AOMATT 2014

The 7th SPIE International Symposium on

Advanced Optical Manufacturing and Testing Technologies

26-29 April 2014
Harbin International Conference Center
Harbin China

Sponsored by:

COS - The Chinese Optical Society
IOE - Institute of Optics and Electronics,
- Chinese Academy of Sciences
SPIE - The International Society for Optics and Photonics
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Ministry of Science and Technology of China
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Honorary Chair:

ZHOU Bingkun, President of Chinese Optical Society (COS), Academician, CAS

Symposium General Chair:

ZHOU Liwei, President of Beijing Optical Society, Academician, CAE

Conferences:

1 Large Mirror and Telescopes
2 Advanced Optical Manufacturing Technologies
3 Optical Test, Measurement Technology and Equipments
4 Design, Manufacturing and Testing of Micro and Nano Optical Devices and Systems
5 Opto Electronics Material and Devices
6 Smart Structure and Materials in Manufacturing and Testing

Plenary Presentation

9:00-12:40 April 26 Plenaries 1 to 5 Globe Theatre

Location: Globe Theatre, Harbin International Conference Center

Plenary Session 1

Chair:

(Time: 9:00 to 9:40)

1. **Manufacturing the Optics for the Thirty Meter Telescope**
   30 米望远镜光学制造
   Prof. Larry Stepp (USA)
   Telescope Department Head for the Thirty Meter Telescope Project, USA
   美国三十米望远镜项目主任，美国加州大学 TMT（三十米望远镜）

(Time: 9:40 to 10:20)

2. **The Progress of the European Extremely Large Telescope**
   欧洲极大型望远镜研制进展
   Dr. Bernard Delabre (Germany)
   Optical Design Engineer, ESO-European Southern Observatory
   欧洲南方天文台光学设计师，项目负责人

(Time: 10:20 to 11:00)

3. **Method and procedure for the high-efficiency and ultra-precision diamond turning of large optical mirrors**
   大口径光学反射镜高效超精密金刚石切削工艺方法
   Dr. Tao Sun (China)
   Prof. and Director of the Centre for Precision Engineering(CPE)
   哈尔滨工业大学 精密工程所所长、孙涛教授

Tea time (11:00-11:20)

Plenary Session 2

Chair:

(Time: 11:20 to 12:00)

4. **Precision nanometrology for fabrication of micro optics**
   微光学加工中的精密纳米测量
   Dr. Wei Gao (Japan)
   Professor and the Director of Research Center for Precision Nanosystems, Dept. of Nanomechanics of Tohoku University
   日本东北大学 纳米机械系 精密纳米系统研究中心主任，高伟教授

(Time: 12:00 to 12:40)

5. **Advanced Manufacturing and Testing Technologies for Multiple Mirror Space Telescopes**
   多反射镜空间望远镜制造与检测技术
   Dr. Zhang Xuejun (China)
   Prof. Vice President of Changchun Institute of Optics, Fine Mechanics and Physics, CAS
   中国科学院长春光学精密机械与物理研究所，张学军博士/副所长

Lunch time (13:00-14:00)

14:00-17:00 April 26 Plenaries 6 to 9 Globe Theatre

Location: Globe Theatre, Harbin International Conference Center

Plenary Session 3

Chair:

(Time: 14:00 to 14:40)

6. Diffractive optical elements: fabrication and application

衍射光学元件: 制造和应用

Prof. A.G. Poleshchuk (Russia)

Head of the Laboratory Of Diffractive Optics

俄罗斯科学院远东分院自动化与电子学研究所，衍射光学实验室主任 A.抛莱斯丘克教授

Institute of Automation and Electrometry, Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia

(Time: 14:40 to 15:20)

7. Advanced ion beam finishing and atmospheric plasma technology for high end optics

先进离子束加工及应用于高端光学元件的大气等离子体技术

Dr. Axel SCHINDLER (Germany)

Science and Technology Consultant in ion beam and plasma technology for ultra-precision surface processing

超精密表面加工离子束与等离子体技术科技顾问

Leibniz Institute of Surface Modification, IOM

德国莱布尼兹 IOM 表面优化研究所

Tea time (15:20-15:40)

Plenary Session 4

Chair:

(Time: 15:40 to 16:20)

8. Complex hybrid plasmonics: new materials and new functionalities

复杂混合离子激元: 新材料与新功能

Dr. Harald Giessen (Germany)

Chair for Ultrafast Nanooptics in the Department of Physics at the University of Stuttgart

斯图加特大学物理系超快纳米光学实验室主任，剑桥大学客座研究员

(Time: 16:20 to 17:00)

9. Manipulating the polarization states of electromagnetic waves using sub-wavelength structures

利用亚波长结构操控电磁波偏振态

Prof. LUO Xiangang (China)

Director of State Key Laboratory of Optical Technologies on Nano-Fabrication and Micro-Engineering

中国科学院光电技术研究所研究员，微细加工光学技术国家重点实室主任，国家973 计划首席科学家

9:00-9:40 April 26 ····· Plenary Presentation 1
Globe Theatre

■ ***Plenary Presentation 1***

Title: Manufacturing the Optics for the Thirty Meter Telescope

Prof. Larry Stepp (USA)
Telescope Department Head for the Thirty Meter Telescope Project, USA

Abstract: Astronomy is in the midst of a revolution fueled in part by the widespread availability of ground-based optical/infrared telescopes in the 8-10 meter class. Just as the total collecting area of large ground-based telescopes more than trebled in the decade from 1993 to 2002, it is poised to double again in the next decade with the construction of several extremely large telescopes. These ELTs are designed with integral adaptive optics systems that will make their images several times sharper than existing telescopes combined with ~10-fold increase in collecting area. To achieve the large aperture size, all of these ELTs will use primary mirrors composed of multiple segments.

The Thirty Meter Telescope will have a 30-meter diameter primary mirror comprising 492 hexagonal segments. Its design is based on the highly successful Keck Observatory 10-meter telescopes, but with an order of magnitude more segments. The secondary and tertiary mirrors are scaled up similarly to sizes more than 3 meters across. As a result, TMT faces new technical and programmatic challenges in manufacturing and testing of its optical elements.

This paper provides an introduction to TMT and discusses the evolution of its optical and optomechanical designs from key decisions based on the science goals. It describes the manufacturing challenges for production of the mirrors and their support systems. Progress in optical fabrication technology development and prototype testing activities is also described. The TMT scientific and industrial partners have made significant advances in developing the technical and manufacturing approaches necessary to successfully build TMT, and the project is now poised to start construction on Mauna Kea in Hawai'i.

Principal Author's Biography: Larry Stepp is the Telescope Department Head for the Thirty Meter Telescope Project, responsible for the telescope structure, optics and controls. Prior to joining TMT, he was the Manager of the AURA New Initiatives Office, which developed the design concept for the 30m Giant Segmented Mirror Telescope, a TMT precursor. From 1991 to 2001, he was the Optics Manager for the Gemini Project, which successfully built two 8-meter optical-infrared telescopes – one on Mauna Kea in Hawai'i and the other on Cerro Pachon in Chile. Before that he was the Manager of the Advanced Optical Telescope Technology Group at NOAO in Tucson, and was responsible for building and testing the 3.5m primary mirror assembly for the WIYN Telescope on Kitt Peak. Stepp has a master's degree in engineering mechanics from the University of Nebraska – Lincoln, followed by graduate courses in Optics at the University of Arizona. He has been involved in the optomechanical design, fabrication and testing of large optics for 30 years and is one of few engineers who has been responsible for producing primary mirror systems using all three of the mirror types used in modern large telescopes: borosilicate honeycomb, thin meniscus, and hexagonal segments. He has been active in the SPIE symposiums on telescopes and instruments for astronomy and has chaired and co-chaired numerous conferences on large telescopes.

9:40-10:20 April 26····· Plenary Presentation 2
Globe Theatre

■ ***Plenary Presentation 2***

Title: The Progress of the European Extremely Large Telescope

Dr. Bernard Delabre (Germany)
Optical Design Engineer, ESO-European Southern Observatory

Abstract: The European Extremely Large Telescope (E-ELT) is a 39 m aperture telescope, the largest of three ELT projects currently underway. The large aperture and diffraction limited performance of the telescope will enable a new era of scientific discovery, such as characterizing the atmospheric composition of near-by extra-solar planets and tackling fundamental problems in cosmology. The telescope will be situated in Amazones in Chile, close-by to the existing ESO facility at Paranal. The telescope is a 5 mirror design which includes 3 powered mirrors (a three-mirror anastigmat or TMA) for a perfect correction of the 10 arc min field of view. The two other mirrors are used for correction of the atmosphere (flat deformable mirror) and field stabilization. To achieve a performance near the theoretical limit, various technical challenges must be met, including maintaining 798 1.4 m hexagonal segments, that comprise the primary mirror, in co-alignment and individual shape to within a few tens of nanometers. This presentation will describe the telescope and presents the actual status of the project.

Principal Author's Biography:
Born on 28-02-1952
Optical engineer
From 1075 to 1977 Design of headlight for car industry
Since 1977 In charge of Optical design for telescope and instrumentation at the European Southern Observatory

10:20-11:00 April 26····· Plenary Presentation 3
Globe Theatre

■ ***Plenary Presentation 3***

Title: Method and procedure for the high-efficiency and ultra-precision diamond turning of large optical mirrors

Dr. Tao Sun (China)
Prof. and Director of the Centre for Precision Engineering (CPE), Harbin Institute of Technology

Abstract: Diamond turning is a deterministic process of mechanical machining for optical components. The machining accuracy is dependent not only on the accuracies of lathes, but also on cutting trajectory, diamond cutting tools, and measurement techniques. In this work, we presented a novel diamond turning machine tool for large optical mirrors. And we introduced the relevant key technologies, such as structure design and testing method for the high-precision tool swing feeding system, motion mode of spherical and aspheric surface machining, cutting trajectory planning of aspheric surface contouring, design of diamond cutting tool, and in-situ shearing interference measurement techniques. Based on the lathe and relevant procedure we have developed, a series of spherical and aspheric optical mirrors can be fabricated with high-efficiency than traditional polishing method, which suits for the mass production of large optical metal mirrors.

Principal Author's Biography: Dr. Tao Sun is currently working as a professor of Mechanical Engineering in Harbin Institute of Technology(HIT), a Ph. D. supervisor of the discipline of Mechanical Manufacturing and Automation. He received his B.E. and M.E. degree in Precision Instrument, and Ph.D. degree in Mechanical Engineering from HIT in 1986, 1991, and 1999, respectively. He has been appointed to the director of the Center for Precision Engineering (CPE) since 2005. He has also been involved as the deputy director of the Center for Technological Applications of Ultra-precision Mechanical Machining, and the director of the Heilongjiang Key Laboratory of Ultra-precision Machining and Nontraditional Machining Techniques. His current research interests are focusing on ultra-precision machining techniques, such as design and application of ultra-precision machine tool, fabrication of diamond cutting tool, micro/nano-fabrication and micro/nano-measurement. He has more than 140 publications.
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11:20-12:00 April 26····· Plenary Presentation 4 Globe Theatre

■ ***Plenary Presentation 4***

Title: Precision nanometrology for fabrication of micro optics

Dr. Wei Gao (Japan)
Professor and the Director of Research Center for Precision Nanosystems, Dept. of Nanomechanics of Tohoku University

Abstract: This keynote will start from an overview of micro-optics from fundamental functions, fabrication methods and applications in precision engineering and nanotechnology. State-of-the-art measuring systems for precision nanometrology of micro-optics with micro-structured surfaces, including diffractive micro-optics such as diffraction gratings and refractive micro-optics such as micro lenses and micro-lens arrays, will then be presented. The measuring systems introduced in the presentation are classified into scanning probe microscope-based systems, mechanical stylus profiling systems and optical evaluation systems. Related research activities carried out in the author's group will also be highlighted.

Principal Author's Biography: Wei Gao received his Bachelor of Precision Intrumentation from Shanghai Jiao Tong University, China, in 1986, followed by MSc and Ph. D from Tohoku University, Japan, in 1991 and 1994, respectively. He is currently a professor and the director of Research Center for Precision Nanosystems, Department of Nanomechanics of Tohoku University. His research interests include precision metrology and micro/nano-metrology. He is a fellow of CIRP, and the International Society for Nanomanufacturing. He serves as the Vice-Chairman of The Scientific Technical Committee Precision Engineering and Metrology of CIRP. He is also an associate editor of the journal of Precision Engineering, and IEEE Transactions on Instrumentation & Measurement. He has published 150 journal papers and applied 50 patents (20 issued). He is the author of the book "Precision Nanometrology – Sensors and Measuring Systems for Nanomanufacturing" (Springer). He has won five Paper Awards from The Japan Society for Precision Engineering (1998, 2003, 2004, 2010, 2011).

12:00-12:40 April 26····· Plenary Presentation 5
Globe Theatre

■ ***Plenary Presentation 5***

Title: Advanced Manufacturing and Testing Technologies for Multiple Mirror Space Telescopes

Dr. Zhang Xuejun (China)
Prof. Vice President of Changchun Institute of Optics, Fine Mechanics and Physics, CAS

Abstract: Three Mirror Anastigmat (TMA) systems including both on-axis and off-axis configurations have been widely used in space applications. In some designs, to correct for high order aberrations and realize large FOV, freeform surfaces are used to provide more design freedoms. This trend brings challenges to optical manufacturing and testing community. In this paper, some new manufacturing technologies such as direct CNC generation, deterministic polishing techniques including CCOS, MRF and IBF Polishing were presented in detail, most importantly the combination strategy of using those modern techniques were discussed. Since testing is critical to make high accurate aspheres, the paper also addressed Computer Generated Hologram (CGH) design and implement to measure large freeform mirrors. In particular, CGH assisted alignment procedure for TMA telescopes were discussed in detail.

Principal Author's Biography: Xuejun Zhang received his Ph.D degree from Changchun Institute of Optics and Fine Mechanics (CIOMP) in 1997. He is now vice president of CIOMP and director of Key Laboratory of Optical Manufacturing and Testing. Dr. Zhang has been engaged in optical system design, manufacturing and testing for more than 20 years, as principle investigator, he has completed numbers of national research projects and won three National Awards for Achievements in Science and Technology (1999, 2008, 2011). He is now in charge of 5 national projects and also the leader of the team of 30 Meter Telescope (TMT) Tertiary Mirror Manufacturing. Dr. Zhang is members of SPIE and OSA and has published over 100 peer reviewed technical papers.

14:00-14:40 April 26····· Plenary Presentation 6
Globe Theatre

■ ***Plenary Presentation 6***

Title: Diffractive optical elements: fabrication and application

Prof. A.G. Poleshchuk (Russia)
Head of the Laboratory Of Diffractive Optics
Institute of Automation and Electrometry, Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia

Abstract: We review our recent progress on development of the methods for fabrication of precision binary and as well as high-efficiency continuous-relief diffractive optical elements (DOEs) by combining complementary advantages of circular laser writing system (CLWS), direct laser beam writing in thermal and photo-sensitive materials and analog lithography. The main limitation and tolerances of writing methods are identified, and their influence on optical performance of DOEs is investigated. The latest results of fabrication and practical applications of DOEs with more then 200 mm diameter and a minimum feature size of 0.5 micrometer for testing large aspheric surfaces with a Fizeau-type interferometer are presented.

Principal Author's Biography: Alexander G. Poleshchuk is ahead of the Laboratory of Diffractive Opticsof the Institute of Automation and Electrometry, Siberian Branch of Russian Academy of Sciences (IAE SB RAS) in Novosibirsk, since 1997. He received an MS degree in radio electronics from the Institute of Communication, Novosibirsk, Russia, and a PhD degree in applied optics from the Institute of Precision Mechanics and Optics, Leningrad, Russia, in 1980. Hereceived a Doctor of Science in laser physics from the Institute of Laser Physics SB RAS, Novosibirsk, Russia, in 2003. His research interests include application for diffractive optical elements (DOE) in optics, laser physics and optical metrology, development of technologies and equipment for fabrication of DOE, laser interferometry and testing of aspherical surfaces.

14:40-15:20 April 26····· Plenary Presentation 7
Globe Theatre

■ ***Plenary Presentation 7***

Title: Advanced ion beam finishing and atmospheric plasma technology for high end optics

Dr. Axel SCHINDLER (Germany)
Science and Technology Consultant in ion beam and plasma technology for ultra-precision surface processing
Leibniz Institute of Surface Modification, IOM

Abstract: Today ultra-precision surface processing is mandatory in high class optics fabrication for almost all modern optics fields like photo lithography advanced optics for measurement equipment, synchrotron and x-ray optics, space and telescope optics laser optics and even more. The high degree of processing accuracy and the wide range of processing parameter adjustment together with their automatic tight control including scaling of the tool size make particle beam related surface techniques like low energy ion beam and plasma assisted chemical processing very attractive in advanced surface processing. Their capability to etch, to figure, to smooth, to structure surfaces and to modify other surface characteristics like to tailor the surface energy and to deposit thin films gives them some kind of key solution. Their status of integration in production lines of optics elements is different today. Ion beam figuring (IBF) is more or less the lens shape finishing standard in the absolute top class optics lithography of DUV and future EUV optics. Atmospheric plasma jet technology is on the way to enter niches in optics fabrication technology. Latest Improvements in IBF technology allow to reduce the cost of ownership of the technology and to enhance its performance with the tendency to extend their use for lower class optics production. The talk summarizes the present status of ion beam figuring for series production in optics and highlight recent advances achieved in R&D mature for ion beam figuring (IBF), ion beam smoothing (IBS), and atmospheric plasma jet machining (PJM) for deep aspherization, nanometer shape error correction and surface smoothing mainly achieved at IOM Leipzig and in more and more cases in tight collaboration with NTG.

Principal Author's Biography: Axel SCHINDLER graduated in semiconductor physics at the Karl-Marx-University in Leipzig, Germany, 1974.
He worked as a Group Leader on R&D of low energy ion beam surface processing in the Leibniz-Institute for Surface Modification Leipzig (IOM) from 1973 and in this position in the field of ultra-precision surface processing by ion beams and plasma jets from 1986 up to his retirement in December 2012. He managed many R&D projects and R&D orders from industry mainly in the field of high class optics manufacturing applications during this time.
Axel Schindler's main scientific and technological interests are low energy ion beam technology and atmospheric plasma jet technology, ultra-precision surface processing by ion beams and plasma jets, ion beam and atmospheric plasma jet etching, deposition and surface modification and last but not least atmospheric plasma jets for future therapy and prophylaxis applications in dentistry.
He holds several patents and is author and co-author, respectively of more than 100 papers and talks.
Today Axel Schindler works as a Science and Technology Consultant in ion beam and plasma technology for ultra-precision surface processing and atmospheric plasma jet application in medicine.

15:40-16:20 April 26····· Plenary Presentation 8
Globe Theatre

■ ***Plenary Presentation 8***

Title: Complex hybrid plasmonics: new materials and new functionalities

Dr. Harald Giessen (Germany)
Chair for Ultrafast Nanooptics in the Department of Physics at the University of Stuttgart

Abstract:

Principal Author's Biography: Harald Giessen (*1966) graduated from Kaiserslautern University with a diploma in Physics and obtained his M.S. and Ph.D. in Optical Sciences from the University of Arizona in 1995. After a postdoc at the Max-Planck-Institute for Solid State Research in Stuttgart he moved to Marburg as Assistant Professor. From 2001-2004, he was associate professor at the University of Bonn. Since 2005, he holds the Chair for Ultrafast Nanooptics in the Department of Physics at the University of Stuttgart. He was guest researcher at the University of Cambridge, and guest professor at the University of Innsbruck and the University of Sydney, at A*Star, Singapore, as well as at Beijing University of Technology. He is associated researcher at the Center for Disruptive Photonic Technologies at Nanyang Technical University, Singapore. He received an ERC Advanced Grant in 2012 for his work on complex nanoplasmonics. He has published more than 290 technical papers in optics related fields. He is on the advisory board of the journals "Advanced Optical Materials", "Nanophotonics: The Journal", and "ACS Photonics". He is a Fellow of the Optical Society of America.

16:20-17:00 April 26····· Plenary Presentation 9
Globe Theatre

■ ***Plenary Presentation 9***

Title: Manipulating the polarization states of electromagnetic waves using sub-wavelength structures

Prof. LUO Xiangang (China)
Director of State Key Laboratory of Optical Technologies on Nano-Fabrication and Micro-Engineering, Institute of Optics and Electronics, CAS

Abstract: The polarization states of electromagnetic waves are of significant interest for various applications including but not limited to imaging, antennas, remote sensors, radiometer, microwave and optical communications. In this work, we present our recent results designs and techniques for manipulation of polarization states using subwavelength structures. Specifically, the broadband anisotropic polarization transformer, inhomogeneous metallic inclusions with polarization singularity, novel chiral antennas with multiband circular dichroism, circular polarized thermal infrared radiation with high efficiency and purity are demonstrated. Realizations in spin-orbital momentum conversion in a particular way through a nanowire are also presented. The proposed designs and method can find applications in various scenarios including nanofabrication, photodetectors, imaging optics, thin absorbers/emitters.

Principal Author's Biography: Xiangang Luo is the Professor at The Institute of Optics and Electronics, Chinese Academy of Sciences and the Director of State Key Lab of Optical Technologies on Nanofabrication and Micro-engineering. Professor Luo received Ph.D from Chinese Academy of Sciences (2001). He was a Research Scientist at The Institute of Physical and Chemical Research (RIKEN) of Japan (2001-2005). Professor Luo's current research focused on micro-nano-optics, subwavelength optics. He has published more than 200 technical papers and 100 patents in optics related fields. He has been a Program Leader and Chief Scientist of the National Key Basic Research and Development Program.