

PROCEEDINGS OF SPIE

Optical Measurement Systems for Industrial Inspection VIII

**Peter H. Lehmann
Wolfgang Osten
Armando Albertazzi**
Editors

**13–16 May 2013
Munich, Germany**

Sponsored by
SPIE

Cooperating Organisations
European Optical Society
German Scientific Laser Society (Wissenschaftliche Gesellschaft
Lasertechnik e.V.)
The European Society for Biomaterials

Published by
SPIE

Volume 8788
Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 8788

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

Optical Measurement Systems for Industrial Inspection VIII, edited by
Peter H. Lehmann, Wolfgang Osten, Armando Albertazzi, Proc. of SPIE Vol. 8788,
878801 · © 2013 SPIE · CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2028782

Proc. of SPIE Vol. 8788 878801-1

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 Measurement Systems for Industrial Inspection VIII*, edited by Peter H. Lehmann, Wolfgang Osten, Armando Albertazzi, Proceedings of SPIE Vol. 8788 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819496041

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. 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

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

xv	<i>Conference Committee</i>
xvii	<i>Introduction</i>

SESSION 1 INTERFEROMETRIC TECHNIQUES

- 8788 02 **Low coherence full field interference microscopy or optical coherence tomography: recent advances, limitations and future trends (Invited Paper)** [8788-1]
I. Abdulhalim, Ilse Katz Ctr. for Nano Scale Science and Technology (Israel)
- 8788 03 **Excess fraction measurement of a transparent glass thickness in wavelength tuning interferometry** [8788-2]
Y. Kim, The Univ. of Tokyo (Japan); K. Hibino, National Institute of Advanced Industrial Science and Technology (Japan); K. Harada, N. Sugita, M. Mitsuishi, The Univ. of Tokyo (Japan)
- 8788 04 **Metrology for adhesive layer of temporary bonding wafers using IR interferometry** [8788-3]
P.-Y. Chang, Y.-S. Ku, C.-H. Cho, Industrial Technology Research Institute (Taiwan)
- 8788 05 **Concept, realization and performance of a two-beam phase-shifting point diffraction interferometer** [8788-4]
N. Voznesenskiy, M. Voznesenskaia, N. Petrova, VTT-NTM OÜ (Estonia); A. Abels, SmartStuff OÜ (Estonia)

SESSION 1 DIGITAL HOLOGRAPHY AND HOLOGRAPHIC MICROSCOPY

- 8788 06 **Sparsity-based denoising method of wrapped-phase reconstructions in digital holography** [8788-5]
P. Memmolo, Istituto Italiano di Tecnologia (Italy) and CNR-Istituto Nazionale di Ottica (Italy); M. Iannone, Istituto Italiano di Tecnologia (Italy); M. Ventre, Univ. of Naples Federico II (Italy); P. A. Netti, Istituto Italiano di Tecnologia (Italy); A. Finizio, M. Paturzo, P. Ferraro, CNR-Istituto Nazionale di Ottica (Italy)
- 8788 07 **Holographic Interferometry based on photorefractive crystal to measure 3D thermo-elastic distortion of composite structures and comparison with finite element models** [8788-6]
C. Thizy, Univ. de Liège (Belgium); F. Eliot, EADS-Astrium (France); D. Ballhause, K. R. Olympio, R. Kluge, EADS-Astrium (Germany); A. Shannon, G. Laduree, European Space Agency ESTEC (Netherlands); D. Logut, EADS-Astrium (France); M. P. Georges, Univ. de Liège (Belgium)
- 8788 08 **Lensless single-exposure super-resolved interferometric microscopy** [8788-7]
L. Granero, C. Ferreira, J. García, V. Micó, Univ. de València (Spain)

- 8788 09 **Resolution enhancement and autofocus in digital holographic microscopy by using structured illumination** [8788-8]
P. Gao, G. Pedrini, W. Osten, Univ. Stuttgart (Germany)
- 8788 0A **Hybrid and transmissive system based on digital holographic microscope and low coherent interferometer for high gradient shape measurement** [8788-9]
K. Liżewski, S. Tomczewski, J. Kostencka, T. Kozacki, Warsaw Univ. of Technology (Poland)
- 8788 0B **Total compensation of chromatic errors in digital color holography using a single recording** [8788-10]
M. Leclercq, LUNAM Univ., Univ. du Maine, CNRS (France); P. Picart, LUNAM Univ., Univ. du Maine, CNRS (France) and École Nationale Supérieure d'Ingénieurs du Mans (France)
- 8788 0D **Lensless object scanning holography for diffuse objects** [8788-12]
J. García, C. Ferreira, V. Micó, Univ. de València (Spain)

SESSION 3 MEASUREMENT OF OPTICAL COMPONENTS AND SYSTEMS

- 8788 0E **A long trace profiler with large dynamical range** [8788-13]
A. Ritucci, M. Rossi, Media Lario Technologies (Italy)
- 8788 0G **Optical characterization method for very small microlenses (sub-50 micron) for industrial mass-production applications** [8788-15]
M.-S. Kim, J. Sunarjo, K. J. Weible, R. Voelkel, SUSS MicroOptics SA (Switzerland)

SESSION 4 DIGITAL HOLOGRAPHY, SHEAROGRAPHY, AND SPECKLE TECHNIQUES

- 8788 0I **Shape reconstruction using dual wavelength digital holography and speckle movements** [8788-17]
D. Khodadad, Luleå Univ. of Technology (Sweden); E. Hällstig, Optronic Partner dp AB (Sweden); M. Sjö Dahl, Luleå Univ. of Technology (Sweden)
- 8788 0J **Digital holographic inspection for the straight pipe inner surface using multiwavelength from laser diodes** [8788-18]
M. Yokota, T. Koyama, T. Kawakami, Shimane Univ. (Japan)
- 8788 0K **Seeing through smoke and flames: a challenge for imaging capabilities, met thanks to digital holography at far infrared** [8788-19]
M. Locatelli, E. Pugliese, M. Paturzo, V. Bianco, A. Finizio, A. Pelagotti, P. Poggi, L. Miccio, R. Meucci, P. Ferraro, CNR-Istituto Nazionale di Ottica (Italy)
- 8788 0L **A computational tool to highlight anomalies on shearographic images in optical flaw detection** [8788-20]
A. V. Fantin, D. P. Willemann, M. Viotti, A. Albertazzi, Federal Univ. of Santa Catarina (Brazil)
- 8788 0M **ESPI based on spatial fringe analysis method using only two sheets of speckle patterns** [8788-21]
Y. Arai, Kansai Univ. (Japan); S. Yokozeki, Jyooko Applied Optics Lab. (Japan)

SESSION 5 POLARIZATION-BASED TECHNIQUES

- 8788 0O **Relation between vectorial source structure and coherence-polarization of light** [8788-23]
R. K. Singh, Indian Institute of Space Science and Technology (India); D. N. Naik, Univ. Stuttgart (Germany); H. Itou, M. M. Brundavanam, Y. Miyamoto, The Univ. of Electro-Communications (Japan); M. Takeda, Utsunomiya Univ. (Japan)
- 8788 0P **A polarization-based frequency shifting interferometry for inspecting transparent objects in microelectronics manufacturing** [8788-24]
S. H. Lee, M. Y. Kim, Kyungpook National Univ. (Korea, Republic of)

SESSION 6 HIGH-SPEED TECHNIQUES

- 8788 0Q **Fast and accurate line scanner based on white light interferometry** [8788-25]
P. Lambelet, R. Moosburger, Heliotis AG (Switzerland)
- 8788 0R **High speed measurement of specular surfaces based on carrier fringe patterns in a line scan Michelson interferometer setup** [8788-26]
H. Knell, P. Lehmann, Univ. Kassel (Germany)
- 8788 0S **Speed-up chromatic sensors by optimized optical filters** [8788-27]
M. Taphanel, B. Hovestreydt, Karlsruher Institut für Technologie (Germany); J. Beyerer, Fraunhofer IOF (Germany)

SESSION 7 CONFOCAL SENSORS

- 8788 0T **Robust evaluation of intensity curves measured by confocal microscopies** [8788-28]
J. Seewig, I. Raid, C. Wiehr, B. A. George, Technische Univ. Kaiserslautern (Germany)
- 8788 0U **Model-based assistance system for confocal measurements of rough surfaces** [8788-29]
F. Mauch, W. Lyda, W. Osten, Institute for Technical Optics, Univ. Stuttgart (Germany)
- 8788 0V **Parallelized chromatic confocal sensor systems** [8788-30]
M. Hillenbrand, A. Grewe, M. Bichra, R. Kleindienst, L. Lorenz, R. Kirner, R. Weiß, S. Sinzinger, Technische Univ. Ilmenau (Germany)
- 8788 0W **Robust signal evaluation for Chromatic Confocal Spectral Interferometry** [8788-31]
T. Boettcher, W. Lyda, M. Gronle, F. Mauch, W. Osten, Univ. Stuttgart (Germany)

SESSION 8 MULTISENSOR APPROACHES

- 8788 0X **Measurement, visualization and analysis of extremely large data sets with a nanopositioning and nanomeasuring machine** [8788-32]
O. Birli, K.-H. Franke, G. Linß, T. Machleidt, E. Manske, F. Schale, H.-C. Schwannecke, E. Sparrer, M. Weiß, Technische Univ. Ilmenau (Germany)

- 8788 0Y **Model-based, active inspection of three-dimensional objects using a multi-sensor measurement system** [8788-33]
M. Gronle, W. Lyda, W. Osten, Univ. Stuttgart (Germany)

SESSION 9 FIBER-OPTICS SENSORS

- 8788 0Z **High-frequency optical fiber microphone for condition-based maintenance application** [8788-34]
D. Tosi, Univ. of Limerick (Ireland); M. Olivero, G. Perrone, A. Vallan, Politecnico di Torino (Italy)
- 8788 10 **A space-borne fiber-optic interrogator module based on narrow-band tunable laser diode for temperature monitoring in telecommunication satellites** [8788-35]
P. Putzer, N. Kuhenuri, A. W. Koch, Technische Univ. München (Germany); S. Schweyer, A. Hurni, M. Plattner, Kayser-Threde GmbH (Germany)
- 8788 11 **Miniature low-cost extrinsic Fabry-Perot interferometer for low-pressure detection** [8788-36]
S. Poeggel, D. Tosi, G. Leen, E. Lewis, Univ. of Limerick (Ireland)
- 8788 12 **Applications of tilted fiber Bragg grating in liquid parameters measurement** [8788-37]
B. Jiang, J. Zhao, A. Rauf, C. Qin, W. Jiang, Northwestern Polytechnical Univ. (China)

SESSION 10 FRINGE PROJECTION

- 8788 13 **Experimental comparison of phase-shifting fringe projection and statistical pattern projection for active triangulation systems** [8788-38]
P. Lutzke, Fraunhofer IOF (Germany); M. Schaffer, Friedrich Schiller Univ. (Germany); P. Kühmstedt, Fraunhofer IOF (Germany); R. Kowarschik, Friedrich Schiller Univ. (Germany); G. Notni, Fraunhofer IOF (Germany)
- 8788 14 **Scanning fringe projection for fast 3D inspection** [8788-135]
M. Honegger, M. Kahl, S. Trunz, S. Rinner, A. Etmeyer, NTB Univ. of Applied Sciences (Switzerland); P. Lambelet, Heliotis AG (Switzerland)
- 8788 15 **High-speed 3D shape measurement using array projection** [8788-40]
S. Heist, M. Sieler, A. Breitbarth, P. Kühmstedt, G. Notni, Fraunhofer IOF (Germany)
- 8788 16 **Influence of the structured illumination frequency content on the correspondence assignment precision in stereophotogrammetry** [8788-41]
M. Große, M. Schaffer, B. Harendt, R. Kowarschik, Institute of Applied Optics (Germany)
- 8788 17 **High resolution measurements of filigree, inner geometries with endoscopic micro fringe projection** [8788-42]
C. Ohrt, M. Kästner, E. Reithmeier, Leibniz Univ. Hannover (Germany)

SESSION 11 ASPHERE MEASUREMENT

- 8788 18 **Measurement of aspheres and free-form surfaces in a non-null test interferometer: reconstruction of high-frequency errors** [8788-43]
G. Baer, J. Schindler, Univ. Stuttgart (Germany); J. Siepman, Mahr GmbH (Germany);
C. Pruß, W. Osten, Univ. Stuttgart (Germany); M. Schulz, Physikalisch-Technische
Bundesanstalt (Germany)
- 8788 19 **Non-contact profiling for high precision fast asphere topology measurement** [8788-44]
J. Petter, G. Berger, Lumphos GmbH (Germany)
- 8788 1A **Highly accurate surface maps from profilometer measurements** [8788-45]
K. M. Medicus, J. D. Nelson, M. P. Mandina, Optimax Systems, Inc. (United States)
- 8788 1B **Lateral location error compensation algorithm for measuring aspheric surfaces by sub-aperture stitching interferometry** [8788-46]
Z. Zhao, H. Zhao, F. Gu, L. Zhang, Xi'an Jiaotong Univ. (China)

SESSION 12 DEFLECTOMETRY

- 8788 1C **Deflectometry vs. interferometry (Invited Paper)** [8788-47]
G. Häusler, C. Faber, E. Olesch, S. Ettl, Univ. of Erlangen-Nuremberg (Germany)
- 8788 1D **Approach to the measurement of astronomical mirrors with new procedures** [8788-48]
E. Hofbauer, R. Rascher, Th. Stubenrauch, J. Liebl, R. Maurer, Hochschule Deggendorf
(Germany); A. Zimmermann, Univ. Passau (Germany); O. Rösch, Technische Univ. München
(Germany); J. Reitberger, Micro Epsilon GmbH (Germany)
- 8788 1E **Precision aspheric optics testing with SCOTS: a deflectometry approach** [8788-49]
P. Su, M. Khreishi, R. Huang, T. Su, J. H. Burge, College of Optical Sciences, The Univ. of
Arizona (United States)
- 8788 1F **Methods to obtain the waveform profile from slope measurements** [8788-50]
A. Moreno, Univ. Autònoma de Barcelona (Spain); M. Espínola, INDO Lens Group S.L.U.
(Spain); J. Martínez, J. Campos, Univ. Autònoma de Barcelona (Spain)
- 8788 1G **Moiré deflectometry under incoherent illumination: 3D profiler for specular surfaces**
[8788-51]
T. Hirose, T. Kitayama, Toyota Central R&D Labs., Inc. (Japan)

SESSION 13 MEASUREMENTS OF LARGE-SCALE OBJECTS

- 8788 1H **Optical profilometer using laser based conical triangulation for inspection of inner geometry of corroded pipes in cylindrical coordinates** [8788-52]
P. D. V. Buschinelli, J. C. Melo, A. Albertazzi Jr., Univ. Federal de Santa Catarina (Brazil);
J. M. C. Santos, C. S. Camerini, Cidade Univ. (Brazil)

- 8788 1I **Active retroreflector with in situ beam analysis to measure the rotational orientation in conjunction with a laser tracker** [8788-53]
O. Hofherr, Univ. of Freiburg (Germany); C. Wachten, PI miCos GmbH (Germany); C. Müller, H. Reinecke, Univ. of Freiburg (Germany)
- 8788 1J **Automated control of robotic camera tacheometers for measurements of industrial large scale objects** [8788-54]
T. Heimonen, J. Leinonen, J. Sipola, Kemi-Tornio Univ. of Applied Sciences (Finland)
- 8788 1K **Development of alignment-guidance device for grooved roll mill using parallel projection imaging technique** [8788-55]
T. Kodama, T. Iwata, D. Yamagami, K. Takagi, JFE Steel Corp. (Japan)
- 8788 1L **Photogrammetry based system for the measurement of cylindrical forgings axis straightness** [8788-56]
A. Zatočilová, R. Poliščuk, D. Paloušek, J. Brandejs, Brno Univ. of Technology (Czech Republic)

SESSION 14 LIGHT SCATTERING TECHNIQUES AND LINEWIDTH MEASUREMENT

- 8788 1N **Sub-nanometer in-die overlay metrology: measurement and simulation at the edge of finiteness** [8788-58]
H.-J. H. Smilde, M. Jak, A. den Boef, M. van Schijndel, M. Bozkurt, A. Fuchs, M. van der Schaar, S. Meyer, S. Morgan, K. Bhattacharyya, ASML Netherlands B.V. (Netherlands); G.-T. Huang, C.-M. Ke, K.-H. Chen, TSMC Ltd. (Taiwan)
- 8788 1O **Nanometrology of periodic nanopillar arrays by means of light scattering** [8788-59]
O. Paul, F. Widulle, B. H. Kleemann, A. Heinrich, Carl Zeiss AG (Germany)
- 8788 1P **Phase information in coherent Fourier scatterometry** [8788-60]
N. Kumar, Technische Univ. Delft (Netherlands); O. El Gawhary, Technische Univ. Delft (Netherlands) and VSL Dutch Metrology Institute (Netherlands); S. Roy, S. F. Pereira, H. P. Urbach, Technische Univ. Delft (Netherlands)
- 8788 1Q **Revisiting parallel catadioptric goniophotometers** [8788-61]
B. Karamata, M. Andersen, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8788 1R **Metrology solutions using optical scatterometry for advanced CMOS: III-V and Germanium multi-gate field-effect transistors** [8788-62]
H.-C. Chin, Nanometrics Inc. (United States); B. Liu, X. Zhang, National Univ. of Singapore (Singapore); M.-L. Ling, C.-H. Yip, Y. Liu, J. Hu, Nanometrics Inc. (United States); Y.-C. Yeo, National Univ. of Singapore (Singapore)
- 8788 1S **The road towards accurate optical width measurements at the industrial level** [8788-63]
B. Bodermann, R. Köning, D. Bergmann, E. Buhr, W. Häbeler-Grohne, J. Flügge, H. Bosse, Physikalisch-Technische Bundesanstalt (Germany)

Part Two

SESSION 15 LASER-DOPPLER TECHNIQUES

- 8788 1T **3D shape measurements of fast moving rough surfaces by two tilted interference fringe systems** [8788-64]
R. Kuschmierz, P. Günther, J. W. Czarske, Technische Univ. Dresden (Germany)
- 8788 1U **Optical vibration analysis of MEMS devices with pm-resolution in x, y, and z directions** [8788-65]
M. Giesen, R. Kowarsch, W. Ochs, M. Winter, C. Rembe, Polytec GmbH (Germany)
- 8788 1V **Characterization and demonstration of a 12-channel Laser-Doppler vibrometer** [8788-66]
T. Haist, C. Lingel, W. Osten, Univ. Stuttgart (Germany); K. Bendel, Robert Bosch GmbH (Germany); M. Giesen, M. Gartner, C. Rembe, Polytec GmbH (Germany)

SESSION 16 STRESS, STRAIN, & DISPLACEMENT MEASUREMENT

- 8788 1X **Diagnostic of structures in heat and power generating industries with utilization of 3D digital image correlation** [8788-68]
M. Malesa, M. Kujawinska, K. Malowany, Warsaw Univ. of Technology (Poland); B. Siwek, KSM Vision Ltd. (Poland)
- 8788 1Y **Integrated digital image correlation for residual stress measurement** [8788-69]
A. Baldi, F. Bertolino, Univ. degli Studi di Padova (Italy)
- 8788 1Z **Infrared differential interference contrast microscopy for overlay metrology on 3D-interconnect bonded wafers** [8788-70]
Y. Ku, D.-M. Shyu, Y.-S. Lin, C.-H. Cho, Industrial Technology Research Institute (Taiwan)

POSTER SESSION

- 8788 20 **A lateral sensor for the alignment of two formation-flying satellites** [8788-71]
S. Roose, Y. Stockman, Ctr. Spatial de Liège (Belgium); Z. Sodnik, European Space Agency ESTEC (Netherlands)
- 8788 22 **Analysis of method of 3D shape reconstruction using scanning deflectometry** [8788-73]
J. Novák, P. Novák, A. Mikš, Czech Technical Univ. in Prague (Czech Republic)
- 8788 23 **CO₂ laser photoacoustic spectrometry: sensitivity and drift analysis** [8788-74]
J. Skřínský, VŠB - Technical Univ. of Ostrava (Czech Republic) and J. Heyrovsky Institute of Physical Chemistry of the ASCR, v.v.i. (Czech Republic); Z. Zelinger, J. Heyrovsky Institute of Physical Chemistry of the ASCR, v.v.i. (Czech Republic); T. Hejzlar, Pavel Palát, Bezpečnost práce a požární ochrana (Czech Republic); V. Nevrlý, B. Baudišová, P. Bitala, VŠB - Technical Univ. of Ostrava (Czech Republic)

- 8788 24 **Imaging sensor for monitoring of the piston mechanism in cylindrical valves** [8788-75]
E. N. Pantiushina, A. A. Gorbachev, Saint-Petersburg National Research Univ. of Information Technologies (Russian Federation)
- 8788 25 **Development of program package for investigation and modeling of carbon nanostructures in diamond like carbon films with the help of Raman scattering and infrared absorption spectra line resolving** [8788-76]
D. B. Hayrapetyan, Russian-Armenian State Univ. (Armenia) and State Engineering Univ. of Armenia (Armenia); L. T. Hovhannisyan, State Engineering Univ. of Armenia (Armenia); P. A. Mantashyan, Institute for Physical Research of NAS RA (Armenia)
- 8788 26 **Temperature sensing by modulating phase of optical fiber** [8788-77]
G. Cheng, P. Xu, C. Hong, Y. Cao, F. Zhu, S. Feng, R. Lin, Shenzhen Univ. (China)
- 8788 27 **Real-time visualization and analysis of airflow field by use of digital holography** [8788-78]
J. Di, B. Wu, X. Chen, J. Liu, J. Wang, J. Zhao, Northwestern Polytechnical Univ. (China)
- 8788 28 **Visual and dynamic measurement of temperature fields by use of digital holographic interferometry** [8788-79]
J. Zhao, J. Di, B. Wu, J. Wang, Q. Wang, H. Jiang, Northwestern Polytechnical Univ. (China)
- 8788 29 **Calibration of misalignment aberrations in cylindrical surface interferometric measurement** [8788-80]
J. Peng, D. Ge, Y. Yu, M. Chen, Shanghai Univ. (China)
- 8788 2C **Three-axis optic-electronic autocollimation system for the inspection of large-scale objects** [8788-83]
I. A. Konyakhin, A. N. Timofeev, A. I. Konyakhin, Saint-Petersburg National Research Univ. of Information Technologies (Russian Federation)
- 8788 2D **Optical device for the improvement of positioning accuracy in large machine tools** [8788-84]
L. Cocola, M. Fedel, M. Mocellin, CNR-Institute of Photonics and Nanotechnologies (Italy); R. Casarin, FPT Industrie S.P.A. (Italy); L. Poletto, CNR-Institute of Photonics and Nanotechnologies (Italy)
- 8788 2E **Measurement uncertainty in the profile detection on solar troughs** [8788-85]
P. Sansoni, D. Fontani, F. Francini, CNR-Istituto Nazionale di Ottica (Italy); S. Toccafondi, M. Messeri, Univ. of Florence (Italy); S. Coraggia, L. Mercatelli, D. Jafrancesco, E. Sani, CNR-Istituto Nazionale di Ottica (Italy)
- 8788 2F **The impact of polarization on metrology performance of the lateral shearing interferometer** [8788-86]
Z. Yao, Institute of Optics and Electronics (China) and Univ. of Chinese Academy of Sciences (China); T. Xing, Institute of Optics and Electronics (China)
- 8788 2G **Comparison of Michelson and Linnik interference microscopes with respect to measurement capabilities and adjustment efforts** [8788-87]
P. Kühnhold, W. Xie, P. Lehmann, Univ. Kassel (Germany)

- 8788 2H **Application of line-scanning microscopy using a linear sensor in semiconductor industry: shape and thickness measurements** [8788-88]
M. P. Macedo, Univ. of Coimbra (Portugal) and Instituto Superior de Engenharia de Coimbra (Portugal); C. M. B. A. Correia, Univ. of Coimbra (Portugal)
- 8788 2J **Optical resolution measurement system for small lens by using slanted-slit method** [8788-90]
K.-Y. Huang, C.-M. Chia, National Taiwan Univ. (Taiwan); E. Chang, Genius Electronic Optical Co. (Taiwan)
- 8788 2K **A compensation method of large aperture optical lens for gravity deformation** [8788-91]
L. Yang, Institute of Optics and Electronics (China) and Univ. of the Chinese Academy of Sciences (China); T. Xing, Institute of Optics and Electronics (China); J. Feng, Institute of Optics and Electronics (China) and Univ. of the Chinese Academy of Sciences (China)
- 8788 2L **Reaching accuracies of Lambda/100 with the Three-Flat-Test** [8788-92]
S. Wittek, Karlsruher Institut für Technologie (Germany) and UPC (Spain)
- 8788 2M **Optical measurement system applied to continuous displacement monitoring of long-span suspension bridges** [8788-93]
L. Lages Martins, National Lab. for Civil Engineering (Portugal); J. M. Rebordão, Univ. of Lisbon (Portugal); A. S. Ribeiro, National Lab. for Civil Engineering (Portugal)
- 8788 2N **Small angle light scattering for a glass fibre diameter characterization** [8788-94]
G. Świrniak, G. Głomb, Wrocław Univ. of Technology (Poland)
- 8788 2O **Design and location deviation of the computer generated holograms used for aspheric surface testing** [8788-95]
J. Feng, Institute of Optics and Electronics (China) and Univ. of Chinese Academy of Sciences (China); C. Deng, T. Xing, Institute of Optics and Electronics (China)
- 8788 2P **Laser welding control by monitoring of plasma** [8788-96]
H. Chmelickova, H. Sebestova, M. Havelkova, L. Rihakova, L. Nozka, Joint Lab. of Optics of Palacky Univ. and Institute of Physics of the Academy of Sciences (Czech Republic)
- 8788 2Q **Design of omnidirectional camera lens system with catadioptric system** [8788-98]
J. H. Jo, S. Lee, H. J. Seo, Hannam Univ. (Korea, Republic of); J. H. Lee, J. M. Kim, JM-Tec. Co. Ltd. (Korea, Republic of)
- 8788 2R **Dual view x-ray inspection system for foreign objects detection in canned food** [8788-99]
Z. Lu, N. Peng, Shanghai Gaojing Metal Defector Instrument Co., Ltd. (China)
- 8788 2S **Development of a zero-method interferometer by means of dynamic generation of reference wave front** [8788-100]
R. Hanayama, K. Ishii, The Graduate School for the Creation of New Photonics Industries (Japan)
- 8788 2T **Absolute scale-based imaging position encoder with submicron accuracy** [8788-101]
A. G. Anisimov, A. V. Pantyushin, O. U. Lashmanov, A. S. Vasilev, A. N. Timofeev, V. V. Korotaev, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation); S. V. Gordeev, SKBIS OAO (Russian Federation)

- 8788 2U **CCD camera-based analysis of thin film growth in industrial PACVD processes** [8788-102]
G. Zauner, T. Schulte, C. Forsich, D. Heim, Upper Austria Univ. of Applied Sciences (Austria)
- 8788 2V **Towards superresolution imaging with optical vortex scanning microscope** [8788-103]
J. Masajada, A. Popiołek-Masajada, I. Augustyniak, Wrocław Univ. of Technology (Poland);
B. Sokolenko, Simferopol State Univ. (Ukraine)
- 8788 2W **Image quality improvement using speckle method in digital holography by means of multi-mode fiber** [8788-104]
H. Funamizu, S. Shimoma, Y. Aizu, Muroran Institute of Technology (Japan)
- 8788 2X **Measurement of residual stress fields in FHPP welding: a comparison between DSPI combined with hole-drilling and neutron diffraction** [8788-105]
M. R. Viotti, A. Albertazzi Jr., Univ. Federal de Santa Catarina (Brazil); P. Staron, Institut für Werkstofforschung (Germany); M. Pisa, Ctr. de Pesquisas e Desenvolvimento (Brazil)
- 8788 2Y **Iterative alignment of reflector segments using a laser tracker** [8788-106]
L. Cabrera Cuevas, M. Lucero Alvarez, A. Leon-Huerta, E. Hernandez Rios, J. Hernandez Lázaro, C. Tzile Torres, D. Castro Santos, D. M. Gale, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); G. Wilson, G. Narayanan, Univ. of Massachusetts (United States);
D. R. Smith, Mechanical Engineering Research Lab. (United States)
- 8788 2Z **Tilted objects EFI in digital holography by two different numerical approaches** [8788-107]
M. Matrecano, M. Paturzo, P. Ferraro, CNR-Istituto Nazionale di Ottica (Italy)
- 8788 31 **Non-Bayesian noise reduction in digital holography by random resampling masks** [8788-109]
V. Bianco, M. Paturzo, CNR-Istituto Nazionale di Ottica (Italy); P. Memmolo, CNR-Istituto Nazionale di Ottica (Italy) and Istituto Italiano di Tecnologia (Italy); A. Finizio, CNR-Istituto Nazionale di Ottica (Italy); B. Javidi, Univ. of Connecticut (United States); P. Ferraro, CNR-Istituto Nazionale di Ottica (Italy)
- 8788 32 **Research of autocollimating angular deformation measurement system for large-size objects control** [8788-110]
T. V. Turgaliev, I. A. Konyakhin, Saint-Petersburg National Research Univ. of Information Technologies (Russian Federation)
- 8788 33 **Design and experiment of testing an off-axis aspheric surface by computer generated hologram** [8788-111]
S. Li, Institute of Optics and Electronics (China) and Univ. of Chinese Academy of Sciences (China); F. Wu, Q. Chen, B. Fan, L. Li, Institute of Optics and Electronics (China)
- 8788 34 **Spectral monitoring of toluene and ethanol in gasoline blends using Fourier-Transform Raman spectroscopy** [8788-112]
V. Ortega Clavero, Univ. of Applied Sciences Offenburg (Germany) and Univ. of Strasbourg (France); A. Weber, W. Schröder, D. Curticepean, Univ. of Applied Sciences Offenburg (Germany); P. Meyrueis, N. Javahiraly, Univ. of Strasbourg (France)
- 8788 35 **Reflection, transmission and color measurement system for the online quality control of float glass coating process** [8788-113]
I. Mamedbeili, F. Cakiroglu, G. Bektas, D. Riza, F. Hacizade, TUBITAK-BILGEM (Turkey)

- 8788 36 **Energetic sensitivity of optical-electronic systems based on polychromatic optical equisignal zone** [8788-114]
A. A. Maraev, A. N. Timofeev, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation)
- 8788 37 **Automatic unit for measuring refractive index of air based on Ciddor equation and its verification using direct interferometric measurement method** [8788-115]
V. Hucl, M. Čížek, J. Hrabina, B. Mikel, Š. Řeřucha, Z. Buchta, P. Jedlička, A. Lešundák, J. Oulehla, L. Mrňa, M. Šarbort, R. Šmíd, J. Lazar, O. Číp, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic)
- 8788 39 **Alignment of a large outdoor antenna surface using a laser tracker** [8788-117]
A. Leon-Huerta, M. Lucero Alvarez, E. Hernandez Rios, C. Tzile Torres, L. Cabrera Cuevas, D. Castro Santos, J. Hernandez Lázaro, D. M. Gale, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); G. Wilson, G. Narayanan, Univ. of Massachusetts (United States)
- 8788 3A **Iterative improvements to the surface error of a 1.7 metre aluminium reflector** [8788-118]
D. Castro Santos, L. Cabrera Cuevas, E. Hernandez Rios, D. M. Gale, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); D. R. Smith, Mechanical Engineering Research Lab. (United States)
- 8788 3B **Efficient testing methodologies for microcameras in a gigapixel imaging system** [8788-119]
S. H. Youn, D. L. Marks, Duke Univ. (United States); P. O. McLaughlin, RPC Photonics (United States); D. J. Brady, J. Kim, Duke Univ. (United States)
- 8788 3C **Wavelength modulation-based method for interference phase detection with reduced optical complexity** [8788-120]
Š. Řeřucha, M. Šarbort, Z. Buchta, B. Mikel, R. Šmíd, M. Čížek, P. Jedlička, J. Řeřucha, J. Lazar, O. Číp, Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic)
- 8788 3D **Camera-based curvature measurement of a large incandescent object** [8788-121]
A. V. H. Ollikkala, T. P. Kananen, A. J. Mäkynen, Univ. of Oulu (Finland); M. Holappa, Rautaruukki Oyj (Finland)
- 8788 3E **Design and analysis of a low-cost compensated POF displacement sensor for industrial applications** [8788-122]
D. Tosi, Univ. of Limerick (Ireland); M. Olivero, G. Perrone, A. Vallan, Politecnico di Torino (Italy)
- 8788 3F **Digital holographic microscopy for the study of nano-fibers** [8788-123]
H. H. Wahba, Damietta Univ. (Egypt) and Luleå Univ. of Technology (Sweden); M. Sjö Dahl, P. Gren, E. Olsson, Luleå Univ. of Technology (Sweden)
- 8788 3G **Implementation of a fringe visibility based algorithm in coherence scanning interferometry for surface roughness measurement** [8788-124]
P. C. Montgomery, F. Salzenstein, D. Montaner, B. Serio, P. Pfeiffer, Lab. des Sciences de l'Ingénieur, de l'Informatique et de l'Imagerie (France)
- 8788 3H **Turbine-blade tip clearance and tip timing measurements using an optical fiber bundle sensor** [8788-125]
I. Garcia, Univ. of the Basque Country (Spain); J. Beloki, Aeronautical Technologies Ctr. (Spain); J. Zubia, G. Durana, G. Aldabaldetrekú, Univ. of the Basque Country (Spain)

- 8788 3I **Precision positioning with suppression of the influence of refractive index of air** [8788-126]
M. Holá, J. Hrabina, J. Oulehla, M. Čížek, B. Mikel, Š. Řeřucha, Z. Buchta, O. Číp, J. Lazar,
Institute of Scientific Instruments of the ASCR, v.v.i. (Czech Republic)
- 8788 3J **Static and (quasi)dynamic calibration of stroboscopic scanning white light interferometer**
[8788-127]
J. Seppä, Ctr. for Metrology and Accreditation (Finland); I. Kassamakov, A. Nolvi, Univ. of
Helsinki (Finland); V. Heikkinen, Ctr. for Metrology and Accreditation (Finland); T. Paulin,
Univ. of Helsinki (Finland); A. Lassila, Ctr. for Metrology and Accreditation (Finland); L. Hao,
National Physical Laboratory (United Kingdom); E. Hæggsröm, Univ. of Helsinki (Finland)
- 8788 3K **Computed tomography of cylindrically symmetric object by use of digital holography**
[8788-128]
Z. Pan, Jinan Univ. (China) and South China Agricultural Univ. (China); S. Li, J. Zhong, Jinan
Univ. (China)
- 8788 3M **Stimulated LIF studied using pulsed digital holography and modelling** [8788-130]
E. Amer, Luleå Univ. of Technology (Sweden) and Zagazig Univ. (Egypt); J. Stenvall,
P. Gren, M. Sjödaahl, Luleå Univ. of Technology (Sweden)
- 8788 3O **Surface normal deblurring caused by conveyor movement for fast surface inspection**
[8788-132]
T. Kurihara, Y. Katsuki, S. Ando, Univ. of Tokyo (Japan)
- 8788 3P **Tape measuring system using linear encoder and digital camera** [8788-133]
T. B. Eom, D. Y. Jeong, M. S. Kim, J. W. Kim, J. A. Kim, Korea Research Institute of Standards
and Science (Korea, Republic of)
- 8788 3Q **Automated hardware and software complex for extended light sources verification**
[8788-134]
E. V. Gorbunova, V. S. Peretyagin, A. N. Chertov, National Research Univ. of Information
Technologies, Mechanics and Optics (Russian Federation)

Author Index

Conference Committee

Symposium Chairs

Wolfgang Osten, Universität Stuttgart (Germany)
Karsten Buse, Fraunhofer-Institut für Physikalische
Messtechnik IPM (Germany)
Andrew J. Moore, Heriot-Watt University (United Kingdom)

Conference Chair

Peter H. Lehmann, Universität Kassel (Germany)

Conference Co-chairs

Wolfgang Osten, Universität Stuttgart (Germany)
Armando Albertazzi, Universidade Federal de Santa Catarina (Brazil)

Conference Programme Committee

Astrid Aksnes, Norwegian University of Science and Technology
(Norway)
Oleg Vyacheslavovich Angelsky, Yuriy Fedkovych Chernivtsi National
University (Ukraine)
Anand Krishna Asundi, Nanyang Technological University (Singapore)
Klaus-Friedrich Beckstette, Carl Zeiss AG (Germany)
Ralf B. Bergmann, Bremer Institut für angewandte Strahltechnik GmbH
(Germany)
Harald Bosse, Physikalisch-Technische Bundesanstalt (Germany)
Karsten Buse, Rheinische Friedrich-Wilhelms- Universität Bonn
(Germany)
Yuri V. Chugui, Technological Design Institute of Scientific Instrument
Engineering (Russian Federation)
Wim M. J Coene, ASML Netherlands B.V. (Netherlands)
Jürgen W. Czarske, Technische Universität Dresden (Germany)
Peter J. de Groot, Zygo Corporation (United States)
Pietro Ferraro, Istituto Nazionale di Ottica (Italy)
Cosme Furlong, Worcester Polytechnic Institute (United States)
Marc P. Georges, Université de Liège (Belgium)
Christophe Gorecki, FEMTO-ST (France)
Andreas Heinrich, Carl Zeiss AG (Germany)
Richard M. Kowarschik, Friedrich-Schiller- Universität Jena (Germany)
Malgorzata Kujawinska, Warsaw University of Technology (Poland)
Eberhard Manske, Technische Universität Ilmenau (Germany)

Fernando Mendoza Santoyo, Centro de Investigaciones en Óptica,
A.C. (Mexico)
Andrew John Moore, Heriot-Watt University (United Kingdom)
Gunther Notni, Fraunhofer-Institut für Angewandte Optik und
Feinmechanik (Germany)
Ryszard J. Pryputniewicz, Worcester Polytechnic Institute (United
States)
Eduard Reithmeier, Leibniz Universität Hannover (Germany)
Christian Rembe, Polytec GmbH (Germany)
Robert Schmitt, RWTH (Germany)
Jörg Seewig, Technische Universität Kaiserslautern (Germany)
Pierre Slangen, Ecole des Mines d'Alès (France)
Marcus Steinbichler, Steinbichler Optotechnik GmbH (Germany)
Mitsuo Takeda, The University of Electro-Communications (Japan)
Cristina Trillo, Universidad de Vigo (Spain)
Rainer Tutsch, Technische Universität Braunschweig (Germany)

Introduction

In 2013, optical metrology systems are well-established and do their job reliably in many fields of industrial inspection. Most measurement systems are based on similar sets of optical standard components. The basics of optical measurement techniques are widely understood and the limitations of optical principles are generally well-known.

So, why is a conference on “Optical Measurement Systems for Industrial Inspection” really needed? The answer is that there are still enough measurement problems to be solved and often optical metrology provides the only promising solutions. Industrial production processes are gaining complexity, precision and speed. Industrial products are becoming continuously more demanding. They require higher and higher accuracy in all three dimensions. At the same time, measuring speed should be increased and measurement systems come closer to production. These demands steadily stimulate the search for new or improved measurement methods, strategies and configurations. Novel components help researchers to meet these industrial requirements. In addition, powerful software tools, e.g. optics design and simulation software, enable to understand, layout, and optimize complex optical systems.

Therefore, the Munich conference still represents an important international forum of scientific exchange and discussion. More than 150 submissions show that the Munich conference series, which was established more than 12 years ago, is a considerable event for researchers working in the field of optical metrology all over the world. With more than 70 oral presentations and more than 60 posters, the 2013 conference could hold the high number and outstanding level of contributions, which made it as successful as it is.

Traditionally, a large number of contributions address optical measurement of three-dimensional geometrical features. The methods focus on both, coherent techniques such as holography and interferometry, as well as incoherent methods like structured light, confocal techniques, or deflectometry.

Since the measuring objects reach from the micrometer or even sub-micrometer range to dimensions of several meters, in this year's conference, there are sessions on large scale objects on the one hand, on light scattering techniques and line-width measurements dealing with smallest structures on the other. A field of application, which still remains in the focus of the conference, is the measurement of optical components, e.g. aspheres, free-form surfaces, and optical systems. And not only here, but in general, it is a basic concern of the conference since its beginnings to address those techniques that go beyond the limits of current optical instruments.

Since it is the people who move things forward, we would like to thank those who supported this conference.

First, we would like to express our sincere gratitude to the program committee for their support in the run-up of the conference. We also thank all authors, especially the distinguished invited speakers: Ibrahim Abdulhalim (Ben-Gurion Univ. of the Negev, Israel), Gerd Häusler (Friedrich-Alexander-Univ. Erlangen-Nürnberg, Germany) and Angela Duparré (Fraunhofer-Institut für Angewandte Optik und Feinmechanik, Jena, Germany) for their stimulating lectures on "Low coherence full field interference microscopy or optical coherence tomography: recent advances, limitations and future trends" (I. Abdulhalim), "Deflectometry vs. interferometry" (G. Häusler) and "Light scattering techniques for efficient surface quality control" (A. Duparré).

Finally, many thanks are due to the SPIE staff for their excellent and cooperative work during the conference organization and the preparation of these proceedings. Thanks are also due to all authors, who not only fill the conference with life, but also give added value to this proceedings volume.

Peter H. Lehmann
Wolfgang Osten
Armando Albertazzi