Explanation of Session Codes

The first part of the code designates the day of the week (Monday=M, Tuesday=Tu, Wednesday=W, Thursday=Th, Friday=F).

The next part indicates the session within the particular day the talk is being given. Each day begins with the letter A and continues alphabetically.

The number on the end of the code signals the position of the talk within the session (first, second, third, etc.).

For example, a presentation numbered MA1 indicates that this paper is being presented on Monday during the 1st session (A) and that it is the first paper presented in session MA.



•Sunday, June 3, 2007•

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

8:00 a.m.–12:00 p.m.
SC295: Optical Coating on Polymers
SC296: Design of Optical Coatings
SC227: Understanding the Optical Properties of Optical Coating Materials

1:00 p.m.–5:00 p.m.
SC297: Mechanical (and Other Functional) Properties and Structural (Including Chemical) Characterization Methods for Optical Films
SC298: Manufacture of Precision Evaporative Coatings
SC299: Design, Pre-Production Analysis, Computational Manufacturing and Reverse Engineering of Optical Coatings

•Monday, June 4, 2007•

Grand Ballroom Foyer
7:30 a.m.–5:30 p.m.
Registration Open

Grand Ballroom Salon B and C
8:30 a.m.–8:35 a.m.
Opening Remarks
Norbert Kaiser, Fraunhofer Inst. für Angewandte Optik und Feinmechanik, Germany.

MA • Deposition of Optical Coatings I

Grand Ballroom Salon B and C
8:35 a.m.–9:45 a.m.
MA • Deposition of Optical Coatings I
Robert Schaffer; Evaporated Coatings, Inc., USA, Presider
Douglas Smith; Plymouth Grating Lab, Inc., USA, Presider

MA1 • 8:35 a.m. **Invited**
Charles Keith Carniglia (1944-2006): In Memoriam, *J. A. Dobrowolski; Natl. Res. Council of Canada, Canada.* Chuck Carniglia was an industrial scientist, an educator and a friend to all he met. He had an important impact on the optical thin film community. This article will highlight his career and accomplishments.

MA2 • 8:55 a.m. **Invited**
New Ideas and Developments in the Field of Optical Coatings, *H. Angus Macleod; Thin Film Ctr., USA.* Optical coatings are enabling demanding current applications ranging from large telescopes to full color display systems. Advances in materials, processes and design techniques all contribute to these successes. Nevertheless problems remain to be solved.

MA3 • 9:25 a.m.
Process Technology, Applications and Potentials of Magnetron Sputtering Technology for Optical Coatings, *Michael Vergoehl[1], Peter Frach[2], Hagen Bartzsch[2], Andreas Pflug[1], Christoph Rickers[1]; [1]Fraunhofer Inst. for Surface Engineering and Thin Films, Germany, [2]Fraunhofer Inst. for Electron Beam and Plasma Technology, Germany.* Different magnetron sputter geometries and modes for the deposition of optical coatings are presented. Examples of AR- and filter coatings are given demonstrating the high potential of this technology for different applications.

MA4 • 9:30 a.m.
Flexible High Throughput Deposition of Optical Coatings Using Closed Field Magnetron Sputtering, *Desmond R. Gibson, Ian Brinkley, Ewan M. Waddell, J. Walls; Applied Multilayers Ltd., UK.* "Closed field" magnetron (CFM) sputtering offers a flexible and high throughput deposition process for optical coatings. CFM sputtering uses two or more metal targets to deposit multilayers comprising dielectrics, metals and conductive oxides optical properties.

MA5 • 9:35 a.m.
Sputter Deposition of Silicon Oxynitride Gradient and Multilayer Coatings, *Jörn Weber, Hagen Bartzsch, Peter Frach; Fraunhofer-Inst. für Elektronenstrahl- und Plasmatechnik (FEP), Germany.* We report on the deposition technology of SiO_xN_y-layer systems by Pulse Magnetron Sputtering and its application. Multilayer and gradient optical filters have been deposited quickly and with low absorption losses.

MA6 • 9:40 a.m.
Stationary and In-Line Reactive Magnetron Sputter Technologies for Deposition of Optical Coatings, *Peter Frach, Hagen Bartzsch, Jörn Weber, Jörn-Steffen Liebig, Volker Kirchhoff; Fraunhofer-Inst. für Elektronenstrahl- und Plasmatechnik (FEP), Germany.* Two new concepts for the high rate deposition of precision optical and antireflective coatings by reactive magnetron sputtering are presented. Examples of AR-coatings, HL- and rugate filters as well as film properties will be shown.

Grand Ballroom Foyer
9:45 a.m.–10:50 a.m.
Coffee Break

MB • Manufacturing Problem / Deposition of Coatings II

Grand Ballroom Salon B and C
10:15 a.m.–11:15 a.m.
MB • Manufacturing Problem / Deposition of Coatings II
Svetlana Dligatch; Commonwealth Science and Industrial Res. Organization, Australia, Presider
Jianda Shao; Shanghai Inst. of Optics and Fine Mechanics, China, Presider

MB1 • 10:15 a.m. **Invited**
2007 OSA Topical Meeting on Optical Interference Coatings: Manufacturing Problem, *Stephen Browning[1], George Dobrowolski[2]; [1]Ball Aerospace & Technologies Corp., USA, [2]Natl. Res. Council of Canada, Canada.* Measurements will be presented of experimental filters submitted to the third thin film manufacturing problem where the object was to produce multilayers with measured colorimetric performance as close as possible to that specified.

MB2 • 10:45 a.m.
Optical Properties of Plasma Ion-Assisted Deposition Silicon Coatings: Application to the Manufacture of Blocking Filters for the Near-Infrared Region, *Stephane Bruynooghe; Carl Zeiss AG, Germany.* We report on the preparation and characterization of the optical constants of silicon coatings deposited by electron-beam-gun with plasma-IAD. Through the fabrication of longwave-pass filters we assure the reliability of the optical constants we determined.

MB3 • 10:50 a.m.
Plasma Sources for Precision Optical Coatings, *Harro Hagedorn, Rudolf Beckmann, Rainer Götzelmann, Holger Reus, Alfons Zöller; Leybold Optics GmbH, Germany.* The performance of a new large rf-plasma source for large box coaters is investigated in respect to layer performance and achievable growth rates. The optical constants of SiO_2 and TiO_2 thin films are presented.

MB4 • 10:55 a.m.
SiO_x, SiN_x, SiN_xO_y Deposited by ICP-CVD System with Optimized Uniformity for Optical Coatings, *Xiaonan Tan, Jacek Wojcik, Haiqiang Zhang, Peter Mascher; McMaster Univ., Canada.* A newly designed ICP-CVD system with *in situ* spectroscopic ellipsometry has been constructed and calibrated for the deposition of high quality thin films optimized for optical coatings and other applications.

MB5 • 11:00 a.m.
A New Process to Deposit AlF_3 Thin Films, *Bo-Huei Liao, Ming-Chung Liu, Cheng-Chung Lee; Natl. Central Univ., Taiwan.* Aluminum fluoride thin films have been deposited by magnetron sputtering of aluminum target with CF_4 as working gas at room temperature. The AlF_3 thin film coated at 20W sputtering power has the best quality.

MB6 • 11:05 a.m.
Organic Roll Coating to Form Interference Layers, *Ken McCarthy; Multilayer Coating Technologies, USA.* This presentation will discuss an anti-reflection layer coated from a solution of organic polymers. The optical properties of this layer will be delineated, along with the required uniformity down-web, cross-web, roll-to-roll and batch-to-batch.

MB7 • 11:10 a.m.
High Power Pulse Magnetron Sputtering: A New Process for Industrial High Quality Optical Coatings? *Michael Vergoehl, Ralf Bandorf, Peter Giesel; Fraunhofer Inst. for Surface Engineering and Thin Films, Germany.* In high power pulse magnetron sputtering (HPPMS), a high ionisation of the sputtered material can be obtained. We applied HPPMS to deposit TiO_2 optical thin films. Material and process properties are discussed.

PMAB • Poster Session I

Grand Ballroom Salon A
11:15 a.m.–12:15 p.m.
PMAB • Poster Session I

Posters included in this session are:

MA3
MA4
MA5
MA6
MB2
MB3
MB4
MB5
MB6
MB7

Kiva Ballroom
12:15 p.m.–1:30 p.m.
Lunch

MC • Nanoscale Coatings

Grand Ballroom Salon B and C
1:30 p.m.–2:45 p.m.
MC • Nanoscale Coatings
Martina Gerken; Univ. Karlsruhe, Germany, Presider
Zhanshan Wang; Tongji Univ., China, Presider

MC1 • 1:30 p.m. **Invited**
Atomic Engineering with Multilayers, *Troy W. Barbee; Lawrence Livermore Natl. Lab, USA.* Abstract not available.

MC2 • 2:00 p.m. **Invited**
Micro-and Nanostructured Optical Thin Films: Potential and Applications, *François R. Flory[1], Ludovic Escoubas[2], Jean-Jacques Simon[2], Philippe Torchio[2]; [1]ENSPM, France, [2]EGIM, Technopole de Chateau-Gombert, France.* Optical properties of artificially or naturally micro/nano structured thin films are discussed. The modelling of these properties is considered with examples of electromagnetic field distribution and of applications like sensors, integrated optics, solar cells, antireflection, etc.

MC3 • 2:30 p.m.
A Facile, Novel Methodology for Preparation of Multilayer Metal/Polymer Composite Films, *Akihiro Matsubayashi[1], Kenji Fukunaga[1], Tetsurou Tsuji[1], Kikuo Ataka[1], Hisashi Ohsaki[2]; [1]Corporate Res. and Development, Ube Industries, Ltd., Japan, [2]Res. Ctr. for Advanced Science and Technology, Univ. of Tokyo, Japan.* Metal/polymer composite multilayer films were prepared through optical interference. Metal nanoparticles were aligned in the row with a constant spacing. This scheme will give a new production methodology for a band-selective optical mirror.

MC4 • 2:35 p.m.
Stochastic Subwavelength Structures on Polymer Surfaces for Antireflection Purposes, *Robert Leitel[1,2], Irmina Wendling[1,2], Peter Munzert[2], Ulrike Schulz[2], Norbert Kaiser[2], Andreas Tünnermann[1,2]; [1]Inst. für Angewandte Physik, Friedrich Schiller Univ., Germany, [2]Fraunhofer Inst. für Angewandte Optik und Feinmechanik, Germany.*
Subwavelength structures of sufficient height are capable to reduce the Fresnel reflection of surfaces. A new technique is presented to produce stochastic structures on polymer surfaces by low-pressure plasma-ion treatment, showing excellent broadband antireflective properties.

MC5 • 2:40 p.m.
Optical Resonances in an Aligned Al Nano-Rod Array, *Yi-Jun Jen, Ching-Wei Yu; Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan.* The anomalous attenuated total reflection dips measured from an aligned aluminum nano-rod array film prepared by oblique angle deposition are interpreted and analyzed their sensitivity in optical constants determination in the Kretschmann configuration.

Grand Ballroom Foyer
2:45 p.m.–3:15 p.m.
Coffee Break

MD • Photonic Structures/ Materials

Grand Ballroom Salon B and C
3:15 p.m.–4:30 p.m.
MD • Photonic Structures/Materials
Angela Duparré; Fraunhofer Inst. Angewandte Optik und Feinmechanik, Germany, Presider
Roland Loercher; Carl Zeiss AG, Germany, Presider

MD1 • 3:15 p.m. **Invited**
Chemically-Prepared Silica Films with Single Crystalline Mesoporous Structures, *Hirokatsu Miyata; Canon Res. Ctr., Leading-Edge Technology Development Headquarters, Canon Inc., Japan.* Self-assembly of surfactant molecules and silica oligomers on various substrates with surface anisotropy leads to the formation of silica films in which in-plane arrangement of regular mesopores shows long range correlation on the macroscopic scale.

MD2 • 3:45 p.m.
Fabrication of 3-Dimension Photonic Crystal Using Self-Assembly and Autocloning Technologies, *Te-Hung Chang, Sheng-hui Chen, Chia-Hua Chan, Chii -Chang Chen, Cheng-Chung Lee; Dept. of Optics and Photonics, Thin Film Technology Ctr., Natl. Central Univ., Taiwan.* Self-assembly of microspheres prepared from air-liquid interface to construct two-dimension structural substrate and the thin-film autocloning technologies using E-beam gun evaporation with IAD superimposed on the periodic corrugation pattern were combined to fabricate three-dimension PhCs.

MD3 • 3:50 p.m.
Graded Wave-Like Two-Dimensional Photonic Crystal Made of Thin Films, *Xu Liu, Y. Y. Li, B. Q. Wang, P. F. Gu; Zhejiang Univ., China.* We present a study of filling factor graded wave-like two-dimensional photonic crystal possessing a superbending effect which is polarization dependent.

MD4 • 3:55 p.m.
Simulation of the Re-Shaping Process for Auto-Cloned Photonic Crystal, *Chen Yang Huang[1,2], Hao Min Ku[2], Shu Jung Hsu[2], Cheng Wei Chu[1], Shiuh Chao[2]; [1]Opto-Electronics and System Labs, Industrial Technology Res. Inst., Taiwan, [2]Inst. of Photonics Technologies, Natl. Tsing Hua Univ., Taiwan.* A simulation study of the re-shaping process for the auto-cloned photonic crystals is presented. The re-shaping is achieved by deposition-etching on periodic substrate. By adjusting the angular-dependent etching curve, the saw-tooth topography can be achieved.

MD5 • 4:00 p.m.
Surface Wave Excitation at 1-D Photonic Crystal-Metal Interface, *Aldo Santiago Ramirez Duverger[1,2], Raul Garcia Llamas[2], Jorge Gaspar-Armenta[2]; [1]Dept. de Fisica, Univ. de Sonora, Mexico, [2]Dept. de Investigacion en Fisica, Univ. de Sonora, Mexico.* A surface wave at the 1-D photonic crystal-metal interface is observed experimentally. Spectral reflection and transmission measurements of the incident light on a system formed by a finite 1DPC and a metal film are reported.

MD6 • 4:05 p.m.
Scanning Force Microscopy of Coatings and Nanostructured Surfaces, *Marcel Flemming, Angela Duparré; Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* The capability of scanning force microscopy and subsequent PSD data evaluation for the investigation of functional surface nanostructures is demonstrated. Critical effects emerging from measurements in the nanometer scale are discussed.

MD7 • 4:10 p.m.
Study of $Ge_{15}Sb_{20}S_{65}$ and $Te_{20}As_{30}Se_{50}$ Chalcogenide Coatings, *Michel Cathelinaud[1], Laetitia Abel-Tiberini[1], Michel Lequime[1], Frédéric Charpentier[2], Virginie Nazabal[2], Marie-Laure Anne[2], Jean-Luc Adam[2], Petr Nemec[3], Miloslav Frumar[3], Alain Moreac[4]; [1]Inst. Fresnel, France, [2]Sciences Chimiques de Rennes, Univ. Rennes, France, [3]Univ. of Pardubice, Czech Republic, [4]GMCM, Univ. Rennes, France.* We investigated high index chalcogenide thin films manufacturing by two deposition processes. Their physical and chemical properties have been compared to the bulk ones. First example of application to bandpass filtering is reported.

MD8 • 4:15 p.m.
Investigation of Sn-Based Alternatives to Cadmium in Thin Film Coatings, *Steven J. Wakeham[1], Gary J. Hawkins[1], Graham R. Henderson[2], Nick A. Carthey[2]; [1]Univ. of Reading, UK, [2]Johnson Matthey Plc, UK.* New Sn-based materials have been deposited and characterised in terms of their optical and mechanical properties and compared with existing cadmium-based thin films that currently find wide spread use in the optoelectronic and semiconductor industries.

MD9 • 4:20 p.m.
Novel UV Cross-Link Coating Materials for Advanced Planarization Technology on Substrates, *Satoshi Takei, Yusuke Horiguchi, Tetsuya Shinjo, Yasuyuki Nakajima; Nissan Chemical Industries, Ltd., Japan.* Thickness bias between blanket field and dense via arrays is not acceptable for advanced planarization process. Novel UV cross- link materials had great properties such as little thickness bias, high planarization, and void free filling.

MD10 • 4:25 p.m.
Properties, Growth and Filter Applications of a-SiN_x:H Alloys Prepared in Pulsed Radiofrequency Plasma, *Richard Vernhes, Oleg Zabeida, Jolanta Klemberg-Sapieha, Ludvik Martinu; Ecole Polytechnique de Montreal, Canada.* SiN_x:H alloys ($0.47<x<1.35$) are prepared by varying the duty cycle in a pulsed RF PECVD process, while keeping the gas mixture constant; a high-quality Fabry-Perot filter is fabricated.

PMCD • Poster Session II

Grand Ballroom Salon A
4:30 p.m.–5:30 p.m.
PMCD • Poster Session II

Posters included in this session are:

MC3
MC4
MC5
MD2
MD3
MD4
MD5
MD6
MD7
MD8
MD9
MD10

Grand Ballroom Salon B and C
5:30 p.m.–6:30 p.m.
Evening Session

•Tuesday, June 5, 2007•

Grand Ballroom Foyer
7:30 a.m.–5:30 p.m.
Registration Open

TuA • Coating Microstructure

Grand Ballroom Salon B and C
8:30 a.m.–9:45 a.m.
TuA • Coating Microstructure
Ludvik Martinu; Ecole Polytechnique Montreal, Canada, Presider
Michael K. Trubetskov; Res. Computing Ctr. of Moscow State Univ., Russian Federation, Presider

TuA1 • 8:30 a.m. **Invited**
Nanoamorphous Optical Coatings, *Hans Pulker; Univ. of Innsbruck, Austria.* Nanoamorphous structure, homogeneous microstructure, smooth topography, high density, and excellent optical and mechanical properties were obtained with metal oxide films deposited by reactive low-voltage ion plating. Reliable reproducibility and environmental stability could be achieved.

TuA2 • 9:00 a.m.
Optical and Structural Properties of LaF_3 Thin Films, *Martin Bischoff[1], Dieter Gaebler[2], Norbert Kaiser[2], Andreas Tuennermann[2,1]; [1]Friedrich-Schiller-Univ., Inst. of Applied Physics, Germany, [2]Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* LaF_3 thin films of different thicknesses were deposited on CaF_2 (111) and silicon substrates by boat evaporation at a relatively low substrate temperature of 150°C. Optical and mechanical properties have been investigated and are discussed.

TuA3 • 9:05 a.m.
Similarities and Differences in the Growth and the Optical Properties of Reactive Evaporated and IAD Deposited High Index Cubic Metal Oxide Films, *Roland Thielsch; Southwall Europe GmbH, Germany.* (Y)ZrO_2, Y_2O_3 and CeO_2 films were manufactured by evaporation and ion assisted deposition. XRD structural analysis, pole figure measurements, and analysis of the refractive index revealed differences in the growth and in-plane alignment.

TuA4 • 9:10 a.m.
Residual Stress and Optical Properties of TiO_2 Thin Film During Annealing by Differential Deposition Methods, *Hsi-Chao Chen[1], Kuan-Shiang Lee[2], Cheng-Chung Lee[2]; [1]Dept. of Electro-Optical Engineering, De Lin Inst. of Technology, Taiwan, [2]Thin Film Technology Ctr., Natl. Central Univ., Taiwan.* TiO_2 films were prepared by differential deposition methods. At sputter, stress was released after annealing. At evaporation, XRD showed the anatase crystal. TiO_2 films deposited by sputter were more stable than by evaporation during annealing.

TuA5 • 9:15 a.m.
Crystal Phase Transition of HfO_2 Films Evaporated by Plasma Ion-Assisted Deposition, *Jue Wang, Robert L. Maier, Horst Schreiber; Corning Tropel Corp., USA.* HfO_2 films were evaluated by spectroscopic ellipsometry, indicating crystal phase transition due to plasma ion momentum transfer during deposition. The film inhomogeneity, surface roughness and crystal phase were confirmed by SEM, AFM and XRD.

TuA6 • 9:20 a.m.
Applications of Mixture Oxide Materials for fs Optics
Marco Jupé, Marc Lappschies, Lars Jensen, Kai Starke, Detlev Ristau; Laser Zentrum Hannover e.V., Germany. By applying a modified IBS technology, and in conjunction with new design concepts, the damage threshold of fs optics could be doubled. Thereby, thin film dielectric components were manufactured by mixing of several oxide materials.

TuA7 • 9:25 a.m.
Extension of Ion Beam Sputtered Oxide Mixtures into the UV Spectral Range, *Marc Lappschies, Marco Jupé, Detlev Ristau; Laser Zentrum Hannover e.V., Germany.* Ion-beam co-sputtered films with differing ratios of silica showed a transparency extended into the near ultra-violet range. Some coating examples demonstrate the extension to wavelength ranges which are normally not accessible by applying the materials.

TuA8 • 9:30 a.m.
Optical Properties of TiO_2-SiO_2 Mixture Thin Films Produced by Ion-Beam Sputtering, *Tatiana V. Amotchkina[1], Detlev Ristau[2], Mark Lappschies[2], Marco Jupe[2], Alexander V. Tikhonravov[1], Michael K. Trubetskov[1]; [1]Res. Computing Ctr., Moscow State Univ., Russian Federation, [2]Laser Zentrum Hannover e.V., Germany.* Optical properties of titanium dioxide–silica dioxide mixture thin films produced by ion-beam sputtering are investigated in a wide range of material mixture ratios. The obtained experimental results are compared with different dispersion theories.

TuA9 • 9:35 a.m.
Increasing Application Potential of Titanium Oxide Based Mixed Materials for Optical Interference Coatings on Mineral Glasses and Plastics, *Markus Stolze[1], Ulrike Schulz[2], Markus Fuhr[3], Walter Zültzke[4]; [1]UMICORE Materials AG, Liechtenstein, [2]Fraunhofer Inst. for Applied Optics & Precision Engineering (IOF), Germany, [3]Leybold Optics GmbH, Headquarters, R and D, Dept. Ophthalmics, Germany, [4]Consulting, Germany.* Titania-based films were deposited with conventional and ion assisted e-beam deposition from Ti_3O_5 and mixed materials Ti_3O_5:X and DRALO. Investigations yielded considerably reduced film stress for the mixtures at an acceptable decrease in refractive index.

TuA10 • 9:40 a.m.
Microstructure Determination of Porous Si:H Samples by Reflectance Methods, *Jerzy F. Ciosek; Inst. of Optoelectronics, Military Univ. of Technology, Poland.* Microstructure of Si(001):H Czochralski grown single crystalline wafer with 50 nm thick surface $Si0_2$ layer is investigated. Hydrogen dose implantation ($D \le 4x10^{16}$ cm^{-2}) results in a creation of porous (spongy) -like buried Si layer.

Grand Ballroom Foyer
9:45 a.m.–10:15 a.m.
Coffee Break

Grand Ballroom Foyer
9:45 a.m.–3:25 p.m.
Exhibits Open

TuB • Coating Stress

Grand Ballroom Salon B and C
10:15 a.m.–11:20 a.m.
TuB • Coating Stress
Roberto Machorro; CCMC, Mexico, Presider
Shigetaro Ogura; Kobe Design Univ., Japan, Presider

TuB1 • 10:15 a.m. Invited
Mechanical Properties of Thin Films, *Frank Richter[1], Thomas Chudoba[2], Norbert Schwarzer[3]; [1]Inst. für Physik, Chemnitz Univ. of Technology, Germany, [2]Advanced Surface Mechanics (ASMEC), Germany, [3]Saxonian Inst. of Surface Mechanics, Germany.* A novel approach to mechanical properties of thin films based on combined nano-indentation and theoretical modelling is presented. It enables the determination of mechanical film parameters and predictive modelling of mechanical behaviour of thin films.

TuB2 • 10:45 a.m.
All Dielectric Low Wavefront Distortion Polarization Insensitive Beamsplitters, *Keqi Zhang, Ali Smajkiewicz; Barr Associates, USA.* A polarization insensitive, low wavefront distortion 50% beamsplitter is presented. 0.2% split of s and p polarization from 1540nm to 1575nm and less than 1/30th waves peak to valley surface error at 632.8nm were achieved.

TuB3 • 10:50 a.m.
Residual Stress of Rugate Filter made with Ta_2O_5-SiO_2 Composite Thin Films by RF Ion-Beam Sputtering, *Chien-Jen Tang[1], Cheng-Chung Jaing[2], Kuan-Shiang Lee[1], Wei-Ting Shen[2], Cheng-Chung Lee[1]; [1]Natl. Central Univ., Taiwan, [2]Dept. of Optoelectronic System Engineering, Minghsin Univ. of Science and Technology, Taiwan.* Rugate filters made by composite film of Ta-Si oxide have been realized by using RF ion-beam sputtering. The residual stress and deflection of different refractive-indices of stepwise film stacks and rugate filter have been studied.

TuB4 • 10:55 a.m.
Stress Measurement of Al Film Deposited on Flexible Substrates by Shadow Moiré Method, *Kuan-Shiang Lee[1], Chien-Jen Tang[1], Hsi-Chao Chen[2], Cheng-Chung Lee[1]; [1]Natl. Central Univ., Taiwan, [2]De Lin Inst. of Technology, Taiwan.* Shadow moiré method used to measure stress of thin film on flexible substrates was proposed. For Al film deposited on polyimide substrate, using DC magnetron sputtering, the corresponding tensile stress is 0.450±0.042GPa.

TuB5 • 11:00 a.m.
Stress Compensation in Fluoride Coatings for the VUV Spectral Range, *Stefan Günster, Manfred Dieckmann, Henrik Ehlers, Detlev Ristau; Laser Zentrum Hannover, Germany.* Fluoride materials deposited with conventional thermal evaporation techniques show a high tensile stress. The effect of stress compensation by inserting compressive silicon oxide layers into the tensile fluoride stack is investigated.

TuB6 • 11:05 a.m.
Residual Stress of Obliquely Deposited MgF_2 Thin Films, *Cheng-Chung Jaing[1], Ming-Chung Liu[2], Cheng-Chung Lee[2], Wen-Hao Cho[2], Wei-Ting Shen[3], Chien-Jen Tang[2]; [1]Dept. of Optoelectronic System Engineering, Minghsin Univ. of Science and Technology, Taiwan, [2]Dept. of Optics and Photonics, Thin Film Technology Ctr., Natl. Central Univ., Taiwan, [3]Dept. of Electronic Engineering, Minghsin Univ. of Science and Technology, Taiwan.* Effects of columnar angles on the residual stress of MgF_2 films were investigated. The MgF_2 films with a columnar microstructure were obliquely deposited on glass substrates by means of resistive heating evaporation.

TuB7 • 11:10 a.m.
Optical Properties and Residual Stress of YbF_3 Thin Films Deposited at Different Temperatures, *Ying Wang, Yue-guang Zhang, Wei-lan Chen, Xu Liu; State Key Lab of Modern Optical Instrumentation, Zhejiang Univ., China.* The influence of deposition temperature on optical properties and residual stress of YbF_3 was investigated. It's shown that YbF_3 deposited at 160°C has the lowest optical loss and the coating's stress increases with deposition temperature.

TuB8 • 11:15 a.m.
Long Term Stability of Low Index Mixed Fluorides, *David H. Cushing; Retired, USA.* The properties of a few mixed fluoride filters are examined for wavelength stability. Results for visible and near IR are shown.

PTuAB • Poster Session III

Grand Ballroom Salon A
11:20 a.m.–12:20 p.m.
PTuAB • Poster Session III

Posters included in this session are:

TuA2
TuA3
TuA4
TuA5
TuA6
TuA7
TuA8
TuA9
TuA10
TuB2
TuB3
TuB4
TuB5
TuB6
TuB7
TuB8

Kiva Ballroom
12:20 p.m.–1:35 p.m.
Lunch

TuC • Birefringent Coatings / Polarizer Coatings

Grand Ballroom Salon B and C
1:35 p.m.–2:55 p.m.
TuC • Birefringent Coatings / Polarizer Coatings
Li Li; Natl. Res. Council of Canada, Canada, Presider
Bruce Perilloux; Coherent Inc, USA, Presider

TuC1 • 1:35 p.m. **Invited**
Manufacture of High Performance Polarizing Beam Splitter for Projection Display Applications , *Penghui Ma, Li Li, Fengchen Lin, J. A. Dobrowolski; Natl. Res. Council of Canada, Canada.* The manufacture and measured performance of a high-performance visible polarizing beam splitter of the Li Li type is described.

TuC2 • 2:05 p.m.
Optical Filters, Reflectors and Polarizers Fashioned with Periodic Leaky-Mode Resonant Layers, *Robert Magnusson, Mehrdad Shokooh-Saremi, Yiwu Ding; Univ. of Connecticut, USA.* Examples of optical devices based on periodic leaky-mode resonant layers are presented. A single-layer element provides narrowband bandpass and bandstop filters and wideband reflectors and polarizers.

TuC3 • 2:10 p.m.
All-Dielectric Front-Surface Wide-Angle and Broadband Non-Polarizing Parallel Plate Beam Splitter, *Shengming Xiong[1], Wenliang Wang[1,2], Yundong Zhang[1]; [1]Inst. of Optics and Electronics, Chinese Acad. of Sciences, China, [2]Graduate School of the Chinese Acad. of Sciences, China.* Three different split ratios wide-angle and broadband non-polarizing parallel plate beam splitters are designed. The spectral wavelength region of the designs are all from 450nm to 650nm, and the incident angle of $45^o \pm 5^o$ in air.

TuC4 • 2:15 p.m.
Embedded Centro-Symmetric Multilayer Stacks as Complete-Transmission Quarter-Wave and Half-Wave Retarders under Conditions of Frustrated Total Internal Reflection, *Siva R. Perla, Rasheed M. A. Azzam; Univ. of New Orleans, USA.* Quarter-wave and half-wave retarders with near complete transmission for both polarizations have been achieved using frustrated total internal reflection by an embedded centro-symmetric multilayer stack. The angular, spectral, and film-thickness sensitivities are considered.

TuC5 • 2:20 p.m.
Influences of the Incident Angle, Orientation of Deposition Plane and Film Thickness on a Polarization Conversion Reflection Filter, *Cheng-Yu Peng, Yi-Jun Jen, Kuen-Teng Shiu; Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan.* The wavelength spectrum of polarization conversion reflection can be modulated to shift by changing thickness, orientation of deposition plane of an anisotropic thin film, and the spectrum also shift with the angle of incidence.

TuC6 • 2:25 p.m.
Optical Constants Determination of an Anisotropic Thin Film by Measuring the Polarization States Associated with Polarization Conversion Reflection, *Yi-Jun Jen, Chih-Wei Liu; Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan.* The sensitivity analysis demonstrates that the polarization state measurement is a sensitive method to detect the optical constants of an anisotropic thin film when the polarization conversion reflection is enhanced.

TuC7 • 2:35 p.m.
Polarization State Modulation for the Reflected Ray from an Anisotropic Thin Film, *Yi-Jun Jen, Cheng-Yu Peng; Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan.* Due to the enhanced polarization conversion for oblique ray incident on an anisotropic thin film, the polarization state of the reflected ray can be modulated by rotating the substrate.

TuC8 • 2:40 p.m.
Positive and Negative Spatial Dispersion Effects of Optical Thin Films, *Xu Liu[1,2], Xuezheng Sun[1], Peifu Gu[1], Yueguang Zhang[1], Haifeng Li[1]; [1]Zhejiang Univ., China, [2]State Key Lab of Modern Optical Instrumentation, China.* The position shifts of the reflective beam, from the thin film filter have been investigated. Not only positive beam shift,but also negative beam shift have found in the common superprism effect of thin film coatings.

TuC9 • 2:45 p.m.
Using Phisweep Technique to Sculpture Anisotropic Optical Thin Films, *Yi-Jun Jen, Chia-Feng Lin; Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan.* Anisotropic thin films with the same columnar tilt angle but different porosities are prepared by Phisweep technique. Films with different ranges of principal indexes reveal their new application in anisotropic thin film design.

Grand Ballroom Foyer
2:55 p.m.–3:25 p.m.
Coffee Break

TuD • Filters

Grand Ballroom Salon B and C
3:25 p.m.–4:40 p.m.
TuD • Filters
Chang Kwon Hwangbo; Inha Univ., Republic of Korea, Presider
Brian Sullivan; Iridian Spectral Technologies, Canada, Presider

TuD1 • 3:25 p.m. **Invited**
Narrowband Multi-Channel Filters and Integrated Optical Filter Arrays, *Zhanshan Wang[1], Yonggang Wu[1], Tian Sang[1], Li Wang[1], Hongfei Jiao[1], Jingtao Zhu[1], Lingyan Chen[1], Shaowei Wang[2], Xiaoshuang Chen[2], Wei Lu[2]; [1]Tongji Univ., China, [2]Chinese Acad. of Sciences, China.* Multiple heterostructures inserted with defects are presented. Single and double layer guided-mode resonance (GMR) Brewster filters with multiple channels are introduced. Single and double chamber integrated optical filter arrays are fabricated.

TuD2 • 3:55 p.m.
Implementation of Long-Wavelength Cut-off Filters Based on Critical Angle, *J. A. Dobrowolski[1], Yanen Guo[1], Li Li[1], Tom Tiwald[2]; [1]Natl. Res. Council of Canada, Canada, [2]J.A. Woollam Co. Inc., USA.* We describe the practical problems that need to be overcome when constructing long-wavelength cut-off filters with extended transmission and rejection regions based on the use of critical angle and the dispersion of refractive indices.

TuD3 • 4:00 p.m.
Rugate Filter with Specified Bandwidth: A New Rule of Thumb, *William H. Southwell; Table Mountain Optics, USA.* An equation has been derived that enables the design of a rugate filter that will exhibit at least an optical density D over a specified bandwidth W.

TuD4 • 4:05 p.m.
Photosensitive Bandpass Filters, *Weidong Shen[1], Michel Cathelinaud[1], Michel Lequime[1], Cecile Aubert[2]; [1]Inst. Fresnel, France, [2]KLOE, France.* First experimental demonstrations of the concept of photosensitive filters are reported. Possible application to the manufacturing of non absorbing apodizing filters is discussed.

TuD5 • 4:10 p.m.
Wide Spectrum Transmission Filters for Image Spectrometry from Space, *Angela M. Piegari[1], Anna Krasilnikova Sytchkova[1], Jiri Bulir[2]; [1]ENEA, Italy, [2]Acad. of Sciences, Czech Republic.* Small-dimension narrow-band transmission filters operating over a wide spectrum, are required for some space instruments. Metal-dielectric optical coatings are proposed to cover a wavelength range from visible to infrared, with a low number of layers.

TuD6 • 4:15 p.m.
Completely Blocked Ultra Violet Filters, *David H. Cushing; Retired, USA.* UV filter designs with high transmission (>40%) and deep blocking (>6 OD) are described. The bandpass is all-dielectric (ADI) with a metal filter (MDM) blocker. An augmented section with short pass properties provides additional blocking.

TuD7 • 4:20 p.m.
A Hitless Tunable Filter Using Optical Multilayer Films for ROADM System, *Hidehiko Yoda, Takayuki Mizuno, Hiroyuki Sasho, Kazuo Shiraishi; Utsunomiya Univ., Japan.* A hitless tunable filters using optical multilayer films have not been realized yet. A novel design for the hitless tunable filter using optical multilayer films has been proposed and its basic operation was demonstrated.

TuD8 • 4:25 p.m.
Optical Filters with Constant Optical Thickness and Refined Refractive Indices, *Stephane Larouche, Ludvik Martinu; Ecole Polytechnique de Montreal, Canada.* We propose an approach to refine the refractive index of layers of optical interference filters while keeping their optical thickness constant. We then demonstrate possible applications of this method.

TuD9 • 4:30 p.m.
Preparation and Characterization of Free-Standing Zr Filter for Soft X-Ray Laser Application, *Yonggang Wu[1,2], Li Zhang[1], Hong Cao[1], Xiuping Zheng[1], Hongfei Jiao[1], Lingyan Chen[1]; [1]Inst. of Precise Optical Engineering and Technology, Tongji Univ., China, [2]Physics Dept., Nantong Univ., China.* 200μg/cm^2 free-standing Zr filters of 20mm in diameter were prepared. Results show that the transmittance is 19% at 13.9nm, Carbon, Oxygen and Nitrogen are the major impurities that affect transmittance in the soft X-ray region.

PTuCD • Poster Session IV

Grand Ballroom Salon A
4:40 p.m.–5:40 p.m.
PTuCD • Poster Session IV

Posters included in this session are:

TuC2
TuC3
TuC4
TuC5
TuC6
TuC7
TuC8
TuC9
TuD2
TuD3
TuD4
TuD5
TuD6
TuD7
TuD8
TuD9

TuE • Postdeadline Session

Grand Ballroom Salon B and C
5:40 p.m.–6:05 p.m.
TuE • Postdeadline Session
Presider to Be Announced

•Wednesday, June 6, 2007•

Grand Ballroom Foyer
8:00 a.m.–5:30 p.m.
Registration Open

WA • Design of Optical Coatings I

Grand Ballroom Salon B and C
8:30 a.m.–9:45 a.m.
WA • Design of Optical Coatings I
Amy L. Rigatti; Univ. of Rochester, USA, Presider
H. Angus Macleod; Thin Film Ctr., USA, Presider

WA1 • 8:30 a.m. **Invited**
Pre-Production Analysis of Optical Coating Manufacturability, *Alexander V. Tikhonravov, Michael K. Trubetskov; Res. Computing Ctr. of, Russian Federation.* We demonstrate that comparative pre-production analysis of expected production errors can be useful for choosing the most practical design from a series of theoretical designs with various combinations of principal design parameters.

WA2 • 9:00 a.m.
Design Opportunities for Better Manufacturability, *Alexander V. Tikhonravov, Michael K. Trubetskov; Res. Computing Ctr., Moscow State Univ., Russian Federation.* We propose a new scheme for obtaining multiple solutions to a design problem. Using hot mirror designs we demonstrate that this scheme can be used for choosing designs satisfying additional practical criteria of better manufacturability.

WA3 • 9:05 a.m.
Reverse Engineering of Fabricated Coatings Using Off-Line and On-Line Photometric Data, *Alexander V. Tikhonravov[1], Michael K. Trubetskov[1], Michael A. Kokarev[1], Silvia Thony[2]; [1]Res. Computing Ctr., Moscow State Univ., Russian Federation, [2]SwissOptic AG, Switzerland.* We propose an approach to the determination of thicknesses of individual coating layers from on-line monitoring data. We demonstrate an application of this approach to the analysis of the 52-layer filter.

WA4 • 9:10 a.m.
Monitoring and Control of Optical Thin Film "Fencepost" Designs of Various Types, *Ronald R. Willey; Willey Optical, Consultants, USA.* The monitoring of Fencepost Designs offers error compensation and reduction. There tend to be two or more extrema within the monitoring of each layer between the fenceposts. This has a self calibrating effect on layers.

WA5 • 9:15 a.m.
Design of Complex Rugate Filters, *Pierre G. Verly; Natl. Res. Council of Canada, Canada.* An accurate procedure based on Fourier techniques and the optimization of inhomogeneous films is presented for the design of rugate optical filters with arbitrary spectral shapes.

WA6 • 9:20 a.m.
Designing High-Efficiency Interference Coatings With Atomic Layer Deposited TiO_2 Layers, *Jennifer D. T. Kruschwitz; JK Consulting, USA.* Atomic Layer Deposition (ALD) has enabled the manufacturing of high-efficiency optical interference coatings. This paper reviews the interference coating designing methodology necessary to use TiO_2 as an optical material when deposited using ALD.

WA7 • 9:25 a.m.
Designing Phase-Sensitive Mirrors by Minimizing Complex Error Energy in the Frequency Domain, *Jonathan R. Birge; MIT, USA.* The direct optimization of complex filter error, modulo zeroth-and first-order phase, is proposed as an alternative to GDD optimization. In the appropriate norm, this is equivalent to minimizing the error energy for a given input.

WA8 • 9:30 a.m.
Wide-Angle, High-Extinction-Ratio, IR Polarizing Beam Splitters Using Frustrated Total Internal Reflection by an Embedded Centro-Symmetric Multilayer, *Siva R. Perla, Rasheed M. A. Azzam; Univ. of New Orleans, USA.* Polarizing beam splitters using embedded centro-symmetric multilayer stacks operating under conditions of frustrated total internal reflection are described. The spectral and angular sensitivities of these devices are considered.

WA9 • 9:35 a.m.
Advanced Dispersive Optics for the VIS-IR Range, *Volodymyr Pervak[1], Sergei Naumov[1], Adrian Cavalieri[1], Xun Gu[1], Michael K. Trubetskov[2], Alexander V. Tikhonravov[2], Ferenc Krausz[1], Alexander Apolonski[3]; [1]Max Planck Inst. of Quantum Optics, Germany, [2]Res. Computing Ctr., Russian Federation, [3]Ludwig-Maximilians-Univ. München, Germany.* We report on two types of dispersive mirrors: ultrabroadband chirped mirrors with reflectivity and dispersion covering 1.5 octaves (and supporting 2.6-fs pulses), and high-dispersive mirrors for kHz Ti:Sa oscillator-amplifier system and Ti:Sa CPO compressors.

WA10 • 9:40 a.m.
Design of Attenuated Phase-shift Masks for Extreme Ultraviolet Lithography with High Inspection Contrast in Deep Ultraviolet Regime, *Hee Young Kang, Jang-Hoon Lee, Chang Kwon Hwangbo; Inha Univ., Republic of Korea.* Attenuated phase-shift masks based on a Fabry-Perot interferometer for extreme ultraviolet lithography have designed, which show not only 180° phase-shift with attenuated reflectance ratio below 0.1 at 13.5-nm, but also high inspection contrast at 257-nm.

Grand Ballroom Foyer
9:45 a.m.–10:15 a.m.
Coffee Break

Grand Ballroom Foyer
9:45 a.m.–3:20 p.m.
Exhibits Open

WB • Design Problem / Design of Optical Coatings II

Grand Ballroom Salon B and C
10:15 a.m.–11:20 a.m.
WB • Design Problem / Design of Optical Coatings II
J. A. Dobrowolski; Natl. Res. Council of Canada, Canada, Presider
Jennifer Kruschwitz; JK Consulting, USA, Presider

WB1 • 10:15 a.m. Invited
OIC 2007: Design Problem Results, *Markus Tilsch, Karen Hendrix; JDSU, USA.* A triple bandpass filter and a non-polarizing beamsplitter were the design contest problems. A total of 50 submissions were received. The winners will be announced and an in-depth analysis of the designs will be presented.

WB2 • 10:45 a.m.
Design of Multilayer Coatings with Specific Angular Dependencies of Color Properties, *Alexander V. Tikhonravov, Michael K. Trubetskov, Tatiana V. Amotchkina, Sergey A. Yanshin; Res. Computing Ctr., Moscow State Univ., Russian Federation.* It is shown that multilayer dielectric coatings can provide a great variety of angular dependencies of their color properties.

WB3 • 10:50 a.m.
Theoretical Notes on One Magic Reflectance Value, *Alexander V. Tikhonravov, Michael K. Trubetskov, Tatiana V. Amotchkina; Res. Computing Ctr., Moscow State Univ., Russian Federation.* We derive a simple approximation for the transmittance derivative versus the thickness of an outer coating layer. This approximation allows one to estimate the transmittance sensitivity to thickness variations.

WB4 • 10:55 a.m.
Design, Fabrication and Reverse Engineering of Broad Band Chirped Mirrors, *Alexander V. Tikhonravov[1], Michael K. Trubetskov[1], Vladimir Pervak[2], Ferenc Krausz[2,3], Alexander Apolonski[3,4]; [1]Res. Computing Ctr., Moscow State Univ., Russian Federation, [2]Max-Planck-Inst. of Quantum Optics, Germany, [3]Ludwig Maximilian Univ., Germany, [4]Inst. of Automation and Electrometry, Russian Federation.* We present a design - fabrication approach that enables elaborating new types of broad band chirped mirrors in short time periods.

WB5 • 11:00 a.m.
Structural Properties of Antireflection Coatings, *Tatiana V. Amotchkina, Alexander V. Tikhonravov, Michael K. Trubetskov, Sergey A. Yanshin; Res. Computing Ctr., Moscow State Univ., Russian Federation.* Structural properties of antireflection coatings are studied by comparing optimal designs with various total optical thicknesses.

WB6 • 11:05 a.m.
OpenFilters: An Open Source Software for the Design and Optimization of Optical Coatings, *Stephane Larouche, Ludvik Martinu; Ecole Polytechnique de Montreal, Canada.* We release an open source software for the design, optimization and synthesis of optical coatings. It allows the conception of multilayer and graded-index filters and includes refinement and the Fourier transform, needle and step methods.

WB7 • 11:10 a.m.
Applications of a Genetic and Simplex Algorithm Based Hybrid Algorithm in Optical Film Design and Optimization, *Yonggang Wu, Donggong Peng, Hongfei Jiao, Zhenhua Wang, Hong Cao, Li Zhang; Inst. of Precise Optical Engineering and Technology, China.* A new method used to optimize and design film system is developed by combining the improved Float-coded Genetic algorithm with Simplex Algorithm. Examples show that both the global and local searching capacity are excellent.

WB8 • 11:15 a.m.
Optical Interference Coating Design with DGL Global Optimization Algorithms, *Dongguang Li; Edith Cowan Univ., Australia.* The optical coating design using an innovative global optimization algorithm is discussed. The software has been developed, which shows a great advantage in finding a best optical coating optimization design over other conventional design methods.

PWAB • Poster Session V

Grand Ballroom Salon A
11:20 a.m.–12:20 p.m.
PWAB • Poster Session V

Posters included in this session are:

WA2
WA3
WA4
WA5
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WA8
WA9
WA10
WB2
WB3
WB4
WB5
WB6
WB7
WB8

Kiva Ballroom
12:20 p.m.–1:35 p.m.
Lunch

WC • Optical Monitoring

Grand Ballroom Salon B and C
1:35 p.m.–2:50 p.m.
WC • Optical Monitoring
Stephen Browning; Ball Aerospace and Technologies Corp., USA, Presider
Cheng-Chung Lee; Natl. Central Univ., Taiwan, Presider

WC1 • 1:35 p.m. Invited
Optimization of Optical Monitoring of Non-Quarterwave Stacks Using Admittance, *Boo-Young Jung[1], Jang-Hoon Lee[1], Sung-Goo Jung[1], Byung Jin Chun[1], Chang Kwon Hwangbo[1], Young-Jin Song[2], Eung-Soon Kim[2], Jong Sup Kim[3]; [1]Inha Univ., Republic of Korea, [2]Intec Inc., Republic of Korea, [3]Korea Photonics Technology Inst., Republic of Korea.* A new optical monitoring method is proposed, in which the optical admittance and the turning values on admittance diagram are used. Its performance and characteristics have been studied in comparison with prior optical monitoring methods.

WC2 • 2:05 p.m.
Monitoring Strategy Combining the Advantages of Direct and Indirect Optical Monitoring, *Alexander V. Tikhonravov, Michael K. Trubetskov; Res. Computing Ctr., Moscow State Univ., Russian Federation.* We propose direct monochromatic monitoring strategy that allows one to control each new coating layer independently of errors in previously deposited layers.

WC3 • 2:10 p.m.
Direct Optical Monitoring Enables High Performance Applications in Mass Production, *Alfons Zoeller, Michael Boos, Harro Hagedorn, Alexei Kobiak, Holger Reus, Boris Romanov; Leybold Optics GmbH, Germany.* Single wavelength optical monitoring in intermittent mode was investigated. The achieved coincidence between theory and experiment is outstanding. This monitoring technique enables rapid prototyping with tight specifications and high yield in large box coaters.

WC4 • 2:15 p.m.
***In situ* Monitoring and Deposition Control of a Broadband Multilayer Dichroic Filter,** *Svetlana Dligatch, Roger P. Netterfield; Australian Ctr. for Precision Optics, CSIRO, Australia.* We report developments in real-time deposition control of the fabrication of broadband multilayer optical designs with demanding specifications. Combination of real-time ellipsometric monitoring and automated deposition control was used to achieve the required performance.

WC5 • 2:20 p.m.
An Error Compensation Strategy for Broadband Optical Monitoring, *Bruno Badoil, Fabien Lemarchand, Michel Cathelinaud, Michel Lequime; Inst. Fresnel, France.* We present a Broadband Optical Monitoring system which simultaneously measures reflectance and transmittance. The determination of coated thicknesses is integrated into a design software to optimize following layers. Experimental results are given.

WC6 • 2:25 p.m.
Sensitive Optical Monitoring with Error Compensation
Kai Wu, Sheng-Hui Chen, Ming-Sheng Chang, Cheng-Chung Lee; Natl. Central Univ., Taiwan., A way to calculate fluctuant refractive indices and thickness compensation during the deposition has been proposed. A novel monitor method was thereby derived, and a narrow band pass filter with excellent performance has been demonstrated.

WC7 • 2:30 p.m.
Monitoring of Multilayer by Admittance Diagram, *Yu-Ren Chen, Cheng-Chung Lee; Natl. Central Univ., Taiwan.* Admittance diagram was applied in monitoring of the film growth and instant error compensation. The sensitivity was discussed and error compensation in an anti-reflection coating process was demonstrated.

WC8 • 2:35 p.m.
Analysis of Dip Coating Processing Parameters by Double Optical Monitoring, *Flavio Horowitz, Alexandre F. Michels; Inst. de Fisica, UFRGS, Brazil.* Double optical monitoring is applied to look into the influence of withdrawal speed, temperature and relative humidity in the formation of sulfated zirconia and mesoporous silica sol-gel films by dip coating in real time.

WC9 • 2:40 p.m.
Multi-Wavelength Optical Monitoring for Infrared Complex Functions: Application to Process Improvement, *Catherine Grèzes-Besset[1], Nathalie Valette[1], Hélène Krol[1], Didier Torricini[1], Frédéric Chazallet[2], Julie Poupard[3], Laurent Gallais[4], Jean-Yves Natoli[4], Mireille Commandré[4]; [1]CILAS Marseille, France, [2]SHAKTI SA, France, [3]DGA, France, [4]Inst. Fresnel, France.* Use of an infrared direct optical monitoring is presented for realization of complex stacks requiring optical performances on different spectral ranges for infrared applications. Such system is used for process improvement in laser damage application.

WC10 • 2:45 p.m.
On-line Re-engineering of Interference Coatings, *Steffen Wilbrandt[1], Olaf Stenzel[1], Norbert Kaiser[1], Michael K. Trubetskov[2], Alexander V. Tikhonravov[2]; [1]Fraunhofer IOF, Germany, [2]Res. Computing Ctr., Moscow State Univ., Russian Federation.* We demonstrate the potentialities of our new optical monitor (OptiMon) to perform transmission measurements, re-engineering and recalibration of quartz monitor tooling factors during a deposition process. Examples include single layers as well as high-low stacks.

Grand Ballroom Foyer
2:50 p.m.–3:20 p.m.
Coffee Break

WD • Thermal Properties

Grand Ballroom Salon B and C
3:20 p.m.–4:35 p.m.
WD • Thermal Properties
Michael L. Fulton; Ion Beam Optics Inc., USA, Presider
Xu Liu; Zhejiang Univ., China, Presider

WD1 • 3:20 p.m. Invited
Constructing Multilayers with Absorbing Materials, *Juan I. Larruquert, Mónica Fernández-Perea, Manuela Vidal, José A. Méndez, José A. Aznárez; Inst. de Fisica Aplicada, CSIC, Spain.* Procedures for the design of multi-material multilayers with absorbing materials will be presented along with experimental results on multilayer coatings with high reflectance in the extreme UV.

WD2 • 3:50 p.m.
Comparison of Thermal Shifts in Resonant Grating Waveguide Structures and Multilayer Stacks, *Robert Leitel[1,2], Olaf Stenzel[2], Norbert Kaiser[2], Andreas Tünnermann[1,2]; [1]Inst. fuer Angewandte Physik, Friedrich Schiller Univ., Germany, [2]Fraunhofer Inst. für Angewandte Optik und Feinmechanik, Germany.* Resonant grating waveguide structures may find application as narrowband reflection filters. We present a theoretical approach for calculating the thermal shift in such devices. The results are compared to thermal shifts in classical multilayer stacks.

WD3 • 3:55 p.m.
Spatial Beam Switching by Thermal Tuning of a Hybrid Organic-Inorganic Thin-Film Stack, *Felix Glöckler, Sabine Peters, Uli Lemmer, Martina Gerken; Lichttechnisches Inst., Univ. Karlsruhe (TH), Germany.* We experimentally demonstrate thermo-optic tuning of a laser beam's thin-film stack exit position at oblique incidence. A hybrid organic-inorganic resonator design is used to achieve a large change in the group propagation angle with temperature.

WD4 • 4:00 p.m.
Determination of Thermal and Elastic Coefficients of Optical Thin-Film Materials, *Sebastien Michel, Frédéric Lemarquis, Michel Lequime; Inst. Fresnel, France.* A dedicated set-up is proposed for the measurement of thermal and elastic coefficients of single layers, in order to predict the behavior and the range of use of optical coatings with respect to environmental loadings.

WD5 • 4:05 p.m.
Prism Coupling Measurement of Part-Per-Million Extinction in an Optical Thin Film during and after Deposition, *George Dubé[1], Arthur J. Braundmeier, Jr.[2], Steve Chelli[3], Anthony Webb[1], Roland Juhala[1]; [1]MetaStable Instruments, Inc., USA, [2]Southern Illinois Univ.-Edwardsville, USA, [3]Deposition Res. Lab, Inc., USA.* A modified prism coupling technique was used inside a vacuum chamber to measure the very low extinction in an optical thin film as it was being deposited. More conventional modifications were also investigated.

WD6 • 4:10 p.m.
Characterization of Low Losses in Optical Thin Films and Materials, *Christian Muehlig[1], Wolfgang Triebel[1], Siegfried Kufert[1], Helmut Bernitzki[2]; [1]IPHT Jena, Germany, [2]Jenoptik Laser, Optik, Systeme GmbH, Germany.* At various laser wavelengths, the laser induced deflection technique is applied to directly measure residual absorptions in thin films, materials and at surfaces. Accompanying, the laser induced fluorescence is applied to investigate possible absorbing species.

WD7 • 4:15 p.m.
Coefficient of Thermal Expansion and Biaxial Modulus of Thin Films on a Thin Substrate, *Chien-Cheng Kuo, Sheng-Hui Chen, Cheng-Chung Lee; Thin Film Technology Ctr., Dept. of Optics and Photonics, Natl. Central Univ., Taiwan.* A modified Stoney's equation is provided to solve the coefficients of thermal expansion and biaxial modulus of the thin film when the thickness ratio (thin film thickness/substrate thickness) is larger than 1%.

WD8 • 4:20 p.m.
Precise and Practical Measurement of Weak Absorption for Optical Coatings, *Hongbo He, Xia Li, Jianda Shao, Zhengxiu Fan; Shanghai Inst. of Optics and Fine Mechanics, Chinese Acad. of Sciences, China.* In order to improve precision and practicability of an absorption measuring apparatus based on surface thermal lensing, calibration, regulation, and optimization of parameters are investigated. After these, performance of the equipment is concretely advanced.

PWCD • Poster Session VI

Grand Ballroom Salon A
4:35 p.m.–5:35 p.m.
PWCD • Poster Session VI

Posters included in this session are:

WC2	**WD2**
WC3	**WD3**
WC4	**WD4**
WC5	**WD5**
WC6	**WD6**
WC7	**WD7**
WC8	**WD8**
WC9	
WC10	

Poolside
6:00 p.m.–7:30 p.m.
Conference Reception

•Thursday, June 7, 2007•

Grand Ballroom Foyer
8:00 a.m.–5:30 p.m.
Registration Open

ThA • Measurements I

Grand Ballroom Salon B and C
8:30 a.m.–9:45 a.m.
ThA • Measurements I
Claude Amra; Inst. Fresnel, France, Presider
Detlev Ristau; Laser Zentrum Hannover, Germany, Presider

ThA1 • 8:30 a.m. Invited
Standardized Characterization of Optical Losses from the Ultraviolet to Near-Infrared Range, *Kai Starke, I. Balasa, H. Blaschke, L. Jensen, M. Jupé, D. Ristau; Laser Zentrum Hannover e.V., Germany.* An overview of optics characterization standards from UV to NIR range is given. The investigations are focused on the precise determination of optical coatings losses. Examples are presented for fixed wavelength and tunable laser sources.

ThA2 • 9:00 a.m.
UV-VIS-NIR Scatter Measurement Methods for Ultra Precision Surfaces and Coatings, *Stefan Gliech, Ronny Wendt, Angela Duparré; Fraunhofer Inst. Angewandte Optik und Feinmechanik, Germany.* The capabilities of our optimized angle resolved and total light scattering measurement systems in the ultraviolet to near-infrared spectral ranges are described and examples of investigations on multilayer gratings and diamond turned optics given.

ThA3 • 9:05 a.m.
From Angle Resolved Ellipsometry of Light Scattering to Imaging in Random Media, *Gaelle Georges, Laurent Arnaud, Carole Deumié, Claude Amra; Inst. Fresnel, France.* Angular polarimetric measurements of scattered fields are studied for multilayers. The technique permits to separate surface and bulk effects, and provides informations about correlations between layers. It permits to deal with imaging in scattering media.

ThA4 • 9:10 a.m.
Improved Characterization of Optical Surfaces from Scattered Light Measurements, *James E. Harvey[1], Andrey Krywonos[2]; [1]College of Optics and Photonics, USA, [2]Univ. of Central Florida, USA.* A generalized surface scatter theory results in an improved solution to the inverse scattering problem. This new solution eliminates undesirable artifacts in the surface *PSD* function predicted from the classical Rayleigh-Rice theory.

ThA5 • 9:15 a.m.
Characterization of Optical Coatings with a CCD Angular and Spatial Resolved Scatterometer, *Myriam Zerrad, Michel Lequime, Carole Deumie, Claude Amra; Inst. Fresnel, France.* The principle of a new scattering measurement system including a mobile lighting and a fixed CCD array is described. Examples of application of this set-up to the comprehensive characterization of optical coatings are given.

ThA6 • 9:20 a.m.
High-Precision Measurements of the Specular Reflectivity, *Hervé Piombini[1], Philippe Vaorino[1], Frédéric Sabary[1], Daniel Marteau[1], Jimmy Dubard[2], Jacques Hameury[2], Jean-Rémy Filtz[2]; [1]CEA, France, [2]LNE, France.* The spectrophotometer described is designed to measure specular reflectance with a high degree of accuracy. It can measure shape piece, antireflective or reflective coating and make cartographies in order to detect heterogeneities of coating.

ThA7 • 9:25 a.m.
Variations of Transmittance with Relative Humidity in LIL/LMJ Polarizer Coatings, *Gaël Gaborit, Eric Lavastre, Isabelle Lebeaux, Jean-Christophe Poncetta; Commissariat à l'Energie Atomique (CEA), France.* Environmental dependence of HfO_2/SiO_2 polarizer coatings provided for the Laser MegaJoule prototype is presented. Symphonia photometer equipped with a specific controlled environment chamber allows measurements of transmittance uniformity versus relative

ThA8 • 9:30 a.m.
Optical Loss Analysis of Electro-Optic Polymers through Two-Layer Measurement, *Danliang Jin, Lixin Zheng, Anna Barklund, Guomin Yu, Diyun Huang, Baoquan Chen, Merly Moolayil, Yun Fang, Bing Li, Raluca Dinu; Lumera Corp., USA.*
The optical loss of polymeric electro-optic device (~3.0 dB/cm) has been much higher than that of core polymers (<1.8 dB/cm) used, which is related to surface morphology of bottom clad.

ThA9 • 9:35 a.m.
Explicit Refractive Index Determination from the Envelopes of the Ellipsometric Magnitude tan(psi), *Juan C. M. Anton; Univ. Complutense Madrid, Spain.* We present some explicit formulas that link the properties of the interfaces delimiting an interference film to the envelopes of measured tan(ψ). Constants estimation is direct, free from regression analysis, thickness estimation or dispersion models.

ThA10 • 9:40 a.m.
Characterization of Photocatalytic Activity of TiO_2 Thin Films for Optical Applications, *Thomas Neubert, Wenzao Sun, Frank Neumann, Michael Vergoehl; Fraunhofer Inst. for Surface Engineering and Thin Films, Germany.* A simple method for the determination of the photocatalytic activity based on haze measurement of a stearic acid film deposited on the photocatalyst is presented. Results of different TiO_2 films are presented.

Grand Ballroom Foyer
9:45 a.m.–10:15 a.m.
Coffee Break

Grand Ballroom Foyer
9:45 a.m.–3:20 p.m.
Exhibits Open

ThB • Measurement Problem / Measurements II

Grand Ballroom Salon B and C
10:15 a.m.–11:20 a.m.
ThB • Measurement Problem / Measurements II
Mireille Commandré; Inst. Fresnel, France, Presider
Markus Tilsch; JDS Uniphase, USA, Presider

ThB1 • 10:15 a.m. Invited
Measurement Problem, *Angela Duparré[1], Detlef Ristau[2]; [1]Fraunhofer Inst. Angewandte Optik und Feinmechanik, Germany, [2]Laser Zentrum Hannover e.V., Germany.* The Measurement Problem comprises measurements of the T and R spectra and the determination of the optical constants for a single oxide layer on fused silica. The angle of incidence is 45°.

ThB2 • 10:45 a.m.
Elastic and Plastic Deformation of Densified SiO_2 Films, *Jue Wang, Robert L. Maier, Horst Schreiber; Corning Tropel Corp., USA.* Elastic and plastic deformations of densified SiO_2 films prepared by plasma ion-assisted deposition were correlated to reversible and irreversible center wavelength shifts of the correspondent ultraviolet narrow bandpass filters at various temperatures.

ThB3 • 10:50 a.m.
Low Temperature Deposition of Indium Tin Oxide Films by Plasma Ion-Assisted Evaporation, *Kevin Füchsel, Ulrike Schulz, Norbert Kaiser; Fraunhofer Inst. for Applied Optics and Precision Engineering IOF, Germany.* ITO films are suitable to achieve transparent and conductive thin films for a multiplicity of applications. Electrical and optical properties of ITO films prepared by plasma ion-assisted deposition at low substrate temperatures will be presented.

ThB4 • 10:55 a.m.
Characterizing Multilayer, Low Diattenuation Mirrors With a Mueller Matrix Imaging Polarimeter, *Paula K. Smith, Russell A. Chipman; Univ. of Arizona, USA.* A multilayer, low diattenuation mirror was measured with a Muller matrix imaging polarimeter. The measured diattenuation and absolute reflectance were used to characterize the optical constants of each layer *in-situ* using a Levenberg-Marguardt optimization.

ThB5 • 11:00 a.m.
Stoichiometry Monitor in Plasma Assisted Deposition Using Optical Spectroscopy, *Oscar Raymond[1], Javier Salinas[2], Javier Camacho[3], Manuel Guevara[4], Roberto Machorro[1]; [1]Univ. Nacional Autónoma de México, Mexico, [2]INAOE, Mexico, [3]CICESE, Mexico, [4]Univ. Nacional de Trujillo, Peru.* A procedure to monitor the chemical stoichiometry during the plasma assisted deposition processes is presented. A direct observation of predefined spectral lines allows a predictable layer composition.

ThB6 • 11:05 a.m.
Efficiency of Polarimetric z-Probing within Optical Multilayer, *Claude Amra[1], Gaelle Georges[1], Carole Deumié[1], Catherine Grezes-Besset[2]; [1]Inst. Fresnel, France, [2]CILAS, France.* Angular polarimetric phase measurements of the scattered field are studied for multilayers. We can then present a simple technique based on destructive interferences of the polarization states to selectively probe layers within optical multilayer coatings.

ThB7 • 11:10 a.m.
Phase Dispersion of Coatings in the Beam Combiner of a Stellar Interferometer, *Hong Tang; JPL, USA.* The coatings in a beam combiner contribute significantly to the dispersion. An analysis of phase dispersion from coatings in our MAM-2 experimental unit is presented. The dispersion from experimental measurements is compared to the model.

ThB8 • 11:15 a.m.
Measurement of the Mechanical Properties of TiO_2 Thin Films Deposited by Electron Beam Evaporation, *Takashi Inomata[1], Tomonori Aoki[1], Shigetaro Ogura[2]; [1]OPTO-SOLTEC Inc., Japan, [2]Kobe Design Univ., Japan.* The TiO_2 thin films were deposited by electron beam deposition. The mechanical properties, both of adhesion and hardness were decreased with increasing working pressure, respectively.

PThAB • Poster Session VII

Grand Ballroom Salon A
11:20 a.m.–12:20 p.m.
PThAB • Poster Session VII

Posters included in this session are:

ThA2
ThA3
ThA4
ThA5
ThA6
ThA7
ThA8
ThA9
ThA10
ThB2
ThB3
ThB4
ThB5
ThB6
ThB7
ThB8

Kiva Ballroom
12:20 p.m.–1:35 p.m.
Lunch

ThC • Applications I

Grand Ballroom Salon B and C
1:35 p.m.–2:50 p.m.
ThC • Applications I
Alexander V. Tikhonravov; Res. Computing Ctr. of, Russian Federation, Presider
Ric Shimshock; MLD Technologies, LLC, USA, Presider

ThC1 • 1:35 p.m. Invited
Optical Coating Technology Developed for Flexible Concentrator Space Power Arrays, *Michael L. Fulton; Ion Beam Optics Inc., USA.* Coating technology, to protect flexible DC93-500 silicone Fresnel lenses from solar UV darkening, balanced the differential in the coefficients of thermal expansion between the silicone substrate and the coating materials with the film's intrinsic stress.

ThC2 • 2:05 p.m.
Optical Optimization of Organic Solar Cells, *Florent Monestier[1], Jean-Jacques Simon[1], Philippe Torchio[1], Ludovic Escoubas[1], François Flory[1], Aumeur El Amrani[2], André Moliton[2], Bernard Ratier[2], Michel Cathelinaud[3], Christophe Defranoux[4]; [1]TECSEN, France, [2]XLIM, France, [3] Inst. Fresnel, France, [4]SOPRA-SA, France.* The electromagnetic field distribution inside multilayer organic solar cells is simulated and optimized. The relative importance of optical, electrical and morphological properties of the different thin films is discussed.

ThC3 • 2:10 p.m.
High-Contrast OLED with Microcavity Effect, *Daniel Poitras[1], C. C. Kuo[1,2], C. Py[1], L. Li[1]; [1]Natl. Res. Council of Canada, Canada, [2]Thin Film Technology Ctr., Dept. of Optics and Photonics, Natl. Central Univ., Taiwan.* We propose a new type of high-contrast OLED designs, which have low reflectance but still maintain a small cavity effect for efficient emission.

ThC4 • 2:15 p.m.
Metal-Dielectric Selective Reflecting Filter for Mini-Projectors, *Chao-Tsang Wei[1], Ching-Fen Lin[2], Chun-Chuan Lin[1], Rung-Ywan Tsai[1]; [1]Industrial Technology Res. Inst., Taiwan, [2]Natl. Taipei College of Business, Taiwan.* Metal-dielectric multiple band high reflection coatings were deposited on light-shaping flexible plastic substrate for used as a screen with high contrast enhancement performance. This screen was very suitable for mini-projectors with LED as light sources.

ThC5 • 2:20 p.m.
The Critical Role of Optical Interference Coatings in High Brightness–Etendue Limited Systems Such as HDTV Projectors, *Richard A. Flasck; RAF Electronics Corp., USA.*
High brightness, etendue limited systems demonstrate a need for ever higher performance optical interference coatings with uncommon characteristics. Immersed 45 degree dichroics without S-P spectral splits are examples. System and component measurements are reported.

ThC6 • 2:25 p.m.
Transparent Conductive Materials for Art Protection Glass, *Anna Krasilnikova Sytchkova[1], Maria Luisa Grilli[1], Angela M. Piegari[1], Eric Mattmann[2]; [1]ENEA, Italy, [2]Saint Gobain Recherche, France.* Transparent conductive films are studied for their potential application as artwork protection coatings on glass. Analysis of their properties and preliminary results on multilayer coatings are reported. The possibility of large scale production is investigated.

ThC7 • 2:30 p.m.
Optical Interference Coatings for Femtosecond Nonlinear Microscopy, *Gabriel F. Tempea[1], Boris Považay[2], Andreas Assion[1], Andreas Isemann[1], Wladimir Pervak[3], Michael Kempe[4], Andreas Stingl[1], Wolfgang Drexler[2]; [1]Femtolasers Produktions GmbH, Austria, [2]Dept. of Optometry and Vision Sciences, Cardiff Univ., UK, [3]Max-Planck-Inst. für Quantenoptik, Germany, [4]Carl Zeiss Jena GmbH, Res. Ctr., Germany.* Multilayer mirrors compensating the dispersion of scanning microscope optics over 170nm@800nm were designed, manufactured and tested. The interferometric autocorrelation recorded at the focus of the microscope indicated that the mirrors enabled a pulse duration <12fs.

ThC8 • 2:35 p.m.
An Available Optical Thin Film Demultiplexer Based on Superprism Effect, *Xue Zheng Sun, Xu Liu, P. F. Gu, X. Y. Ni; Zhejiang Univ., China.* An available optical thin film demultiplexer based on superprism effect was fabricated and tested in this paper.

ThC9 • 2:40 p.m.
A Model to Calculate the Performance of Halogen Burners with InfraRed Reflecting Multilayer Coatings, *Hans A. van Sprang; Philips Res. Europe., Netherlands.* A model is presented for the calculation of the efficacy gain by the addition of an IRR coating to a halogen burner. Adequate predictions will be presented for various types of burners.

ThC10 • 2:45 p.m.
Progress and Challenges Developing a Coating for Next Generation Gravitational-Wave Detectors, *Andri M. Gretarsson[1], Gregory Harry[2], David Ottaway[2], Juri Agresti[3], Helena Armandula[3], Riccardo DeSalvo[3], Phil Willems[3], Iain Martin[4], Stuart Reid[4], Peter Murray[4], Sheila Rowan[4], Jim Hough[4], Martin Fejer[5], Roger Route[5], Steven Penn[6], Innocenzo Pinto[7], Vincenzo Galdi[7], Giuseppe Castaldi[7], Vincenzo Pierro[7]; [1]Embry-Riddle Aeronautical Univ., USA, [2]LIGO Lab, MIT, USA, [3]LIGO Lab, Caltech, USA, [4]Dept. of Physics and Astronomy, Univ. of Glasgow, UK, [5]Stanford Univ., USA, [6]Physics Dept., Hobart and William Smith Colleges, USA, [7]Univ. of Sannio, Italy.* Advanced long-baseline gravitational-wave interferometers use ion-beam deposited multilayer dielectric coatings. To minimize the detector noise, these coatings have very low optical absorption, low mechanical loss and a low index of refraction change with temperature.

Grand Ballroom Foyer
2:50 p.m.–3:20 p.m.
Coffee Break

ThD • Applications II / Antireflection Coatings

Grand Ballroom Salon B and C
3:20 p.m.–4:40 p.m.
ThD • Applications II / Antireflection Coatings
Angela M. Piegari; ENEA, Italy, Presider
Flavio Horowitz; Inst. de Fisica, Brazil, Presider

ThD1 • 3:20 p.m. Invited
Characterization of Low Level Losses in Optical Thin Films, *Ric Shimshock; MLD Technologies, LLC, USA.* Optical characterization of high performance films (@ ppm level) requires special metrology. We review approaches used to support the challenging characterizations tasks facing the thin film community presented by LIGO, VIRGO and other Programs.

ThD2 • 3:50 p.m.
Investigation of Ion-Beam-Sputtered Silica-Titania Mixtures for Use in Gravitational Wave Interferometer Optics, *Roger P. Netterfield, Mark Gross; CSIRO Industrial Physics, Australia.* Ion-beam-sputtered mixtures of silica and titania are investigated as potential coating materials for use in gravitational wave interferometer optics. Such coatings must have both low optical and mechanical loss to maximize detection sensitivity.

ThD3 • 3:55 p.m.
Antireflection Coatings for Astronomical Silicon Imagers, *Jordana Blacksberg, Shouleh Nikzad; Caltech, JPL, USA.* We have developed a process for broadband antireflection coating of fully fabricated silicon imagers. We discuss modeling, deposition, and optical testing. Results show that many detector goals can be met with a silicon nitride/oxide structure.

ThD4 • 4:00 p.m.
Antireflection Coating AR-Hard with UV-Protective Properties for Polycarbonate, *Ulrike Schulz, Kerstin Lau, Norbert Kaiser; Fraunhofer Inst. for Applied Optics and Precision Engineering, Germany.* Polycarbonate is the chosen material for display covers. The requirements for coatings comprise high abrasion resistance, antireflection properties and challenging environmental durability. A suitable coating has been developed and deposited onto polycarbonate by Plasma-IAD.

ThD5 • 4:05 p.m.
Anti-Reflective Coatings on Plastic Substrates, *Lynley J. Crawford[1], Neil R. Edmonds[1], Peter N. Plimmer[1], Jonathan Lowy[2]; [1]Univ. of Auckland, New Zealand, [2]Anti-Reflective Technologies Ltd., New Zealand.* High application temperatures mean that conventional anti-reflective (AR) coatings can only be applied to glass substrates. A new, easily applied anti-reflective coating has been designed which can be applied to both plastic and glass substrates.

ThD6 • 4:10 p.m.
Adhesion Enhancement by Surface Pretreatment with Argon-Helium Plasma for Antireflection Coating on TAC, *Shuan-Wen Wang, Chien-Jen Tang, Cheng-Chung Lee; Natl. Central Univ., Taiwan.* Adhesion enhancement of optical thin films on TAC can be achieved by using argon-helium plasma surface pretreatment. Good adhesion anti-reflection coating on TAC with an interface layer refinement was demonstrated.

ThD7 • 4:15 p.m.
Antireflection Coatings for Improvement of Longitudinal Magneto-Optic Kerr Effect Contrast, *Ursula Gibson[1], Patrick Cantwell[2], H. Angus Macleod[3]; [1]Thayer School of Engineering, Dartmouth College, USA, [2]Purdue Univ., USA, [3]Thin Films Ctr., USA.* We describe the use of optical coatings to improve the longitudinal magneto-optical response of both planar films on dielectric substrates. Antireflection coatings improve the signal to noise ratio.

ThD8 • 4:20 p.m.
Anti-Reflection Coating of Diamond, for Use at Elevated Temperatures, *Simon D. Childs[1], Gilbert W. Smith[1], Timothy P. Mollart[1], Warrick Allen[1], Richard H. Bennett[1], Clare F. Kennedy[2], J. E. Field[2]; [1]QinetiQ, UK, [2]Cavendish Lab, UK.* An anti-reflection and anti-oxidation coating for use at high temperatures was developed for diamond windows. High temperature baking, thermal shock and erosion tests were performed to evaluate the performance and durability of the coating.

ThD9 • 4:25 p.m.
Preparation of MgF_2-SiO_2 Thin Films with Low Refractive Index by Sol-Gel Process, *Hitoshi Ishizawa, T. Murata, A. Tanaka; Nikon Corp., Japan.* Porous MgF_2-SiO_2 films with low refractive index of 1.26 were made by sol-gel process. The film was consisted of MgF_2 particles and SiO_2 binder connecting them. The refractive index was variable with the processing conditions.

ThD10 • 4:30 p.m.
Sol-Gel Coatings Ageing in LIL Pockels Cells, *Eric Lavastre, Cédric Maunier, Gaël Gaborit, Jean-Christophe Poncetta, Christophe Leymarie, Thierry Berthier, Eric Pasini, Pascal Père, Karine Vallé, Laurence Beaurain, Philippe Belleville, Caroline Gamache; Commissariat à l'Energie Atomique (CEA), France.* The behaviour of antireflective coatings of LIL Pockels cells is discussed. Gas-discharge plasma environments turn out to be severe conditions for sol-gel coatings of KDP crystal. Typical damaged Sol-Gel and an alternative coating are presented.

ThD11 • 4:35 p.m.
Investigations of MgF_2 Optical Thin Films with Ultra-Low Refractive Indices Prepared from Autoclaved Sols, *Tsuyoshi Murata, Hitoshi Ishizawa, Akira Tanaka; Nikon Corp., Japan.* We have confirmed that our porous MgF_2 coatings can be uniformly formed on ϕ 300 mm substrates as a single coating and as a hybrid coating with sublayers formed by physical vapor deposition.

PThCD • Poster Session VIII

Grand Ballroom Salon A
4:40 p.m.–5:40 p.m.
PThCD • Poster Session VIII

Posters included in this session are:

ThC2
ThC3
ThC4
ThC5
ThC6
ThC7
ThC8
ThC9
ThC10
ThD2
ThD3
ThD4
ThD5
ThD6
ThD7
ThD8
ThD9
ThD10
ThD11

Grand Ballroom Salon B and C
5:40 p.m.–6:40 p.m.
Evening Session

•Friday, June 8, 2007•

Grand Ballroom Foyer
8:00 a.m.–12:00 p.m.
Registration Open

FA • Short and Intense Wavelength Coatings

Grand Ballroom Salon B and C
8:30 a.m.–9:45 a.m.
FA • Short and Intense Wavelength Coatings
Ulrike Schulz; Fraunhofer IOF, Germany, Presider
Michael Jacobson; Optical Data Associates, USA, Presider

FA1 • 8:30 a.m. Invited
High-Performance Optical Coatings for VUV Lithography Application, *Christoph Zaczek, Alexandra Pazidis, Horst Feldermann; Carl Zeiss SMT AG, Germany.* Top level requirements and challenges for the optical coatings in the latest generation of 193nm lithography optics are presented. Emphasis is placed on the influence of different parameters on the optical properties of such coatings.

FA2 • 9:00 a.m.
EUV Multilayer Optics at the Fraunhofer IOF, *Norbert Kaiser[1], Sergiy Yulin[1], Torsten Feigl[1], Nicolas Benoit[2], Andreas Tünnermann[1,2]; [1]Fraunhofer Inst. Angewandte Optik und Feinmechanik, Germany, [2]Friedrich-Schiller-Univ., Inst. für Angewandte Physik, Germany.***,** The deposition of high reflective, laterally graded, thermal and radiation stable multilayers mirrors is one of the major challenges of EUVL development. The development of optics at the Fraunhofer IOF is presented in this paper.

FA3 • 9:05 a.m.
Instrument for the Measurement of EUV Reflectance and Scattering – MERLIN, *Sven Schröder[1], Mathias Kamprath[2], Stefan Gliech[2], Angela Duparré[2], Andreas Tünnermann[1,2]; [1]Friedrich-Schiller-Univ., Inst. of Applied Optics, Germany, [2]Fraunhofer Inst., Applied Optics and Precision Engineering, Germany.* A system is presented for measurements of reflectance and scattering at 13.5 nm. The system enables the at-wavelength characterization of EUV optical components. Examples are presented for Mo/Si multilayers deposited onto superpolished substrates.

FA4 • 9:10 a.m.
X Rays Reflective Multilayers Optic for Microbeam Radiation Therapy at the European Synchrotron Radiation Facility, *Christine Borel, Alberto Bravin, Christian Morawe, Herwig Requardt, Olivier Hignette; European Synchrotron Radiation Facility, France.* We present fisrt experimental results on the fabrication and characterization of x-rays reflective multilayers optic providing micro beams for synchrotron radiation therapy foreseen at ESRF Insertion device medical beamline ID17.

FA5 • 9:15 a.m.
Roughness Evolution and Scatter Losses of Multilayers for 193 nm, *Sven Schröder[1], Angela Duparré[2], Andreas Tünnermann[1,2]; [1]Friedrich-Schiller-Univ., Inst. of Applied Physics, Germany, [2]Fraunhofer Inst., Applied Optics and Precision Engineering, Germany.* The roughness and scattering of highly reflective mirrors for 193 nm deposited onto differently polished substrates were measured and analyzed. The influence of interface roughness and optical film thickness on the scatter losses is discussed.

FA6 • 9:20 a.m.
Determination of Optical Constants of Thin Films in the VUV and Soft X-Ray Spectral Region with Synchrotron Spectroscopic Ellipsometry, *Minghong Yang; Inst. for Analytical Sciences, Germany.* Optical constants determination of thin films used in the XUV spectral region is experimentally demonstrated with BESSY II synchrotron ellipsometry, which can provide continuous, precise spectra of optical constants over a broadband XUV spectral region.

FA7 • 9:25 a.m.
Fluoride Antireflection Coatings at 193nm by Resistive Heating Boat, *Ming-Chung Liu[1], Cheng-Chung Lee[1], Masaaki Kaneko[2], Kazuhide Nakahira[2], Yuuichi Takano[2]; [1]Natl. Central Univ., Taiwan, [2]Lens Div., Tochigi Nikon, Japan.* Fluoride materials, MgF_2,AlF_3,LaF_3 and GdF_3 are used for antireflection coatings at 193nm by resistive heating boat. Optical characteristics, microstructure, stress, and laser-induced damage threshold (LIDT) of the films have been investigated.

FA8 • 9:30 a.m.
Reflecting at 30.4 and Antireflecting at 58.4 nm, *David D. Allred, R. Steven Turley; Brigham Young Univ., USA.* Multilayer mirrors for 30.4nm can image the earth's magnetosphere using light from the sun's corona scattered off He+. Neutral He atoms scatter at 58.4nm. We will discuss the latest work in minimizing 58.4 reflection.

FA9 • 9:35 a.m.
High Reflectivity Multilayer Mirror for He-II Radiation at 30.4nm in Solar Physics Application, *Jingtao Zhu[1], Zhanshan Wang[1], Shumin Zhang[1], Hongchang Wang[1], Wenjuan Wu[1], Bei Wang[1], Yao Xu[1], Zhong Zhang[1], Fengli Wang[1], Lingyan Chen[1], Hongjun Zhou[2], Tonglin Huo[2]; [1]Tongji Univ., China, [2]Natl. Synchrotron Radiation Lab (NSRL), Univ. of Science and Technology of China, China.* The SiC/Mg and B_4C/Mo/Si multilayers were fabricated for He-II radiation at 30.4nm. The measured reflectivitier were 38.0% for SiC/Mg multilayer at incident angle 12 degree, and 32.5% for B_4C/Mo/Si multilayer at 5 degree, respectively.

FA10 • 9:40 a.m.
X-Ray Diffraction Properties of Silica Thin Films Having Single Crystalline Mesoporous Structures, *Takashi Noma[1], Hirokatsu Miyata[1], Kazuhiro Takada[1], Atsuo Iida[2]; [1]Canon Res. Ctr., Japan, [2]Photon Factory, Inst. of Materials Structure Science KEK, Japan.* Detailed X-ray diffraction study of silica films with single crystalline mesoporous structures shows that the behavior of X-rays in these mesoporous materials with nano-scaled structural regularity is quite identical to that in real crystals.

Grand Ballroom Foyer
9:45 a.m.–10:15 a.m.
Coffee Break

FB • Laser Damage

Grand Ballroom Salon B and C
10:15 a.m.–11:20 a.m.
FB • Laser Damage
Pierre G. Verly; Natl. Res. Council of Canada, Canada, Presider
James B. Oliver; Univ. of Rochester, USA, Presider

FB1 • 10:15 a.m. **Invited**
Femtosecond Pulse Laser Damage in Thin Films, *Mark Mero[1,2], Jianhua Liu[1], Ali J. Sabbah[1], Benjamin Clapp[1], Jayesh Jasapara[1], Wolfgang Rudolph[1]; [1]Univ. of New Mexico, USA, [2]Max Born Inst., Germany.* The damage behavior of different dielectric oxide thin films commonly used in optical coatings and the underlying excitation and relaxation mechanisms have been investigated using near-infrared, sub-picosecond laser pulses.

FB2 • 10:45 a.m.
Analysis of Material Modifications in Laser-Damaged HfO_2 Thin Films, *Laurent Gallais, Frank Wagner, Alessandra Ciapponi, Jeremie Capoulade, Jean-Yves Natoli, Mireille Commandre; Inst. Fresnel, France.* We analyze the local morphological, optical and structural modifications on damages created in different Hafnia thin films exposed to high fluence 1064 and 355 nm nanosecond laser irradiation.

FB3 • 10:50 a.m.
Laser Damage Resistance of HfO_2 Thin Films Deposited by Electron Beam Deposition, Reactive Low Voltage Ion Plating and Dual Ion Beam Sputtering, *Laurent Gallais, Jérémie Capoulade, Jean-Yves Natoli, Mireille Commandré, Michel Cathelinaud, Cihan Koc, Michel Lequime; Inst. Fresnel, France.* We study the laser damage resistance at 1064 and 355nm of HfO_2 thin films deposited by three different processes in various conditions. We compare their Laser Induced Damage Threshold obtained trough several measurement procedures.

FB4 • 10:55 a.m.
Influence of the Laser Beam Size on the Laser-Induced Damage in Thin Films and Substrates, *Jérémie Capoulade, Jean-Yves Natoli, Anne Hildenbrand, Laurent Gallais, Mireille Commandré; Inst. Fresnel, France.* The influence of the laser beam size on the laser-induced damage threshold (LIDT) in thin films and substrates is investigated. LIDT measurements realized with beam of different dimensions give information on laser damage precursors.

FB5 • 11:00 a.m.
Light Intensification Modeling of Coating Inclusions Irradiated at 351 and 1053 nm, *Christopher J. Stolz[1], Scott Hafeman[2], Thomas V. Pistor[2]; [1]Lawrence Livermore Natl. Lab, USA, [2]Panoramic Technology Inc., USA.* Electric-field modeling provides insight into the laser damage potential of nodular defects. This study explores the impact of irradiation wavelength on light intensification of a deeply-imbedded spherical inclusion at normal and oblique incidence.

FB6 • 11:05 a.m.
Graded Index Broadband Antireflection Coating by Glancing Angle Deposition and Its Application in Laser System, *Kui Yi, Zicai Shen, Jianda Shao, Zhengxiu Fan; Shanghai Institue of Optics and Fine Mechanics, Chinese Acad. of Sciences, China.* ZrO_2 and SiO_2 broadband antireflection (AR) coatings are prepared by glancing angle deposition. These AR coatings exhibiting excellent optical properties and high damage threshold is applicable to used in high-energy laser system.

FB7 • 11:10 a.m.
Contaminant Resistant Sol-Gel Coatings for High Peak Power Laser Applications, *Kenneth L. Marshall, Valerie Rapson, Yingrui Zhang, Gary Mitchell, Amy Rigatti; Univ. of Rochester, USA.* Contamination of sol-gel anti-reflective (AR) coatings by volatile organic compounds reduces their efficiency. Cohydrolysis of TEOS-based sol-gels with select organosiloxanes produces sol-gel AR's with both excellent contamination resistance and high laser damage resistance.

FB8 • 11:15 a.m.
Plasma Formation and Growth Initiated by Inclusions in Nanosecond-Pulse-Driven Damage of Optical Coatings, *Chaoyang Wei[1,2], Hongbo He[1], Kui Yi[1], Jianda Shao[1], Zhengxiu Fan[1]; [1]R & D Ctr. for Optical Thin Film Coatings, Shanghai Inst. of Optics and Fine Mechanics, China, [2]Graduate School of the Chinese Acad. of Sciences, China.* A possible plasma formation model considering the temperature dependence of band gap of host material during the nanosecond-pulse-driven damage of optical coatings is proposed and the growth of plasma region is also investigated.

Grand Ballroom Salon B & C
11:20 a.m.– 11:25 a.m.
Closing Remarks
Christopher Stolz; Lawrence Livermore Natl. Lab, USA.

PFAB • Poster Session IX

Grand Ballroom Salon A
11:25 a.m.–12:25 p.m.
PFAB • Poster Session IX

Posters included in this session are:

FA2	**FB2**
FA3	**FB3**
FA4	**FB4**
FA5	**FB5**
FA6	**FB6**
FA7	**FB7**
FA8	**FB8**
FA9	
FA10	

Grand Ballroom Foyer
12:25 p.m. –1:15 p.m.
Box Lunch

Key to Authors and Presiders

G

H

I

J

K

L