

PROCEEDINGS OF SPIE

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

Front Matter: Volume 8563

, "Front Matter: Volume 8563," Proc. SPIE 8563, Optical Metrology and Inspection for Industrial Applications II, 856301 (7 January 2013); doi: 10.1117/12.2017914

SPIE.

Event: Photonics Asia, 2012, Beijing, China

PROCEEDINGS OF SPIE

Optical Metrology and Inspection for Industrial Applications II

Kevin G. Harding
Peisen S. Huang
Toru Yoshizawa
Editors

5–7 November 2012
Beijing, China

Sponsored by
SPIE
COS—Chinese Optical Society

Cooperating Organizations

Tsinghua University (China) • Peking University (China) • Zhejiang University (China) • Beijing Institute of Technology (China) • Beijing University of Posts and Telecommunications (China) • University of Science and Technology of China (China) • Tianjin University (China) • Nankai University (China) • Changchun University of Science and Technology (China) • University of Shanghai for Science and Technology (China) • Capital Normal University (China) • Huazhong University of Science and Technology (China) • Beijing Jiaotong University (China) • Shanghai Institute of Optics and Fine Mechanics (China) • Changchun Institute of Optics and Fine Mechanics (China) • Institute of Semiconductors (China) • Institute of Optics and Electronics (China) • Institute of Physics (China) • Shanghai Institute of Technical Physics (China) • China Instrument and Control Society (China) • Optoelectronics Technology Committee, COS (China) • SPIE National Committee in China (China) • Japan Optical Society (Japan) • Korea Optical Society (Korea, Republic of) • Australia Optical Society (Australia) • Singapore Optical Society (Singapore)

Supporting Organizations

CAST—China Association for Science and Technology (China)
NSFC—National Nature Science Foundation (China)

Published by
SPIE

Volume 8563

Proceedings of SPIE 0277-786X, V.8563

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

Optical Metrology and Inspection for Industrial Applications II, edited by Kevin G. Harding,
Peisen S. Huang, Toru Yoshizawa, Proc. of SPIE Vol. 8563, 856301 · © 2012 SPIE
CCC code: 0277-786/12/\$18 · doi: 10.1117/12.2017914

Proc. of SPIE Vol. 8563 856301-1

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 *Optical Metrology and Inspection for Industrial Applications II*, edited by Kevin G. Harding, Peisen S. Huang, Toru Yoshizawa, Proceedings of SPIE Vol. 8563 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819493187

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 © 2012, 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. 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/12/\$18.00.

Printed in the United States of America.

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

SPIE 
Digital Library

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

- ix *Symposium Committees*
- xi *Conference Committee*
- xiii *Introduction*
- xv Quantum dot lasers and relevant nanoheterostructures (Plenary Paper) [8552-1]
A. E. Zhukov, N. V. Kryzhanovskaya, A. V. Savelyev, A. M. Nadtochiy, E. M. Arakcheeva,
F. I. Zubov, V. V. Korenev, Saint-Petersburg Academic Univ. (Russian Federation);
M. V. Maximov, Y. M. Shernyakov, M. M. Kulagina, I. A. Slovinskiy, Ioffe Physical-Technical
Institute (Russian Federation); D. A. Livshits, Innolume GmbH (Germany); A. Kapsalis,
C. Mesaritakis, D. Syvridis, Univ. of Athens (Greece); A. Mintairov, Univ. of Notre Dame
(United States)

SESSION 1 METROLOGY MODELING AND SIMULATION

- 8563 02 **Multi-frequency sweeping interferometry using spatial optical frequency modulation**
[8563-3]
S. Choi, H. Kato, O. Sasaki, T. Suzuki, Niigata Univ. (Japan)
- 8563 03 **Simulation of real-time large-scale absolute distance measurement with a pair of femtosecond frequency comb lasers** [8563-4]
Y. Li, Q. Zhou, K. Ni, G. Wu, X. Qiao, Tsinghua Univ. (China)
- 8563 04 **An approach to compensate the object movement errors in phase shifting profilometry**
[8563-2]
L. Lu, J. Xi, Y. Yu, Univ. of Wollongong (Australia); L. Song, Tianjin Polytechnic Univ. (China)
- 8563 05 **A composite quality-guided phase unwrapping algorithm for fast 3D profile measurement (Invited Paper)** [8563-1]
K. Chen, J. Xi, Y. Yu, Univ. of Wollongong (Australia); L. Song, Tianjin Polytechnic Univ. (China)

SESSION 2 METROLOGY CALIBRATION

- 8563 06 **A data processing method to improve the accuracy of depth measurement by binocular stereo vision system** [8563-7]
J. Tang, M. Zhang, L. Wang, Zhejiang Univ. (China)
- 8563 07 **Coordinates calibration in precision detection of 3D optical deformation measurement system** [8563-8]
H. Lu, C. Hu, X. Wang, Y. Gao, W. Wu, National Univ. of Defense Technology (China)

- 8563 08 **Ball-bar based self-calibration technique for five-axis optical measurement system** [8563-5]
X. M. Du, Huazhong Univ. of Science & Technology (China) and GE Global Research (China); J. Gu, GE Global Research (China); K. G. Harding, GE Global Research (United States)
- 8563 09 **A new 3D measurement method and its calibration based on the combination of binocular and monocular vision** [8563-6]
D. Li, J. Tian, X. Yang, Shenzhen Univ. (China)

SESSION 3 METROLOGY APPLICATIONS I

- 8563 0A **Imaging Stokes polarimeter by dual rotating retarder and analyzer and its application of evaluation of Japanese lacquer** [8563-13]
R. Mizutani, T. Ishikawa, M. Ayama, Y. Otani, Utsunomiya Univ. (Japan)
- 8563 0B **Absolute measurement of optical surface profile with a Fizeau interferometer (Invited Paper)** [8563-10]
O. Sasaki, A. Watanabe, S. Choi, T. Suzuki, Niigata Univ. (Japan)
- 8563 0C **Spindle error motion measurement using concentric circle grating and phase modulation interferometers** [8563-11]
M. Aketagawa, M. Madden, S. Uesugi, T. Kumagai, Y. Maeda, Nagaoka Univ. of Technology (Japan); E. Okuyama, Akita Univ. (Japan)

SESSION 4 3D METHODS I

- 8563 0F **Circular gratings' moiré effect for projection measurement in volume optical computerized tomography with two-step phase-shifting method** [8563-16]
J. Wang, Y. Song, Z. Li, A. He, Nanjing Univ. of Science and Technology (China)
- 8563 0G **Phase shift reflectometry for sub-surface defect detection (Invited Paper)** [8563-14]
A. Asundi, H. Lei, Nanyang Technological Univ. (Singapore); T. K. M. Eden, P. Sreemathy, W. S. May, Raffles Girls' School Secondary (Singapore)
- 8563 0H **Continuous turbine blade creep measurement based on Moiré** [8563-15]
Y. Liao, R. Tait, K. Harding, E. J. Nieters, W. C. Hasz, N. Piche, GE Global Research (United States)

SESSION 5 3D METHODS II

- 8563 0J **Towards a one step geometric calibration of an optical coherence tomography** [8563-21]
J. Díaz Díaz, M. Rahlves, Leibniz Univ. Hannover (Germany); O. Majdani, Medizinische Hochschule Hannover (Germany); E. Reithmeier, T. Ortmaier, Leibniz Univ. Hannover (Germany)
- 8563 0K **Real-time displacement measurement using VCSEL interferometer** [8563-20]
T. Suzuki, N. Yamada, O. Sasaki, S. Choi, Niigata Univ. (Japan)

- 8563 OL **Small size probe for inner profile measurement of pipes using optical fiber ring beam device (Invited Paper)** [8563-18]
T. Wakayama, K. Machi, Saitama Medical Univ. (Japan); T. Yoshizawa, NPO 3D Associates (Japan)
- 8563 OM **Fiber-optic confocal probe with an integrated real-time apex finder for high-precision center thickness measurement of ball lenses** [8563-19]
A. Somboonkaew, R. Amarit, S. Chanhorm, National Electronics and Computer Technology Ctr. (Thailand); B. Sutapun, Suranaree Univ. of Technology (Thailand)
- 8563 ON **OCT for industrial applications** [8563-22]
G. Song, K. Harding, GE Global Research (United States)

SESSION 6 METROLOGY APPLICATIONS II

- 8563 OO **Extended depth of field for visual measurement systems with depth-invariant magnification** [8563-28]
Y. Zhao, Y. Qu, BeiHang Univ. (China)
- 8563 OP **Simultaneous measurement of birefringence magnitude and direction using Wollaston prism** [8563-27]
L. Liu, A. Zeng, Shanghai Institute of Optics and Fine Mechanics (China) and Graduate Univ. of the Chinese Academy of Sciences (China); B. Chen, Shanghai Institute of Optics and Fine Mechanics (China) and Zhejiang Univ. (China); L. Zheng, Shanghai Institute of Optics and Fine Mechanics (China); H. Huang, Shanghai Institute of Optics and Fine Mechanics (China) and Graduate Univ. of the Chinese Academy of Sciences (China)
- 8563 OQ **Image detection of inner wall surface of holes in metal sheets through polarization using a 3D TV monitor** [8563-26]
T. Suzuki, K. Nakano, S. Muramatsu, Niigata Univ. (Japan); T. Oitate, Totsuka Metal Industry Co., Ltd. (Japan)
- 8563 OR **Industrial surface finish method comparison for fine finish measurements (Invited Paper)** [8563-23]
K. Harding, E. Heidari, R. Tait, GE Global Research (United States); G. Xie, Z. Zhai, GE Global Research (China)

SESSION 7 NDT METHODS

- 8563 OU **Temporal phase retrieval in dynamic speckle interferometry by adaptive empirical mode decomposition** [8563-30]
H. Zhang, Tianjin Univ. (China); J. He, Tianjin Univ. of Technology and Education (China); M. Zhu, Z. Huang, Tianjin Univ. (China)
- 8563 OV **Holographic approach to detection of delamination areas in layered polymeric waveguides by means of strain solitons** [8563-31]
I. V. Semenova, G. V. Dreiden, A. F. Ioffe Physical-Technical Institute (Russian Federation); K. R. Khusnutdinova, Loughborough Univ. (United Kingdom); A. M. Samsonov, A. F. Ioffe Physical-Technical Institute (Russian Federation)

POSTER SESSION

- 8563 0W **Research of dynamic detecting the raw silk fineness on line by a linear CCD and FPGA** [8563-35]
F. Liu, W. Zhou, G. Chen, H. G. Yi, Soochow Univ. (China)
- 8563 0X **An optoelectronic system for the in-flight measurement of helicopter rotor blades' motions and strains** [8563-36]
Y. Huang, Tsinghua Univ. (China); W. Cheng, Chinese Flight Test Establishment (China); Y. Li, Tsinghua Univ. (China); W. Li, Chinese Flight Test Establishment (China)
- 8563 0Y **A speed auto-adaptable system for high speed inspection of rail-track defects** [8563-37]
J. Ge, Y. Luo, J. Zhang, L. Guo, L. Sun, Z. Chen, Jinan Univ. (China)
- 8563 10 **Simultaneous measurements of atmospheric NO₂ and HONO using IBBCEAS with a near-ultraviolet LED** [8563-39]
L. Ling, Anhui Institute of Optics and Fine Mechanics (China) and Anhui Univ. of Science and Technology (China); P. Xie, M. Qin, R. Hu, N. Zheng, F. Si, Anhui Institute of Optics and Fine Mechanics (China)
- 8563 12 **Research on the video detection device in the invisible part of stay cable anchorage system** [8563-41]
L. Cai, N. Deng, Z. Xiao, Guilin Univ. of Electronic Technology (China)
- 8563 13 **Dynamic measurements by color gratings projection method using a two-step Fourier transform method** [8563-42]
K. Kamiya, T. Nomura, A. Tanbo, M. Kimihisa, Toyama Prefectural Univ. (Japan); T. Hatsuzou, Univ. of Toyama (Japan); S. Suzuki, Nagano National College of Technology (Japan)
- 8563 14 **Multiple pulse train interference-based measurement of refractive index of air using a femtosecond optical frequency comb** [8563-43]
D. Wei, K. Takamasu, H. Matsumoto, The Univ. of Tokyo (Japan)
- 8563 15 **Use of ellipsometer to determine the optical properties of the satellite surface coated materials** [8563-44]
Y. Li, Z. Wu, L. Bai, Xidian Univ. (China)
- 8563 16 **Traceable dual-frequency measurement of Zeeman split He-Ne lasers using an optical frequency comb locked external cavity diode laser** [8563-45]
H. Wei, X. Wu, L. Zhou, J. Zhang, Y. Li, Tsinghua Univ. (China)
- 8563 17 **A method for phase unwrapping base digital spackle correlation** [8563-46]
D. He, A. Li, X. Liu, X. Peng, Shenzhen Univ. (China)
- 8563 18 **Analysis of non-uniformity of irradiance measurement uncertainties of a pulsed solar simulator** [8563-32]
Y. He, L. Xiong, H. Meng, J. Zhang, D. Liu, J. Zhang, National Institute of Metrology (China)

- 8563 19 **Geometric calibration and accuracy assessment of a multispectral imager on UAVs** [8563-49]
F. Zheng, Institute of Remote Sensing Applications (China) and Graduate Univ. of the Chinese Academy of Sciences (China); T. Yu, X. Chen, J. Chen, G. Yuan, Institute of Remote Sensing Applications (China)
- 8563 1A **Technology of optical azimuth transmission** [8563-50]
H. Lu, C. Hu, X. Wang, Y. Gao, National Univ. of Defense Technology (China)
- 8563 1E **Algorithm research of high-precision optical interferometric phase demodulation based on FPGA** [8563-52]
C. Zhi, J. Sun, Harbin Engineering Univ. (China)
- 8563 1G **Interferometric determination of the silicon sphere diameter using a laser frequency tuning system calibrated by a Fabry-Perot cavity** [8563-25]
X. Wu, J. Zhang, H. Wei, Y. Li, Tsinghua Univ. (China)

Author Index

Symposium Committees

General Chairs

Eustace L. Dereniak, College of Optical Sciences, The University of Arizona (United States)

Bingkun Zhou, Tsinghua University (China)

General Cochairs

Arthur Chiou, National Yang-Ming University (Taiwan, China)

Zhizhan Xu, Shanghai Institute of Optics and Fine Mechanics (China)

Jianlin Cao, China Ministry of Science and Technology (China)

Junhao Chu, Shanghai Institute of Technical Physics (China)

Technical Program Chairs

Songlin Zhuang, Shanghai University of Science and Technology (China)

Xingde Li, Johns Hopkins University (United States)

Technical Program Cochairs

Qiming Wang, Institute of Semiconductors (China)

Xu Liu, Zhejiang University (China)

Daoyin Yu, Tianjin University (China)

Qihuang Gong, Peking University (China)

Tianchu Li, National Institute of Metrology (China)

Wei Huang, Nanjing University of Posts and Telecommunications (China)

Local Organizing Committee Chair

Guangcan Guo, University of Science and Technology of China (China)

Local Organizing Committee Cochairs

Guoqiang Ni, Beijing Institute of Technology (China)
Shusen Xie, Fujian Normal University (China)
Xiaomin Ren, Beijing University of Posts and Telecommunications
(China)
Ying Gu, PLA General Hospital (China)
Huilin Jiang, Changchun University of Science and Technology
(China)

General Secretary

Qihuang Gong, Peking University (China)

Local Organizing Committee

Yan Li, Chinese Optical Society/Peking University (China)
Zhiping Zhou, Peking University (China)
Changhe Zhou, Shanghai Institute of Optics and Fine Mechanics
(China)
Qingming Luo, Huazhong University of Science and Technology
(China)
Chongxiu Yu, Beijing University of Posts and Telecommunications
(China)
Hongda Chen, Institute of Semiconductors (China)
Yongtian Wang, Beijing Institute of Technology (China)
Yiping Cui, Southeast University (China)
Xuping Zhang, Nanjing University (China)
Feijun Song, Daheng Corporation (China)
Cunlin Zhang, Capital Normal University (China)
Yanting Lu, Nanjing University (China)
Yuejin Zhao, Beijing Institute of Technology (China)
Chunqing Gao, Beijing Institute of Technology (China)
Tiegen Liu, Tianjin University (China)
Xiaocong Yuan, Nankai University (China)
Weimin Chen, Chongqing University (China)
Zhongwei Fan, Academy of Optoelectronics (China)
Hanyi Zhang, Tsinghua University (China)
Lan Wu, Zhejiang University (China)
Yongsheng Zhang, University of Science and Technology of China
(China)
Hong Yang, Peking University (China)
Xiaoying Li, Tianjin University (China)
Lin Zhai, Chinese Optical Society (China)

Conference Committee

Conference Chairs

Kevin G. Harding, GE Global Research (United States)
Peisen S. Huang, Univ. of Michigan-Shanghai Jiao Tong University
Joint Institute (China)
Toru Yoshizawa, NPO 3D Associates (Japan)

Conference Program Committee

Masato Aketagawa, Nagaoka University of Technology (Japan)
Yasuhiko Arai, Kansai University (Japan)
Dong Chen, Bruker Nano Inc. (United States)
Jun Chen, Tokyo Polytechnic University (Japan)
Khaled J. Habib, Kuwait Institute for Scientific Research (Kuwait)
Qingying Jim Hu, QUEST Integrated, Inc. (United States)
Lianhua Jin, University of Yamanashi (Japan)
Dieter Just, European Organisation for the Exploitation of
Meteorological Satellites (Germany)
Kazuhide Kamiya, Toyama Prefectural University (Japan)
Katsuichi Kitagawa, Toray Precision Company, Ltd. (Japan)
Guangrong Liu, Beijing Institute of Technology (China)
Liren Liu, Shanghai Institute of Optics and Fine Mechanics (China)
Yukitoshi Otani, Utsunomiya University (Japan)
Kemao Qian, Nanyang Technological University (Singapore)
Osami Sasaki, Niigata University (Japan)
Chen-Ko Sung, Fraunhofer-Institut für Optronik, Systemtechnik und
Bildauswertung (Germany)
Xiaodi Tan, Sony Corporation (Japan)
Joseph D. Tobiasson, Micro Encoder Inc. (United States)
Rainer Tutsch, Technische Universität Braunschweig (Germany)
Jiangtao Xi, University of Wollongong (Australia)
Jian Xu, A*STAR Singapore Institute of Manufacturing Technology
(Singapore)
Hao Zhang, Tianjin University (China)
Qing-Chuan Zhang, University of Science and Technology of China
(China)
Song Zhang, Iowa State University (United States)

Session Chairs

- 1 Metrology Modeling and Simulation
Kevin G. Harding, GE Global Research (United States)
Toru Yoshizawa, NPO 3D Associates (Japan)

- 2 Metrology Calibration
Toru Yoshizawa, NPO 3D Associates (Japan)
- 3 Metrology Applications I
Jiangtao Xi, University of Wollongong (Australia)
- 4 3D Methods I
Toru Yoshizawa, NPO 3D Associates (Japan)
- 5 3D Methods II
Kevin G. Harding, GE Global Research (United States)
- 6 Metrology Applications II
Toru Yoshizawa, NPO 3D Associates (Japan)
- 7 NDT Methods
Osami Sasaki, Niigata University (Japan)

Introduction

This is the proceedings of the Conference on Optical Metrology and Inspection for Industrial Applications II that was held as part of SPIE/COS Photonics Asia (in Beijing, China, on 5-7 November 2012). This conference focuses on methods, analysis, and applications of optical metrology and inspection as applied to various industries with particular emphasis on manufacturing. The field of optical metrology and inspection has grown to wide acceptance for many applications in industries. For example, the advances in machine/robot vision have provided compact, smart camera systems, new cameras and lighting systems, and better ways of communicating with the outside world. In dimensional metrology, two and three-dimensional methods have seen wide use in the electronics industry, but have also made advances in traditional manufacturing areas such as automotive and aerospace manufacturing. These methods are being used for defect inspection, precision measurements, and the detection of flaws. Modern computing power has made analysis methods such as phase-shifting a viable tool for fast on-line inspection for process control and metrology applications. This conference is intended to address the latest advances and future developments in the areas of optical inspection and metrology as they are applied to practical applications of industry.

In these proceedings, papers submitted to the conference are presented in the following sessions: Metrology modeling and simulation, Metrology calibration, Metrology applications, 3D methods, and NDT methods. In addition to optical principles and techniques, imaging methods have also become more and more popular in practical applications due to rapid advance of processing techniques and various optoelectrical devices.

Kevin G. Harding
Peisen S. Huang
Toru Yoshizawa

