

# PROCEEDINGS OF SPIE

[SPIDigitalLibrary.org/conference-proceedings-of-spie](https://spiedigitallibrary.org/conference-proceedings-of-spie)

## Front Matter: Volume 8769

, "Front Matter: Volume 8769," Proc. SPIE 8769, International Conference on Optics in Precision Engineering and Nanotechnology (icOPEN2013), 876901 (1 July 2013); doi: 10.1117/12.2032090

**SPIE.**

Event: International Conference on Optics in Precision Engineering and Nanotechnology (icOPEN2013), 2013, Singapore, Singapore

# PROCEEDINGS OF SPIE

## ***International Conference on Optics in Precision Engineering and Nanotechnology (icOPEN2013)***

**Chenggen Quan  
Kemao Qian  
Anand Asundi**  
*Editors*

**9–11 April 2013  
Singapore**

*Organized by*  
Optics and Photonics Society of Singapore • Centre for Optical and Laser Engineering, Nanyang Technological University (Singapore) • A\*STAR National Metrology Center (Singapore)

*Sponsored by*  
Lee Foundation • Centre for Optical and Laser Engineering, NTU (Singapore) • SPIE • International Commission for Optics

*Supported by*  
National University of Singapore (Singapore) • Automatic Optical Inspection Equipment Association (Taiwan) • Japan Society for Precision Engineering • Singapore Institute of Manufacturing Technology, A\*STAR (Singapore) • Laser Institute of America

*Published by*  
SPIE

**Volume 8769**

Proceedings of SPIE 0277-786X, V. 8769

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

International Conference on Optics in Precision Engineering and Nanotechnology (icOPEN2013),  
edited by Chenggen Quan, Kemao Qian, Anand Asundi, Proc. of SPIE Vol. 8769, 876901  
© 2013 SPIE · CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2032090

Proc. of SPIE Vol. 8769 876901-1

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *International Conference on Optics in Precision Engineering and Nanotechnology (icOPEN2013)*, edited by Chenggen Quan, Kemao Qian, Anand Asundi, Proceedings of SPIE Vol. 8769 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819495679

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) Fax +1 360 647 1445

SPIE.org

Copyright © 2013, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/13/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.



[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID Number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID Number.

# Contents

## Part One

xix *Conference Committee*  
xxiii *Introduction*

---

### KEYNOTE PRESENTATION

---

- 8769 02 **Surface form metrology of micro-optics (Keynote Paper)** [8769-162]  
B. Xu, Z. Jia, X. Li, Tohoku Univ. (Japan); Y.-L. Chen, Tohoku Univ. (Japan) and Zhejiang Univ. (China); Y. Shimizu, S. Ito, W. Gao, Tohoku Univ. (Japan)

---

### SPECIAL INVITED PRESENTATIONS

---

- 8769 03 **3D shape and eccentricity measurements of fast rotating rough objects by two mutually tilted interference fringe systems (Invited Paper)** [8769-189]  
J. W. Czarske, R. Kuschmierz, P. Günther, Technische Univ. Dresden (Germany)
- 8769 04 **Interferometric measurement of functional surfaces (Invited Paper)** [8769-278]  
P. Lehmann, W. Xie, P. Kühnhold, J. Niehues, Univ. of Kassel (Germany)
- 8769 05 **Making, testing, applying: some progress in the field of micro-optics at ITO (Invited Paper)** [8769-169]  
W. Osten, G. Baer, M. Häfner, W. Lyda, C. Pruss, R. Reichle, F. Schaal, Univ. Stuttgart (Germany)
- 8769 06 **Micro-probing system for coordinate metrology using a particle controlled by optical radiation pressure based on standing wave scale sensing method (Invited Paper)** [8769-273]  
Y. Takaya, M. Michihata, T. Hayashi, Osaka Univ. (Japan)
- 8769 07 **Optical metrology of semiconductor wafers in lithography (Invited Paper)** [8769-260]  
A. J. den Boef, ASML Netherlands B.V. (Netherlands)

---

### SESSION 1.1 SPECIAL SESSION: SURFACE METROLOGY AND PRECISION ENGINEERING I

---

- 8769 08 **Real-time 3D capturing-visualization conversion for light field microscopy (Invited Paper)** [8769-212]  
B. Lee, J. Kim, Seoul National Univ. (Korea, Republic of)
- 8769 09 **Pixel length calibration using a pattern matching method for secondary-electron images** [8769-228]  
K. Sugawara, I. Misumi, S. Gonda, AIST (Japan)

- 8769 0A **Toroidal surface measurement with elliptical lenslet array** [8769-235]  
W. Guo, National Metrology Ctr., A\*STAR (Singapore) and Nanyang Technological Univ. (Singapore); L. Zhao, National Metrology Ctr., A\*STAR (Singapore); I-M. Chen, Nanyang Technological Univ. (Singapore)
- 8769 0B **Gated imaging for multi-layer wave-front sensing and surface reconstruction** [8769-185]  
C. Tan, Multimedia Univ. (Malaysia); X. Wang, Monash Univ. (Malaysia); W. K. Lim, Multimedia Univ. (Malaysia); Y. H. Ng, T. Y. Chai, Univ. Tunku Abdul Rahman (Malaysia)

---

### SESSION 1.2 OPTICAL METROLOGY AND INSTRUMENTATION I

---

- 8769 0C **High speed digital holographic interferometry for hypersonic flow visualization (Invited Paper)** [8769-183]  
G. M. Hegde, G. Jagdeesh, K. P. J. Reddy, Indian Institute of Science (India)
- 8769 0D **Dynamic measurement for the solution concentration variation using digital holographic interferometry and discussion for the measuring accuracy (Invited Paper)** [8769-168]  
J. Zhao, Y. Zhang, H. Jiang, J. Di, Northwestern Polytechnical Univ. (China)
- 8769 0E **A reference workpiece for voxel size correction in x-ray computed tomography** [8769-187]  
J. J. Liffon, Univ. of Southampton (United Kingdom) and Singapore Institute of Manufacturing Technology (Singapore); K. J. Cross, Univ. of Southampton (United Kingdom); A. A. Malcolm, Singapore Institute of Manufacturing Technology (Singapore); J. W. McBride, Univ. of Southampton Malaysia Campus (Malaysia)
- 8769 0F **Method to obtain the high contrast images of blood vessel for oxygen saturation calculation** [8769-106]  
H.-Y. Tsai, Y.-J. Chen, H.-C. Chang, K.-C. Huang, Instrument Technology Research Ctr. (Taiwan)
- 8769 0G **Dual wavelength digital holography for improving the measurement accuracy** [8769-174]  
J. Di, Northwestern Polytechnical Univ. (China); W. Qu, Ngee Ann Polytechnic (Singapore); B. Wu, X. Chen, J. Zhao, Northwestern Polytechnical Univ. (China); A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 0H **Measurement of the shape of objects by two wavelength interferometry** [8769-138]  
P. Pavlíček, Palacky Univ. (Czech Republic); D. N. Naik, Univ. Stuttgart (Germany)
- 8769 0I **Free and global pose calibration of a rotating laser monocular vision sensor for robotic 3D measurement system** [8769-37]  
L. Li, J. Xi, Shanghai Jiao Tong Univ. (China)

---

### SESSION 1.3 OPTICAL METROLOGY AND INSTRUMENTATION II

---

- 8769 0J **Measurement and standardization of eye safety for optical radiation of LED products** [8769-144]  
T. Mou, Zhejiang Univ. (China); Z. Peng, China National Luminaires Quality Supervision Testing Ctr. (China)

- 8769 OK **Investigation of bias radiation effect on PV cell measurement** [8769-279]  
X. Huang, National Metrology Ctr., A\*STAR (Singapore); C. Quan, J. Chan, National Univ. of Singapore (Singapore); P. Ng, National Metrology Ctr., A\*STAR (Singapore)
- 8769 OL **Effects of integrating sphere conditions on the sphere uniformity** [8769-200]  
K. Wasapinyokul, R. Leecharoen, S. Chanyawadee, R. Chuenchom, P. Jamparung, C. Charoenkit, K. Chumpol, N. Damduang, S. Choowongin, A. Krachangmol, National Institute of Metrology (Thailand)
- 8769 OM **Study of applying fiber based laser with the primary standard for optical power and improvement of spectral responsivity scales in near IR range** [8769-283]  
J. Zhang, National Metrology Ctr., A\*STAR (Singapore); J. J. Teo, Nanyang Technological Univ. (Singapore); X. Huang, National Metrology Ctr., A\*STAR (Singapore)
- 8769 ON **Estimation of the sampling interval error for LED measurement with a goniophotometer** [8769-207]  
W. Zhao, H. Liu, National Institute of Metrology (China); J. Liu, Beijing Normal Univ. (China)
- 8769 OO **Rugometric and microtopographic inspection of teeth enamel** [8769-12]  
M. F. Costa, Univ. do Minho (Portugal); P. B. Pereira, Univ. de Santiago de Compostela (Spain)

---

## SESSION 2.1 SPECIAL SESSION: DIGITAL IMAGE CORRELATION I

---

- 8769 OP **Automated and accurate initialization of digital image correlation for large deformation measurement (Invited Paper)** [8769-29]  
Y. Zhou, J. Chen, Shanghai Jiao Tong Univ. (China); B. Pan, Beihang Univ. (China)
- 8769 OQ **Systematic errors in digital image correlation induced by environment temperature variation around the digital camera (Invited Paper)** [8769-161]  
Q. Ma, Beijing Institute of Technology (China); S. Ma, Key Lab. of Dynamics and Control of Flight Vehicles (China); Y. Zhang, Beijing Institute of Technology (China)
- 8769 OR **Digital image correlation using energy minimization in full-field displacement and strain measurement (Invited Paper)** [8769-152]  
X. Huo, Hefei Univ. of Technology (China); T. Cheng, Univ. of Science and Technology of China (China); J. Tan, Hefei Univ. of Technology (China); Y. Gao, Y. Cai, Univ. of Science and Technology of China (China)
- 8769 OS **The elimination of pseudo strains in 2D-DIC caused by out-of-plane translation using light strip method (Invited Paper)** [8769-75]  
Z. Wang, S. Wang, Z. Wang, Tianjin Univ. (China)

---

## SESSION 2.2 PRECISION MEASUREMENT AND IMAGE PROCESSING I

---

- 8769 OT **The hype cycle in 3D displays: inherent limits of autostereoscopy** [8769-7]  
A. Grasnack, Univ. of Hagen (Germany)

- 8769 0U **An image-processing software package: UU and Fig for optical metrology applications** [8769-277]  
L. Chen, Singapore Univ. of Technology and Design (Singapore)
- 8769 0V **Solving inverse problems for off-axis holography using Twist** [8769-149]  
X. Wu, W. Zhou, Y. Yu, Shanghai Univ. (China)
- 8769 0W **Multi-point laser coherent detection system and its applications in experimental mechanics** [8769-14]  
C. Yang, Nanyang Technological Univ. (Singapore) and Univ. of Science and Technology of China (China); Y. J. Xu, Nanyang Technological Univ. (Singapore) and Southeast Univ. (China); M. Guo, H. Liu, K. Yan, J. Yuan, Y. Fu, Nanyang Technological Univ. (Singapore)
- 8769 0X **Multiple image encryption based on known-plaintext attack and modified G-S phase retrieval algorithm** [8769-8]  
S. K. Rajput, N. K. Nishchal, Indian Institute of Technology Patna (India)
- 8769 0Y **Variable-focus cylindrical liquid lens array** [8769-275]  
W. Zhao, D. Liang, J. Zhang, C. Liu, S. Zang, Q. Wang, Sichuan Univ. (China)

---

### SESSION 2.3 PRECISION MEASUREMENT AND IMAGE PROCESSING II

---

- 8769 0Z **Analysis of grating inscribed micro-cantilever for high resolution AFM probe** [8769-171]  
N. Balajee, D. R. Mahapatra, G. M. Hegde, Indian Institute of Science (India)
- 8769 10 **Using modulation transfer function for estimate measurement errors of the digital image correlation method** [8769-202]  
W.-C. Wang, National Tsing Hua Univ. (Taiwan); C.-H. Hwang, Instrument Technology Research Ctr. (Taiwan); Y.-H. Chen, T.-H. Chuang, National Tsing Hua Univ. (Taiwan)
- 8769 11 **Dynamic focal spots registration algorithm for freeform surface measurement** [8769-244]  
W. Guo, National Metrology Ctr., A\*STAR (Singapore) and Nanyang Technological Univ. (Singapore); L. Zhao, National Metrology Ctr., A\*STAR (Singapore); I.-M. Chen, Nanyang Technological Univ. (Singapore)
- 8769 12 **The in-situ 3D measurement system combined with CNC machine tools** [8769-248]  
H. Zhao, H. Jiang, X. Li, Beihang Univ. (China); S. Sui, L. Tang, Chengdu Aircraft Co. (China); X. Liang, X. Diao, J. Dai, Beihang Univ. (China)
- 8769 13 **Camera calibration and 3D surface reconstruction for multi-camera semi-circular DIC system** [8769-201]  
C.-H. Hwang, Instrument Technology Research Ctr. (Taiwan); W.-C. Wang, National Tsing Hua Univ. (Taiwan); Y.-H. Chen, Instrument Technology Research Ctr. (Taiwan) and National Tsing Hua Univ. (Taiwan)
- 8769 14 **An experimental analysis of the real contact area between an electrical contact and a glass plane** [8769-276]  
M. Down, L. Jiang, Univ. of Southampton (United Kingdom); J. W. McBride, Univ. of Southampton Malaysian Campus (Malaysia)

---

**SESSION 3.1 SPECIAL SESSION: DYNAMICS MEASUREMENT**

---

- 8769 15 **Interferometrical techniques for the investigation of dynamic events (Invited Paper)** [8769-146]  
G. Pedrini, Univ. Stuttgart (Germany); I. Alexeenko, Immanuel Kant Baltic Federal Univ. (Russian Federation); W. Osten, Univ. Stuttgart (Germany)
- 8769 16 **Monitoring the rotation status of wind turbine blades using high-speed camera system (Invited Paper)** [8769-100]  
D. Zhang, Shanghai Univ. (China) and Shanghai Key Lab. of Mechanics in Energy Engineering (China); J. Chen, Shanghai Jiao Tong Univ. (China); Q. Wang, K. Li, Shanghai Univ. (China) and Shanghai Key Lab. of Mechanics in Energy Engineering (China)
- 8769 17 **Some discussion on high-speed-imaging-based optical coherent measurement (Invited Paper)** [8769-13]  
Y. Fu, J. Yuan, Nanyang Technological Univ. (Singapore); Y. J. Xu, Nanyang Technological Univ. (Singapore) and Southeast Univ. (China); M. Guo, H. Liu, K. Yan, Nanyang Technological Univ. (Singapore); C. Yang, Nanyang Technological Univ. (Singapore) and Univ. of Science and Technology of China (China); H. Miao, Univ. of Science and Technology of China (China)

---

**SESSION 3.2 OPTICAL METROLOGY AND INSTRUMENTATION III**

---

- 8769 18 **A phase-stepped white light ellipsometer** [8769-117]  
L. R. Watkins, The Univ. of Auckland (New Zealand)
- 8769 19 **One-dimensional surface profile measurement by detection of reflecting direction of a scanned laser beam** [8769-190]  
O. Sasaki, Niigata Univ. (Japan); R. Shinozaki, Union Tool Co. (Japan); T. Suzuki, Niigata Univ. (Japan)
- 8769 1A **Full-field displacement measurement by double symmetrical illumination through reflection holograms** [8769-33]  
V. Sainov, A. Baldjiev, E. Stoykova, Institute of Optical Materials and Technologies (Bulgaria)
- 8769 1B **Temperature effect on measurements of spectral responsivity of reference solar cell** [8769-280]  
X. Huang, National Metrology Ctr., A\*STAR (Singapore); C. Quan, Y. Li, National Univ. of Singapore (Singapore); P. Ng, National Metrology Ctr., A\*STAR (Singapore)
- 8769 1C **Study on fabricating of micro-pyramid array by precision diamond turning** [8769-255]  
C.-L. Chao, W.-C. Lin, W.-C. Chou, J.-L. Ko, Tamkang Univ. (Taiwan); K.-J. Ma, Chung-Hua Univ. (Taiwan); C.-W. Chao, Hsing-Wu Univ. (Taiwan)



### SESSION 3.3 OPTICAL METROLOGY AND INSTRUMENTATION IV

---

- 8769 1D **Simultaneous microstructuring and functionalisation of surfaces with picosecond laser** [8769-148]  
J. Hildenhagen, K. Dickmann, J. Neyer, C. Wieschendorf, Muenster Univ. of Applied Sciences (Germany)
- 8769 1E **A simulation study on the inspection of transparent circuits with narrow line widths by using a PDLC/ITO film** [8769-193]  
C.-H. Chan, S.-C. Lin, National Tsing Hua Univ. (Taiwan); Y.-T. Zou, C.-T. Chen, T.-K. Liu, C.-H. Chen, H.-W. Wang, Industrial Technology Research Institute (Taiwan)
- 8769 1F **Development of a 3D laser scanning system for the cavity** [8769-181]  
K. Chen, D. Zhang, Y. S. Zhang, Beijing General Research Institute of Mining & Metallurgy (China)

### SESSION 4.1 SPECIAL SESSION: 3D SHAPE MEASUREMENT

---

- 8769 1G **State of the art of compact optical 3D profile measurement apparatuses: from outer surface to inner surface measurement (Invited Paper)** [8769-233]  
T. Yoshizawa, Non-profit Organization 3D Associates (Japan); T. Wakayama, Saitama Medical Univ. (Japan)
- 8769 1H **Research progress and application of dynamic three-dimensional shape measurement (Invited Paper)** [8769-196]  
Q. Zhang, X. Su, Sichuan Univ. (China)
- 8769 1I **Three-dimensional imaging and display of real-existing scene using fringe (Invited Paper)** [8769-47]  
Y. Li, H. Wang, L. Ma, Y. Shi, Zhejiang Normal Univ. (China)
- 8769 1J **Characteristic evaluation of linear LED grating projector for high-speed shape measurement (Invited Paper)** [8769-269]  
M. Fujigaki, T. Yokoyama, Y. Oura, T. Sakaguchi, Wakayama Univ. (Japan); D. Asai, HIKARI Co., Ltd. (Japan); Y. Murata, Wakayama Univ. (Japan)
- 8769 1K **Specular 3D shape measurement with a compact fringe reflection system (Invited Paper)** [8769-98]  
L. Huang, J. X. Wong, A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 1L **Carrier frequency removal in phase measuring deflectometry with non-telecentric imaging (Invited Paper)** [8769-61]  
H. Yue, Y. Wu, L. Song, B. Zhao, Z. Ou, Y. Liu, Univ. of Electronic Science and Technology of China (China)

---

**SESSION 4.2 PRECISION MEASUREMENT AND IMAGE PROCESSING III**

---

- 8769 1M **Joint transform correlator using JPEG-compressed reference images (Invited Paper)** [8769-78]  
J. Widjaja, Suranaree Univ. of Technology (Thailand)
- 8769 1N **Ensemble of hybrid genetic algorithm for two-dimensional phase unwrapping** [8769-172]  
D. Balakrishnan, C. Quan, C. J. Tay, National Univ. of Singapore (Singapore)
- 8769 1O **3D digital image correlation investigation of PLC effect in a new Ni-Co base superalloy** [8769-151]  
Y. Gao, S. H. Fu, T. Cheng, Univ. of Science and Technology of China (China); X. Huo, Hefei Univ. of Technology (China); Q. C. Zhang, Univ. of Science and Technology of China (China)
- 8769 1P **Window size selection of windowed Fourier ridges for phase discontinuity in quality-guided phase unwrapping** [8769-199]  
M. Zhao, Q. Kemao, Nanyang Technological Univ. (Singapore)
- 8769 1Q **Quantitative phase from defocused intensity by image deconvolution** [8769-69]  
C. Zuo, Nanjing Univ. of Science and Technology (China), Nanyang Technological Univ. (Singapore), and Beijing Institute of Technology (China); Q. Chen, Nanjing Univ. of Science and Technology (China) and Beijing Institute of Technology (China); A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 1R **CCD evaluation for estimating measurement precision in lateral shearing interferometry** [8769-153]  
B. Liu, Xi'an Jiaotong Univ. (China) and Xi'an Technological Univ. (China); B. Li, Xi'an Jiaotong Univ. (China); A. Tian, Xi'an Technological Univ. (China); B. Li, Xi'an Jiaotong Univ. (China)

**Part Two**

---

**SESSION 4.3 OPTICAL FABRICATION AND SURFACE METROLOGY**

---

- 8769 1S **Fabrication of multilevel spiral phase plates by focused ion beam milling** [8769-213]  
V. Pramitha, A. Vijayakumar, S. Bhattacharya, Indian Institute of Technology Madras (India)
- 8769 1T **Individually controlled multi-focus on a line for two-photon polymerization based on computer-generated holograms** [8769-220]  
J. Li, L. Yang, Y. Hu, C. Zhang, J. Chu, W. Huang, Univ. of Science and Technology of China (China)
- 8769 1U **Precision grinding of tungsten carbide mold insert for molding of sub-millimeter glass aspheric lenses** [8769-256]  
C.-L. Chao, C.-J. Chang, Tamkang Univ. (Taiwan); C.-C. Chen, Instrument Technology Research Ctr. (Taiwan); W.-C. Chou, Tamkang Univ. (Taiwan); K.-J. Ma, Chung-Hua Univ. (Taiwan)

- 8769 1V **Evolution of titanium surfaces irradiated by femtosecond laser pulses with different wavelengths** [8769-236]  
G. Li, J. Li, Univ. of Science and Technology of China (China); X. Li, Southwest Univ. of Science and Technology (China); Z. Zhu, Y. Hu, J. Chu, W. Huang, Univ. of Science and Technology of China (China)
- 8769 1W **White light blinded IR photo-detection of a Si-based MIS structure with multi-dielectric layers** [8769-116]  
S. W. Fang, National Univ. of Kaohsiung (Taiwan); H. J. Chen, Ubilux Technology Inc. (Taiwan); M. C. Shih, National Univ. of Kaohsiung (Taiwan)
- 8769 1X **Hydrostatic pressure based liquid level sensing using FBG: a comparative study** [8769-264]  
S. D., National Institute of Technology, Warangal (India) and Vidya Jyothi Institute of Technology (India); S. S. M., S. K., National Institute of Technology, Warangal (India)

---

#### SESSION 5.1 SPECIAL SESSION: INFORMATION SECURITY

---

- 8769 1Y **Fractional domain asymmetric cryptosystem and cryptanalysis (Invited Paper)** [8769-6]  
S. K. Rajput, N. K. Nishchal, Indian Institute of Technology Patna (India)
- 8769 1Z **Color image cryptosystem based on discrete cosine transform in gyrator transform domain spiral-phase encoding (Invited Paper)** [8769-93]  
M. R. Abuturab, Maulana Azad College of Engineering and Technology (India)
- 8769 20 **Image encryption under spatially incoherent illumination (Invited Paper)** [8769-11]  
Z. Xie, Harbin Institute of Technology (China); J. Zang, Capital Normal Univ. (China); Y. Zhang, Harbin Institute of Technology (China) and Capital Normal Univ. (China)
- 8769 21 **Robust video watermarking scheme using computer generated holographic technique (Invited Paper)** [8769-4]  
J. Li, Hanshan Normal Univ. (China)

---

#### SESSION 5.2 SENSORS AND ACTUATORS; FIBER OPTIC SENSORS

---

- 8769 22 **Real time monitoring of petroleum leakage detection using etched fiber Bragg grating** [8769-223]  
B. N. Shivananju, Indian Institute of Science (India); M. Kiran, S. P. Nithin, M. J. Vidya, R. V. College of Engineering (India); G. M. Hegde, S. Asokan, Indian Institute of Science (India)
- 8769 23 **Modeling and simulation of fiber Bragg grating pressure sensor for underwater application** [8769-40]  
P. Sharan, S. S., C. Kumar, The Oxford College of Engineering (India); T. Srinivas, Indian Institute of Science (India)
- 8769 24 **Measurement of index of refraction of unknown solution using a microstructure fiber Bragg grating** [8769-115]  
C. J. Kang, Z. C. Chen, M. C. Shih, National Univ. of Kaohsiung (Taiwan)

- 8769 25 **Design of a sensor for asphalt pavement pressure field measurements** [8769-20]  
H. Liu, Southeast Univ. (China); D. Liang, Nanjing Univ. of Aeronautics and Astronautics (China); X. Han, Southeast Univ. (China); X. Wang, Naval Aeronautical Engineering Institute (China)
- 8769 26 **FBG interrogation method based on wavelength-swept laser** [8769-88]  
C. Qin, J. Zhao, B. Jiang, A. Rauf, Northwestern Polytechnical Univ. (China); D. Wang, Avic Xi'an Flight Automatic Control Research Institute (China); D. Yang, Northwestern Polytechnical Univ. (China)

---

### SESSION 5.3 PRECISION ENGINEERING

---

- 8769 27 **Diaphragm based high sensitive FBG pressure sensor** [8769-239]  
V. R. P., S. K., S. S. M., K. P., National Institute of Technology, Warangal (India)
- 8769 28 **Aligning precisely polarization maintaining photonic crystal fiber and conventional single-mode fiber by online spectrum monitoring** [8769-243]  
Y. Jiang, Nanjing Univ. of Aeronautics and Astronautics (China) and Nanjing Forestry Univ. (China); J. Zeng, D. Liang, Nanjing Univ. of Aeronautics and Astronautics (China); X. Ni, Nanjing Forestry Univ. (China); W. Luo, Fiberhome Telecommunication Technologies Co. Ltd. (China)
- 8769 29 **A simple 1×2 plastic optical fiber coupler based vibration sensor** [8769-237]  
K. P., D. D., S. K., V. R. P., National Institute of Technology, Warangal (India)
- 8769 2A **Fiber optic liquid level sensor using multimode fused coupler** [8769-265]  
S. D., National Institute of Technology, Warangal (India) and Vidya Jyothi Institute of Technology (India); S. S. M., S. K., S. P. R. L. N., National Institute of Technology, Warangal (India)

---

### SESSION 6.1 SPECIAL SESSION: FRINGE ANALYSIS

---

- 8769 2B **Novel rotation algorithm for phase unwrapping to solve problems of holes and noise (AFPA) (Invited Paper)** [8769-123]  
J.-F. Weng, Y.-L. Lo, National Cheng Kung Univ. (Taiwan)
- 8769 2C **Two-dimensional sampling moiré method for fast and accurate phase analysis of single fringe pattern (Invited Paper)** [8769-127]  
S. Ri, H. Tsuda, AIST (Japan)
- 8769 2D **PDE (ODE)-based image processing methods for optical interferometry fringe (Invited Paper)** [8769-136]  
C. Tang, Q. Mi, H. Yan, J. Yang, Tianjin Univ. (China); S. Liu, Shenyang Xinle Aerospace Co., Ltd. (China)
- 8769 2E **Development of a fast and accurate color-encoded digital fringe projection profilometry (Invited Paper)** [8769-68]  
Z. Liu, Beihang Univ. (China) and National Univ. of Singapore (Singapore); C. Quan, C. J. Tay, National Univ. of Singapore (Singapore)

- 8769 2F **Precision heterodyne ellipsometry with an improved conic fitting algorithm (Invited Paper)** [8769-141]  
L. R. Watkins, M. J. Collett, The Univ. of Auckland (New Zealand)

---

**SESSION 6.2 CHARACTERISATION OF OPTICAL MATERIALS**

---

- 8769 2G **Colliding plasma plume dynamics and ZnO thin film deposition (Invited Paper)** [8769-259]  
S. L. Gupta, R. P. Singh, R. K. Thareja, Indian Institute of Technology Kanpur (India)
- 8769 2H **Optical behavior of spirooxazine incorporated vinyl functional silicates thin film under UV irradiation** [8769-133]  
S. A. Nazri, M. Z. A. Malek, M. T. Zainuddin, N. M. A. Aziz, N. Z. I. Mohamed, SIRIM Berhad (Malaysia)
- 8769 2I **Analytical study on the three-dimensional temperature field of KDP crystal irradiated by sinusoidal modulated laser** [8769-184]  
Y. Zhang, H. Shen, R. Zhu, Nanjing Univ. of Science and Technology (China)
- 8769 2J **A high absorptance terahertz coating** [8769-203]  
Y. Deng, Q. Sun, J. Yu, J. Wang, Y. Lin, National Institute of Metrology (China)

---

**SESSION 6.3 OPTICAL AND SYSTEM DESIGN; COMPUTATIONAL OPTICS**

---

- 8769 2K **Stress optical path difference analysis of off-axis lens ray trace footprint** [8769-147]  
M.-Y. Hsu, C.-Y. Chan, W.-C. Lin, K.-H. Wu, C.-W. Chen, S.-T. Chan, T.-M. Huang, Instrument Technology Research Ctr. (Taiwan)
- 8769 2L **Photo-thermal modifications in ultrafast laser inscribed chalcogenide glass waveguides** [8769-109]  
G. Sivakumar, T. Sabapathy, A. Ayiriveetil, Indian Institute of Science (India); A. K. Kar, Heriot-Watt Univ. (United Kingdom); S. Asokan, Indian Institute of Science (India)
- 8769 2M **One-time ray-tracing method for the optimization of illumination system** [8769-252]  
S.-C. Chu, H.-L. Yang, National Cheng Kung Univ. (Taiwan)
- 8769 2N **Effect of stress and interface defects on photoluminescence of Si nano-crystals embedded in SiO<sub>2</sub>** [8769-179]  
B. M. Shenoy, G. M. Hegde, D. R. Mahapatra, Indian Institute of Science (India)

---

**POSTER SESSION: OPTICAL METROLOGY AND INSTRUMENTATION**

---

- 8769 2O **A new method of real-time detection of pH based on polyaniline-coated tapered optical fiber** [8769-205]  
Y. Hu, W. Tao, Y. Bi, H. Zhao, Shanghai Jiao Tong Univ. (China)

- 8769 2P **Near infrared non-destructive inspection of inner qualities by multivariate analysis** [8769-48]  
C.-W. Chen, Instrument Technology Research Ctr. (Taiwan); Y.-S. Lee, S.-P. Ying, Minghsin Univ. of Science and Technology (Taiwan); C.-K. Ku, Taipei Municipal Univ. of Education (Taiwan); M.-Y. Hsu, Instrument Technology Research Ctr. (Taiwan)
- 8769 2Q **To develop a high speed auto-alignment system by dual machine vision based alignment system** [8769-76]  
C.-J. Chen, Instrument Technology Research Ctr. (Taiwan); W. Jywe, Y. Teng, National Formosa Univ. (Taiwan); Y.-J. Chen, M.-W. Hung, Instrument Technology Research Ctr. (Taiwan)
- 8769 2R **Combining bundle adjustment and laser tracker for precise position measurement of fiber ends** [8769-114]  
M. Feng, Y. Gu, C. Zhai, Univ. of Science and Technology of China (China)
- 8769 2S **Specular surface measurement based on fringe reflection and study on 3D shape reconstruction technique** [8769-122]  
R. Zhu, R. Zhu, Q. Song, J. Li, Nanjing Univ. of Science and Technology (China)
- 8769 2T **Measurement of two-dimensional distribution of temperature with surface plasmon resonance** [8769-131]  
Y.-C. Chu, K.-H. Chen, Feng Chia Univ. (Taiwan); J.-Y. Lin, National Changhua Univ. of Education (Taiwan); J.-H. Chen, Feng Chia Univ. (Taiwan); H.-S. Chiu, Lunghwa Univ. of Science and Technology (Taiwan); T.-M. Chen, Feng Chia Univ. (Taiwan)
- 8769 2U **A filter lens for optical compensation in transmission spectrum** [8769-164]  
Y.-H. Lin, H.-Y. Tsai, H.-C. Chang, C.-J. Weng, K.-C. Huang, Instrument Technology Research Ctr. (Taiwan)
- 8769 2V **Application of digital image correlation for long-distance bridge deflection measurement** [8769-167]  
L. Tian, Beijing Institute of Opto-Electronic Technology (China); B. Pan, Beijing Univ. of Aeronautics and Astronautics (China); Y. Cai, H. Liang, Y. Zhao, Beijing Institute of Opto-Electronic Technology (China)
- 8769 2W **The relationships between system transfer function and power spectral density measurements** [8769-188]  
X. Wang, J. Li, R. Zhu, R. Ji, Nanjing Univ. of Science and Technology (China)
- 8769 2X **Experimental research of digital holographic microscopic measuring** [8769-191]  
X. Zhu, F. Chen, J. Li, Xi'an Technological Univ. (China)
- 8769 2Y **4D metrology of flapping-wing micro air vehicle based on fringe projection** [8769-197]  
Q. Zhang, Sichuan Univ. (China); L. Huang, Y.-W. Chin, L.-G. Keong, A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 2Z **An on-line monitoring technique for trace gases in atmosphere based on differential optical absorption spectroscopy** [8769-247]  
L. Q. Sun, K. X. Cheng, H. D. Yang, Q. S. He, Tsinghua Univ. (China)

- 8769 30 **Investigation of surface and subsurface profile, techniques of measurement, and replication of the Chinese Magic Mirror** [8769-249]  
E. T. Kang Min, S. M. Watt, P. Sreemathy, Raffles Girls' School (Secondary) (Singapore);  
L. Huang, A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 31 **Single-shot quantitative phase microscopy with the transport-of-intensity equation**  
[8769-70]  
C. Zuo, Nanjing Univ. of Science and Technology (China), Nanyang Technological Univ.  
(Singapore), and Beijing Institute of Technology (China); Q. Chen, Nanjing Univ. of Science  
and Technology (China) and Beijing Institute of Technology (China); W. Qu, Ngee Ann  
Polytechnic (Singapore); A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 32 **A study on the yellow ring distribution of MR-16 WLED triplet lens module** [8769-107]  
C.-C. Yang, H.-Y. Tsai, Y.-J. Chen, K.-C. Huang, Instrument Technology Research Ctr.  
(Taiwan)
- 8769 33 **Device fabrication of insoluble donor-acceptor-donor structured molecule by pulsed laser  
deposition: a comparative study using different laser source** [8769-182]  
S. S. K., A. D. Rao, R. K., Indian Institute of Science (India); R. Kumar, S. A. Ramakrishna,  
Indian Institute of Technology Kanpur (India); P. C. Ramamurthy, Indian Institute of Science  
(India)
- 8769 34 **Computer generated holograms design in null testing of optical freeform surfaces**  
[8769-209]  
Y. Huang, J. Ma, R. Zhu, H. Shen, Nanjing Univ. of Science and Technology (China)
- 8769 35 **Long-range hybrid plasmonic waveguide comprising a cylinder nanowire surrounded by a  
high-index contrast dielectric medium on low-index dielectric substrates** [8769-113]  
C. C. Huang, National Chung Hsing Univ. (Taiwan)
- 8769 36 **A new methodology to realise primary spectral radiance scale for supporting LED and SSL  
characterisation** [8769-281]  
J. Zhou, Y. Liu, National Metrology Ctr., A\*STAR (Singapore)

---

**POSTER SESSION: 3D IMAGING AND DISPLAY**

---

- 8769 37 **Digital holography display (3)** [8769-89]  
C. P. Lee, Ngee Ann Polytechnic (Singapore); H. Zheng, Shanghai Univ. (China); Y. P. Chia,  
C. Y. Cheng, Y. Yu, Ngee Ann Polytechnic (Singapore); Y. Yu, Shanghai Univ. (China);  
A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 38 **Three-dimensional shape measurement with wavelength-modulated laser base on fiber  
optic interferometer projection** [8769-105]  
R. Zhu, Q. Song, R. Zhu, J. Li, Nanjing Univ. of Science and Technology (China)
- 8769 39 **Method for image quality improvement of full-color holographic projection system**  
[8769-217]  
H. Zheng, Z. Zeng, T. Wang, C. Wang, Y. Yu, Shanghai Univ. (China)

- 8769 3A **Unambiguous range extension of a phase-shift based lidar by using two laser diodes with different modulation frequencies** [8769-271]  
J. Jang, S. Hwang, K. Park, Gwangju Institute of Science and Technology (Korea, Republic of)

---

**POSTER SESSION: OPTICAL SYSTEM DESIGN**

---

- 8769 3B **A numerical method for designing gradient-index fiber probes** [8769-31]  
C. Wang, X. Xia, S. Bi, Shanghai Univ. (China); X. Li, Tianjin Univ. (China); L. Wang, Shanghai Institute of Optics and Fine Mechanics (China); Y. Yu, Shanghai Univ. (China)
- 8769 3C **Physical phase compensation in digital holographic microscopy by using of electrical tunable lens** [8769-231]  
W. Qu, C. Y. Cheng, Ngee Ann Polytechnic (Singapore); A. Asundi, Nanyang Technological Univ. (Singapore)
- 8769 3D **Fresnel lens with multiple focus modes using polymer stabilized liquid crystals** [8769-250]  
H.-F. Shih, S.-C. Li, National Chung Hsing Univ. (Taiwan); C.-L. Tien, Feng Chia Univ. (Taiwan)

---

**POSTER SESSION: MICROSCOPY AND IMAGING**

---

- 8769 3E **The Nonlinear Logarithm Method (NLLM) to adjust the color deviation of fluorescent images** [8769-97]  
Y.-J. Chen, H.-C. Chang, K.-C. Huang, Instrument Technology Research Ctr. (Taiwan); C.-H. Chang, Kaohsiung Medical Univ. (Taiwan)
- 8769 3F **Surface defect inspection for power inductor** [8769-163]  
C.-L. Chang, W.-H. Wu, C.-J. Chen, H.-J. Huang, Instrument Technology Research Ctr. (Taiwan)
- 8769 3G **Analysis of excitation-intensity-dependent diffraction and acceleration characteristics of finite half-Bessel beams** [8769-175]  
K. Lee, I. Lee, B. Lee, Seoul National Univ. (Korea, Republic of)
- 8769 3H **Three-dimensional refractive index measurement by digital holographic microscopy** [8769-211]  
L. Ma, H. Wang, Y. Li, L. Su, Zhejiang Normal Univ. (China)
- 8769 3I **Auto gain tuning method for high performance of atomic force microscope** [8769-272]  
J. Jeong, J. Jo, K. Park, Gwangju Institute of Science and Technology (Korea, Republic of)
- 8769 3J **Capturing and stitching images with a large viewing angle and low distortion properties for upper gastrointestinal endoscopy** [8769-95]  
Y.-C. Liu, C.-K. Chung, J.-Y. Lai, H.-C. Chang, Instrument Technology Research Ctr. (Taiwan); F.-Y. Hsu, Taiwan Surgical Corp. (Taiwan)



---

**POSTER SESSION: PRECISION ENGINEERING**

---

- 8769 3K **Alternative displacement sensor with reflection type holographic grating** [8769-55]  
Y.-Y. Ho, Z.-R. Lin, C.-C. Hsu, Yuan Ze Univ. (Taiwan); C.-C. Wu, Tamkang Univ. (Taiwan);  
J.-Y. Lee, National Central Univ. (Taiwan)
- 8769 3L **Effects of macro- and micro-hole milling parameters on Al<sub>2</sub>O<sub>3</sub> ceramics using an ultraviolet laser system** [8769-128]  
W. T. Hsiao, S. F. Tseng, C. K. Chung, K. C. Huang, Instrument Technology Research Ctr.  
(Taiwan); M. F. Chen, National Changhua Univ. of Education (Taiwan)
- 8769 3M **Study on ultrafine machining of a complex microlens mold with a lenticular pattern on an aspherical surface** [8769-208]  
T.-J. Je, E. Jeon, H.-H. Kim, H.-J. Choi, D.-S. Choi, Korea Institute of Machinery & Materials  
(Korea, Republic of)
- 8769 3N **Weighing of moving vehicles using fiber optic polarimetric sensor** [8769-270]  
H. L. Ng-Lee, K. N., J. K. Lau, Z. C. D. Song, W. S. Seah, Ngee Ann Polytechnic (Singapore);  
A. K. Asundi, Nanyang Technological Univ. (Singapore)

---

**POSTER SESSION: OPTICAL FABRICATION AND MATERIALS**

---

- 8769 3O **Fabrication of a hybrid optical micro-component with a thermosetting polymer and glass**  
[8769-99]  
C.-Y. Huang, C.-C. Chen, K.-S. Chang, H.-Y. Chou, W.-Y. Hsu, Instrument Technology  
Research Ctr. (Taiwan); T.-X. Lee, National Taiwan Univ. of Science and Technology  
(Taiwan)
- 8769 3P **Cleaving parameters studies on glass fibers laser cutting** [8769-130]  
W.-H. Wu, C.-L. Chang, M.-W. Hung, Instrument Technology Research Ctr. (Taiwan)
- 8769 3Q **Ultra-precision diamond milling of aspheric microlens array** [8769-150]  
C.-C. Chen, C.-Y. Huang, Y.-C. Cheng, W.-Y. Hsu, Instrument Technology Research Ctr.  
(Taiwan)
- 8769 3R **Optical loss and residual stress measurement of infrared chalcogenide glasses and analysis on its influencing factors** [8769-218]  
B. Song, Y. Yang, Ningbo Univ. (China); Z. Jia, Shandong Univ. (China); F. Chen, C. Lin,  
S. Dai, X. Wang, X. Shen, T. Xu, Q. Nie, Ningbo Univ. (China)
- 8769 3U **Low loss waveguide on chalcogenide glass using ultrafast laser at low repetition rate**  
[8769-71]  
T. Sabapathy, G. Sivakumar, A. Ayiriveetil, Indian Institute of Science (India); A. K. Kar,  
Heriot-Watt Univ. (United Kingdom); S. Asokan, Indian Institute of Science (India)
- 8769 3Z **Comparison of different image recognition methods for characterization of micro-gyroscopes** [8769-42]  
W. Sun, T. Yin, Nanjing Univ. of Aeronautics and Astronautics (China); X. Kang, Nanjing Univ.  
of Science and Technology (China); X.-Y. He, Southeast Univ. (China)

- 8769 41 **The influence of acoustic wave diffraction on stored light based on SBS in an optical fiber**  
[8769-35]  
S. Shen, Y. Ding, Beijing Univ. of Chemical Technology (China)

*Author Index*



# Conference Committee

## *Conference Chairs*

**A. Asundi**, Nanyang Technological University (Singapore)  
**T. Liew**, National Metrology Center, A\*STAR (Singapore)

## *Program Committee*

**C. Quan**, National University of Singapore (Singapore)  
**K. Qian**, Nanyang Technological University (Singapore)  
**L. Zhao**, National Metrology Center, A\*STAR (Singapore)  
**C. J. Tay**, National University of Singapore (Singapore)  
**Y. Fu**, Nanyang Technological University (Singapore)  
**S. L. Tan**, National Metrology Center, A\*STAR (Singapore)  
**L. Huang**, Nanyang Technological University (Singapore)  
**S. L. Toh**, National University of Singapore (Singapore)  
**X. Huang**, National Metrology Center, A\*STAR (Singapore)  
**Z. P. Fang**, Singapore Institute of Manufacturing Technology, A\*STAR (Singapore)  
**C. Zhu**, Sunny Instruments Singapore (Singapore)

## *International Advisory Committee*

<b>Andreas Heinrich</b> (Germany)	<b>Mou Tongsheng</b> (China)
<b>Liang-Chia Chen</b> (Taiwan)	<b>K. C. Fan</b> (Taiwan)
<b>Jim Trolinger</b> (United States)	<b>George Barbastathis</b> (United States)
<b>Armando Albertazzi</b> (Brazil)	<b>Otani Yukitoshi</b> (Japan)
<b>Lianxiang Yang</b> (United States)	<b>Keith Emery</b> (United States)
<b>Jim Wyant</b> (United States)	<b>Gopal Hedge</b> (India)
<b>Bahram Javidi</b> (United States)	<b>Peter De Groot</b> (United States)
<b>Lo Yu Lung</b> (Taiwan)	<b>Kevin Harding</b> (United States)
<b>Jin Guo Fan</b> (China)	<b>Hans Tiziani</b> (Germany)
<b>Brian Culshaw</b> (United Kingdom)	<b>Pietro Ferrero</b> (Italy)
<b>Malgorzata Kujawska</b> (Poland)	<b>Richard Leach</b> (United Kingdom)
<b>Johannes A. Soons</b> (United States)	<b>Hillar Aben</b> (Estonia)
<b>ByoungHo Lee</b> (Korea)	<b>Pramod Rastogi</b> (Switzerland)
<b>Manuel Costa</b> (Portugal)	<b>Richard Silver</b> (United States)
<b>John McBride</b> (United Kingdom)	<b>Ingrid Dewolf</b> (Belgium)
<b>Chang Chisheng</b> (Taiwan)	<b>Ralph Tatam</b> (United Kingdom)
<b>Martin Huenten</b> (Germany)	<b>S. Sumriddetchkajorn</b> (Thailand)
<b>Joris Dirckx</b> (Belgium)	<b>Jannick Rolland</b> (United States)
<b>C. Depeursinge</b> (Switzerland)	<b>Ramon Rodriguez Vera</b> (Mexico)
<b>Motoharu Fujigaki</b> (Japan)	<b>Theodore V. Vorburger</b> (United States)
<b>Jyoti Mazumder</b> (United States)	<b>Tian Ailing</b> (China)
<b>Dario Ambrosini</b> (Italy)	<b>Wei Gao</b> (Japan)

**Yingjie Yu** (China)  
**W. Osten** (Germany)

**Xie H. M.** (China)  
**Zhanshan Wang** (China)

*Session Chairs*

- 1.0 Keynote Lecture: Surface Form Metrology of Micro-Optics  
**T. Liew**, National Metrology Center, A\*STAR (Singapore)
- 3.0 Special Invited Session: Optical Metrology of Function Surface  
**W. Osten**, Universität Stuttgart (Germany)
- 5.0 Special Invited Session: Micro-Optics  
**J. Czarske**, Technische Universität Dresden (Germany)
- 1.1 Special Session: Surface Metrology and Precision Engineering  
**S. L. Tan**, National Metrology Center, A\*STAR (Singapore)  
**W. Gao**, Tohoku University (Japan)
- 1.2 Optical Metrology and Instrumentation I  
**C. J. Tay**, National University of Singapore (Singapore)  
**X. Li**, Tsinghua University (China)
- 1.3 Optical Metrology and Instrumentation II  
**Y. L. Lo**, National Cheng Kung University (Taiwan)  
**T. Mou**, Zhejiang University (China)
- 2.1 Special Session: Digital Image Correlation  
**B. Pan**, Beihang University (China)  
**W. C. Wang**, National Tsing Hua University (Taiwan)
- 2.2 Measurement and Image Processing I  
**J. Mazumder**, University of Michigan (United States)  
**D. Zhang**, Shanghai University (China)
- 2.3 Measurement and Image Processing II  
**B. Lee**, Seoul National University (Korea, Republic of)  
**O. Yukitoshi**, Utsunomiya University (Japan)
- 3.1 Special Session: Dynamics Measurement  
**Y. Fu**, Nanyang Technological University (Singapore)  
**G. Pedrini**, Universität Stuttgart (Germany)
- 3.2 Optical Metrology and Instrumentation III  
**T. Yatagai**, Utsunomiya University (Japan)  
**L. R. Watkins**, The University of Auckland (New Zealand)
- 3.3 Optical Metrology and Instrumentation IV  
**L. Zhao**, National Metrology Center, A\*STAR (Singapore)  
**G. Notni**, Fraunhofer-IOF (Germany)
- 4.1 Special Session: Shape Measurement  
**L. Huang**, Nanyang Technological University (Singapore)  
**T. Yoshizawa**, Non-Profit Organization 3D Associates (Japan)

- 4.2 Precision Measurement and Image Processing III  
**G. M. Hegde**, Indian Institute of Science (India)  
**J. Zhao**, Northwestern Polytechnical University (China)
- 4.3 Optical Fabrication and Surface Metrology  
**Z. P. Fang**, Singapore Institute of Manufacturing Technology,  
A\*STAR (Singapore)  
**P. Lehmann**, University of Kassel (Germany)
- 5.1 Special Session: Information Security  
**Y. Zhang**, Capital Normal University (China)  
**N. K. Nishchal**, Indian Institute of Technology Patna (India)
- 5.2 Sensors and Actuators; Fiber Optics Sensors  
**A. D. Boef**, ASML (Netherlands)
- 5.3 Precision Engineering  
**X. Huang**, National Metrology Center, A\*STAR (Singapore)  
**R. K. Thareja**, Indian Institute of Technology Kanpur (India)
- 6.1 Special Session: Fringe Analysis  
**K. Li**, Shanghai University (China)  
**C. Tang**, Tianjin University (China)
- 6.2 Characterisation of Optical Materials  
**S. L. Toh**, National University of Singapore (Singapore)  
**Y. Takaya**, Osaka University (Japan)
- 6.3 Optical and System Design; Computational Optics  
**C. Quan**, National University of Singapore (Singapore)



## Introduction

The second conference of the Optics and Photonics Society of Singapore - the international conference on Optics in Precision Engineering and Nanotechnology (icOPEN2013) was successfully held 9–11 April 2013 at Singapore Expo. The conference was collocated with MTA2013 Exhibition, a leading exhibition in Precision Engineering in the region with over 500 exhibitors from 31 countries and regions. This event featured technologies related to metrology, machine tools and tooling systems. It focused on high-value manufacturing capabilities in aerospace, oil and gas, medical technology and complex equipment. The conference was attended by 182 delegates from 16 countries including students, academicians and company researchers.

Precision engineering and nanotechnology are exploring disruptive technologies to address the increased demands on design, manufacturing, and testing of precise surfaces. There are various advantages to be gained from these surfaces and hence novel solutions are needed. Optics and photonics provided these technologies in manufacturing using lasers and related technologies and in metrology with the development of fast, non-contact, and high resolution measurement. The exhibits attested to this fact with many companies exhibiting novel precision manufacturing and metrology system using optical technologies. Hence this conference was very timely to introduce to the precision engineering community the technological advances in optical engineering which can help revolutionize the precision engineering sector from design through fabrication to testing.

A plenary speaker from Tohoku University (Japan) provided insights into "Surface form metrology of micro-optics," and two special sessions of invited papers highlighted the interesting topics on "Optical Metrology of Functional Surface" and "Micro-Optics." In addition, six sessions of invited papers covered the topics on Surface Metrology and Precision Engineering, Digital Image Correlation, Dynamics Measurement, 3D Shape Measurement, Information Security, and Fringe Analysis. Furthermore, Computational Optics and Image Processing were developed to highlight these novel topics vital both for design and testing especially for Nanotechnology. Other topics include Optical Metrology and Instrumentation, Optical Design including nanoscale optics, optical fabrication, sensors and actuators as well as fiber optic sensors.

We take this opportunity to thank all speakers and authors for contributing to the success of the conference, to members of the organizing committee for their assistance and enthusiastic support, to the session chairs, to our sponsors, and to the staff of Singapore Exhibition Services Pte Ltd for ensuring the efficient execution of the conference program.

**Chenggen Quan**  
**Kemao Qian**  
**Anand Asundi**





Chairman Prof Asundi addressed the delegates at the opening ceremony



Prof Gao Wei presented the keynote lecture