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Interferometry XIV: Techniques and Analysis

**Joanna Schmit
Katherine Creath
Catherine E. Towers**
Editors

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Contents

- ix *Conference Committee*
- xi *Introduction*
- xv *Advanced and shaped light fields for the biosciences (Invited Paper) (Abstract Only)* [7063-02]
K. Dholakia, Univ. of St. Andrews (United Kingdom)

SESSION 1 ON THE FRINGE

- 7063 02 **It's a (meta)material world! The final frontier? (Invited Paper)** [7063-01]
A. D. Boardman, R. C. Mitchell-Thomas, Y. G. Rapoport, N. J. King, Univ. of Salford (United Kingdom)
- 7063 03 **Advanced and shaped light fields for the biosciences (Invited Paper)** [7063-02]
K. Dholakia, Univ. of St. Andrews (United Kingdom)
- 7063 04 **Coarse frequency comb interferometry (Invited Paper)** [7063-03]
J. Schwider, Institute of Optics, Information and Photonics, Max Planck Research Group (Germany)
- 7063 05 **Generalized quantitative approach to two-beam fringe visibility (coherence) with different polarizations and frequencies** [7063-04]
C. Roychoudhuri, Univ. of Connecticut (United States) and Femto Macro Continuum (United States); A. M. Barootkoob, Consultant (United States)

SESSION 2 SPATIAL AND SHEARING TECHNIQUES

- 7063 06 **Spatially phase-shifted digital speckle pattern interferometry (SPS-DSPI) and cryogenic structures: recent improvements (Invited Paper)** [7063-05]
P. Blake, NASA Goddard Space Flight Ctr. (United States); P. Greenfield, W. Hack, J. T. Miller, I. Busko, B. Saif, B. Eegholm, Space Telescope Science Institute (United States); R. Keski-Kuha, NASA Goddard Space Flight Ctr. (United States); M. Bluth, ATK Spacecraft Systems (United States)
- 7063 07 **Instantaneous phase-shift Fizeau interferometer utilizing a synchronous frequency shift mechanism** [7063-06]
B. Kimbrough, E. Frey, J. Millerd, 4D Technology Corp. (United States)
- 7063 08 **Development of a multi-component shearography instrument for surface strain measurement on dynamic objects** [7063-07]
D. Francis, S. W. James, R. P. Tatam, Cranfield Univ. (United Kingdom)

- 7063 09 **Optical wavefront sensor based on sub-wavelength metallic structures** [7063-08]
R. Haïdar, B. Toulon, ONERA/DOTA (France); G. Vincent, ONERA/DOTA (France) and LPN/CNRS (France); S. Collin, LPN/CNRS (France); S. Velghe, Phasics (France); J. Primot, ONERA/DOTA (France); J.-L. Pelouard, LPN/CNRS (France)

SESSION 3 SPECKLE AND UNWRAPPING TECHNIQUES

- 7063 0A **A dynamic in-plane deformation measurement using virtual speckle patterns (Invited Paper)** [7063-09]
Y. Arai, R. Shimamura, Kansai Univ. (Japan); S. Yokozeki, Jyouko Applied Optics Lab. (Japan)
- 7063 0B **The spatial degree of polarization and the first-order statistical properties of polarization speckle** [7063-10]
W. Wang, Heriot-Watt Univ. (United Kingdom); A. Matsuda, The Univ. of Electro-Communications (Japan); S. G. Hanson, Technical Univ. of Denmark (Denmark); M. Takeda, The Univ. of Electro-Communications (Japan)
- 7063 0C **Lockin-speckle-interferometry for non-destructive testing** [7063-11]
P. Menner, H. Gerhard, G. Busse, Univ. of Stuttgart (Germany)
- 7063 0D **Denoising of digital speckle pattern interferometry fringes by means of Bidimensional Empirical Mode Decomposition** [7063-12]
M. B. Bernini, Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina) and Univ. Nacional de Rosario (Argentina); A. Federico, Instituto Nacional de Tecnología Industrial (Argentina); G. H. Kaufmann, Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina) and Univ. Nacional de Rosario (Argentina)
- 7063 0E **Filtering-based phase unwrapping** [7063-13]
K. Qian, W. Gao, H. Wang, Nanyang Technological Univ. (Singapore)

SESSION 4 DIGITAL HOLOGRAPHY AND HETERODYNE TECHNIQUES

- 7063 0F **Investigations and improvements of digital holographic tomography applied for 3D studies of transmissive photonics microelements (Invited Paper)** [7063-14]
M. Kujawinska, A. Jozwicka, T. Kozacki, Warsaw Univ. of Technology (Poland)
- 7063 0G **Strain distribution measurement by digital holographic interferometry using three spherical waves** [7063-15]
M. Fujigaki, K. Shiotani, R. Kido, Y. Morimoto, Wakayama Univ. (Japan)
- 7063 0H **Modeling and optical characterization of vibrating micro- and nanostructures (Invited Paper)** [7063-16]
A. Aksnes, E. Leirset, H. Martinussen, H. E. Engan, Norwegian Univ. of Science and Technology (Norway)
- 7063 0I **Real-time vibration amplitude and phase imaging with heterodyne interferometry and correlation image sensor** [7063-17]
S. Sato, T. Kurihara, S. Ando, The Univ. of Tokyo (Japan)

7063 OJ **Laser confocal feedback profilometry** [7063-18]
X. Wan, S. Zhang, Z. Ren, Tsinghua Univ. (China)

SESSION 5 PHASE ANALYSIS AND FRINGE PROJECTION TECHNIQUES

7063 OK **New algorithms and error analysis for sinusoidal phase shifting interferometry (Invited Paper)** [7063-19]
P. J. de Groot, L. L. Deck, Zygo Corp. (United States)

7063 OL **Iterative algorithm for phase shifting interferometry with finite bandwidth illumination** [7063-20]
F. Munteanu, J. Schmit, Veeco Instruments Inc. (United States)

7063 OM **Simultaneous geometry and color texture acquisition using a single-chip color camera** [7063-21]
S. Zhang, Iowa State Univ. (United States); S.-T. Yau, Harvard Univ. (United States)

7063 ON **Shape and colour measurement of colourful objects by fringe projection** [7063-22]
Z. Zhang, C. E. Towers, D. P. Towers, Univ. of Leeds (United Kingdom)

7063 OO **Moiré topography using a liquid-crystal-grating based frequency modulation technique** [7063-23]
F. Kobayashi, Y. Otani, Tokyo Univ. of Agriculture and Technology (Japan); T. Yoshizawa, Saitama Medical Univ. (Japan)

SESSION 6 THICKNESS MEASUREMENT

7063 OP **Fizeau interferometer for quasi parallel optical plate testing** [7063-24]
A. Styk, K. Patorski, Warsaw Univ. of Technology (Poland)

7063 OQ **Angle-resolved reflectometer for thickness measurement of multi-layered thin-film structures** [7063-25]
W.-D. Joo, J. You, Y.-S. Ghim, S.-W. Kim, Korea Advanced Institute of Science and Technology (Korea, Republic of)

7063 OR **Uncertainty analysis on the absolute thickness of a cavity using a commercial wavelength scanning interferometer** [7063-26]
A. Suratkar, Y.-S. Ghim, A. Davies, Univ. of North Carolina at Charlotte (United States)

7063 OS **Measurement of absolute optical thickness distribution of a mask-glass by wavelength tuning interferometry** [7063-27]
K. Hibino, National Institute of Advanced Industrial Science and Technology (Japan); K. Yangjin, Univ. of Tokyo (Japan); Y. Bitou, S. Ohsawa, National Institute of Advanced Industrial Science and Technology (Japan); N. Sugita, M. Mitsuishi, Univ. of Tokyo (Japan)

SESSION 7 MULTI WAVELENGTH INTERFEROMETRY

- 7063 OT **Dual frequency sweeping interferometry with range-invariant accuracy for absolute distance metrology (Invited Paper)** [7063-28]
A. Cabral, J. M. Rebordão, M. Abreu, INETI – Instituto Nacional de Engenharia, Tecnologia e Inovação (Portugal)
- 7063 OU **Micro Fabry-Perot sensor for surface measurement** [7063-29]
A. Brunfeld, G. Toker, M. T. Roscrow, Jr., B. Clark, Xyratex International Inc. (United States)
- 7063 OV **Optimum wavelength selection for the method of excess fractions** [7063-30]
K. Falaggis, D. P. Towers, C. E. Towers, Univ. of Leeds (United Kingdom)
- 7063 OW **Multiple wavelength interferometry for surface profiling** [7063-47]
U. Paul Kumar, N. Krishna Mohan, M. P. Kothiyal, Indian Institute of Technology Madras (India)
- 7063 OX **A hybrid technique for ultra-high dynamic range interferometry** [7063-32]
K. Falaggis, D. P. Towers, C. E. Towers, Univ. of Leeds (United Kingdom)

SESSION 8 COMPLEX STRUCTURES AND ULTRA SHORT PULSE MEASUREMENT

- 7063 OY **Surface profile detection of nanostructures using a Mueller matrix polarimeter** [7063-33]
Y. Otani, T. Kuwagaito, Y. Mizutani, Tokyo Univ. of Agriculture and Technology (Japan)
- 7063 OZ **3D profilometer employing white-light interferometry for microstructures with large-bevel inclines in brightness-enhanced films** [7063-34]
W. C. Wang, Y. J. Su, S. H. Kuo, Industrial Technology Research Institute (Taiwan)
- 7063 10 **Surface metrology of silicon wafers using a femtosecond pulse laser** [7063-35]
T. Kwon, K.-N. Joo, S.-W. Kim, Korea Advanced Institute of Science and Technology (Korea, Republic of)
- 7063 11 **Noncollinear autocorrelation with radially symmetric nondiffracting beams** [7063-36]
S. Huferath-von Luepke, Bremen Institute of Applied Beam Technology (Germany);
V. Kebbel, bwm GmbH (Germany); M. Bock, S. Kumar Das, R. Grunwald, Max-Born-Institute for Nonlinear Optics and Short-Pulse Spectroscopy (Germany)

SESSION 9 TESTING OF ASPHERIC SURFACES

- 7063 12 **Testing of a diamond-turned off-axis parabolic mirror (Invited Paper)** [7063-37]
J. Burke, CSIRO Materials Science and Engineering-Australian Ctr. for Precision Optics (Australia); K. Wang, A. Bramble, Macquarie Univ. (Australia)
- 7063 13 **Distortion mapping correction in aspheric null testing** [7063-38]
M. Novak, C. Zhao, J. H. Burge, College of Optical Sciences, The Univ. of Arizona (United States)

- 7063 14 **Interferometric null test of a parabolic reflector generating a Hertzian dipole field** [7063-39]
G. Leuchs, K. Mantel, A. Berger, H. Konermann, M. Sondermann, U. Peschel, N. Lindlein, J. Schwider, Institute of Optics, Information, and Photonics, Univ. of Erlangen/Nuremberg (Germany)
- 7063 15 **Optical testing by means of one-dimensional interferograms performed with a point-diffraction interferometer** [7063-41]
L. Rodríguez-Castillo, F. S. Granados-Agustín, A. Cornejo-Rodríguez, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)

SESSION 10 TESTING OF ASPHERIC SURFACES AND WAVEFRONT COLLIMATION

- 7063 16 **Stitching of off-axis sub-aperture null measurements of an aspheric surface** [7063-40]
C. Zhao, J. H. Burge, College of Optical Sciences, The Univ. of Arizona (United States)
- 7063 17 **Measurements of aspheric surfaces** [7063-56]
P. Szwaykowski, R. Castonguay, Engineering Synthesis Design (United States)
- 7063 18 **Wide dynamic beam size range lateral-shear interferometer** [7063-45]
K. U. Hii, K. H. Kwek, Univ. of Malaya (Malaysia)

POSTER SESSION

- 7063 19 **Interferometer design for optical stochastic cooling demonstration at Bates** [7063-42]
J. Hays-Wehle, W. Franklin, F. X. Kärtner, J. van der Laan, R. Milner, A. Siddiqui, C. Tschalär, F. Wang, Massachusetts Institute of Technology (United States)
- 7063 1A **Optical heterodyne laser encoder for in-plane nanopositioning** [7063-48]
C.-C. Wu, C.-C. Hsu, Industrial Technology Research Institute (Taiwan); J.-Y. Lee, National Central Univ. (Taiwan); C.-Y. Liu, Industrial Technology Research Institute (Taiwan)
- 7063 1B **Temporal phase detection of interferograms without frequency carrier** [7063-49]
J. C. Estrada, M. Servin, D. Arroyo, Ctr. de Investigaciones en Óptica (Mexico)
- 7063 1C **Spatial coherence wavelets and the phase-space representation of holography** [7063-51]
R. Betancur, R. Castañeda, J. Restrepo, Univ. Nacional de Colombia Sede Medellín (Colombia)
- 7063 1D **Method for distant diagnostics of layered media inner structure** [7063-53]
A. L. Kalyanov, V. V. Lychagov, D. V. Lyakin, Saratov State Univ. (Russia); V. P. Ryabukho, Saratov State Univ. (Russia) and Institute of Precision Mechanics and Control (Russia)
- 7063 1E **Dynamic measurement of strain in test specimen by fringe projection** [7063-54]
A. León-Huerta, A. Martínez, J. A. Rayas, Ctr. de Investigaciones en Óptica (Mexico); R. Cordero, Univ. de Santiago de Chile (Chile)
- 7063 1F **An ESPI technique based on panoramic interferometry with paraboloid mirrors** [7063-55]
A. Soto, J. B. Hurtado-Ramos, L. Reséndiz, J. J. González Barbosa, Ctr. de Investigación en Ciencia Aplicada y Tecnología Avanzada-IPN Unidad Querétaro (Mexico)

Author Index

Conference Committee

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- 1 On the Fringe
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- 2 Spatial and Shearing Techniques
Mitsuo Takeda, The University of Electro-Communications (Japan)
- 3 Speckle and Unwrapping Techniques
Catherine E. Towers, University of Leeds (United Kingdom)
- 4 Digital Holography and Heterodyne Techniques
Werner P. O. Jüptner, Bremer Institut für Angewandte Strahltechnik (Germany)
- 5 Phase Analysis and Fringe Projection Techniques
Jan Burke, Commonwealth Scientific and Industrial Research Organisation, Materials Science and Engineering (Australia)
- 6 Thickness Measurement
Astrid Aksnes, Norwegian University of Science and Technology (Norway)
- 7 Multi Wavelength Interferometry
Johannes Schwider, Friedrich-Alexander-Universität Erlangen-Nürnberg (Germany)
- 8 Complex Structures and Ultra Short Pulse Measurement
Joanna Schmit, Veeco Instruments Inc. (United States)
- 9 Testing of Aspheric Surfaces
Seung-Woo Kim, Korea Advanced Institute of Science and Technology (Korea, Republic of)
- 10 Testing of Aspheric Surfaces and Wavefront Collimation
Seung-Woo Kim, Korea Advanced Institute of Science and Technology (Korea, Republic of)

Introduction

We thank SPIE, the program committee, the authors, and everyone attending this conference. SPIE continues to provide a forum for exchange of ideas and dissemination of the latest research in interferometry and related fields. As a community we come together at conferences such as this one to share not only our work, but also our professional vision. We reacquaint ourselves with old friends and meet new colleagues. The value of these conferences comes from both the professional insight we gain and the relationships we foster.

Interferometry XIV, which is a continuation of the Interferometry series, consists of two complementary conferences, one dedicated to Techniques and Analysis and the other to Applications. These two conferences present recent developments in analyses and techniques that use interference and projection fringes for highly precise measurements of different objects and their application in a wide range of systems. The proceedings of the two conferences comprising Interferometry XIV are published in two separate volumes as *Interferometry XIV: Techniques and Analysis* (SPIE Proceedings Vol. 7063) and *Interferometry XIV: Applications* (SPIE Proceedings Vol. 7064).

The growing demand for accurate and repeatable measurements of increasingly complex devices, especially in the semiconductor and MEMS industries as well as biological and space sciences, has driven the field of optical metrology to develop innovative techniques that provide fast, precise, real-time assessments of industrial products. While the range of techniques and technologies in interferometry is already vast, researchers strive to find solutions to new challenges that help make invisible things visible and to extend our vision further into outer space as well as into the nano-world.

This conference on Interferometric Techniques and Analysis highlights developments in surface metrology, digital holography, speckle, pulsed and polarization techniques, temporal and spatial phase shifting, low coherence interferometry, multiple wavelength, and fringe projection techniques. Other topics include new developments in vibration insensitive techniques and techniques for the measurement of aspheric surfaces, film thicknesses, surface motion, and stress. In addition, we spotlight cutting-edge papers on optical fields manipulation in a session titled "On the Fringe."

We are pleased to present a conference with such a large number of excellent papers. This proceedings volume contains 50 papers presented at the SPIE Optics and Photonics Meeting in San Diego on August 11–13, 2008. 43 of these papers were presented orally. These papers represent the work of researchers from 20 countries and four continents with invited speakers from the United Kingdom, Japan, Germany, the United States, Poland, Norway, Portugal, and Australia.

During the last conference we had a great time choosing our favorite fringe patterns from those submitted by attendees. The favorite turned out to be distorted fringes reflected from a water surface and then analyzed by the fringe reflection technique presented by Thorsten Bothe from BIAS, Germany (Bremer Institute für Angewandte Strahltechnik) (see Figs. 1 and 2).



Fig.1 Periodic line structure on the side of the building. Top part of winning Fringe Art competition photo taken by T. Bothe from BIAS, Germany.



Fig. 2 Reflection fringes of periodic line structure on the building in Fig1. Bottom part of photo taken by T. Bothe.

Many of us are drawn to the images of fringes in our everyday lives, for observing fringes in our surroundings is, one may say, our professional deviation. With this conference we have continued the biannual "Fringe Art" competition to share our favorite fringe patterns. The winner will be announced in the next conference proceedings.

Until the next Interferometry conference, may you continue to see fringe patterns everywhere.

Joanna Schmit
Katherine Creath
Catherine Towers

Advanced and shaped light fields for the biosciences

Kishan Dholakia

SUPA, School of Physics and Astronomy, University of St Andrews,
Fife KY16 9SS, Scotland
e-mail:kd1@st-and.ac.uk

Advanced photonics using novel holographic beam shaping and interferometry has proved to be a powerful and emergent area in biophotonics. Light may be used in various guises. A prime example is optical micromanipulation. This is a powerful non-contact technique where micrometre sized particles can be grabbed, moved and generally manipulated solely with light. Optical tweezers is the most popular way to implement these forces using a single tightly focused light beam. They have forged an important bridge between physics, chemistry and biology. In recent years there has been a proliferation of activity in this area, fuelled, in part, by the recognition that we need to advance the “optical toolkit”. This essentially means creating more elaborate 2D and 3D light patterns (beam shaping) that can create an optical landscape. Particle and cellular motion on such a landscape will enhance our ability to move and sort particles and importantly, create 2D and 3D arrays of particles [1].

Advanced beam shaping may also be considered useful for the topic of cell transfection. Here we consider the cell membrane which represents the outer extremity of all eukaryotic cells. In mammals, this is a thin (5nm) bi-layer film of lipids, embedded with various protein molecules at interspersed locations. Under normal circumstances, the lipid nature of the cell membrane acts as an impermeable barrier to the passage of most water-soluble molecules. Thus, the selective introduction of therapeutic agents to the inside of dysfunctional or diseased cells remains problematic. Methods for puncturing the cell membrane without causing any collateral damage have been devised and importantly, this includes laser-assisted techniques particularly using multi-photon processes. Bessel modes can be used for “focus-free” photoporation (see fig.1) and offer new opportunities for the field [2]. This talk will cover both aspects of optical trapping, sorting and cell transfection using advanced beam shaping and interferometry.

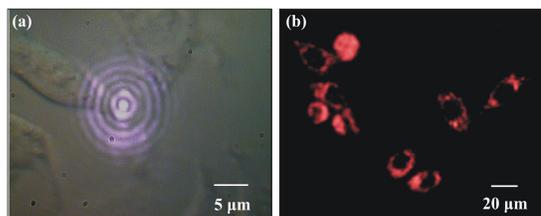


Figure 1. (a) The Bessel beam “focus” is positioned on the cell plane. (b) Upon successful transfection, the cells express the red fluorescent protein and fluoresce red (adapted from reference 2)

[1] “Optical Micromanipulation” K. Dholakia, P Reece and M Gu Chem. Soc. Rev, **37**, 42 - 55 (2008)

[2] “Femtosecond cellular transfection using a non-diffracting light beam” X. Tsampoula, V. Garcés-Chávez, M. Comrie, D. Stevenson, M.B. Agate, F.J. Gunn-Moore, C.T.A. Brown and K Dholakia, Appl Phys Lett **91**, 053902 (2007).

