

PROCEEDINGS OF SPIE

***Instrumentation, Metrology,  
and Standards for  
Nanomanufacturing IV***

**Michael T. Postek  
John A. Allgair**  
*Editors*

**2–4 August 2010  
San Diego, California, United States**

*Sponsored by*  
SPIE

*Technical Cosponsor*  
National Institute of Standards and Technology (United States)

*Published by*  
SPIE

**Volume 7767**

Proceedings of SPIE, 0277-786X, v. 7767

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

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 *Instrumentation, Metrology, and Standards for Nanomanufacturing IV*, edited by Michael T. Postek, John A. Allgair, Proceedings of SPIE Vol. 7767 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 0277-786X

ISBN 9780819482631

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 © 2010, 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/10/\$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 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

vii *Conference Committee*

---

## NANOMANUFACTURING METROLOGY I

---

- 7767 04 **Fabrication of 3D nanostructures with lithographically patterned surfaces by self-folding** [7767-03]  
J.-H. Cho, T. James, D. H. Gracias, The Johns Hopkins Univ. (United States)
- 7767 05 **Development of a high-speed profilometer for manufacturing inspection** [7767-04]  
D. M. Ljubicic, B. Anthony, Massachusetts Institute of Technology (United States)

---

## INSTRUMENTATION AND METROLOGY I

---

- 7767 07 **Nanometer-level alignment using interferometric-spatial-phase-imaging (ISPI) during silicon nanowire growth** [7767-07]  
P. Srisungsitthisunti, Purdue Univ. (United States); E. E. Moon, Massachusetts Institute of Technology (United States); C. Tansarawiput, H. Zhang, M. Qi, X. Xu, Purdue Univ. (United States)
- 7767 08 **Assessment of the mechanical integrity of silicon and diamond-like-carbon coated silicon atomic force microscope probes** [7767-08]  
J. Liu, D. S. Grierson, K. Sridharan, Univ. of Wisconsin-Madison (United States); R. W. Carpick, Univ. of Pennsylvania (United States); K. T. Turner, Univ. of Wisconsin-Madison (United States)

---

## NANOMETROLOGY: STANDARDS

---

- 7767 0C **Reference metrology for nanotechnology: significance, challenges and solutions** [7767-12]  
V. Ukraintsev, Nanometrology International, Inc. (United States); B. Banke, Consultant (United States)
- 7767 0D **Multipurpose instrument calibration standard for particle beam, scanned probe and optical microscopy: NIST reference material (RM) 8820** [7767-13]  
M. T. Postek, A. E. Vladar, W. Keery, National Institute of Standards and Technology (United States); M. Bishop, B. Bunday, J. Allgair, International SEMATECH (United States)
- 7767 0F **Conductive carbon nanotubes for semiconductor metrology** [7767-15]  
V. Vartanian, International SEMATECH Manufacturing Initiative (United States); P. McClure, V. Mancevski, Xidex Corp. (United States); J. J. Kopanski, National Institute of Standards and Technology (United States); P. D. Rack, The Univ. of Tennessee (United States); I. Sitnitsky, M. D. Bresin, V. LaBella, K. Dunn, Univ. at Albany (United States)

---

## INSTRUMENTATION AND METROLOGY II

---

- 7767 OJ **Step height measurement by using heterodyne central fringe identification technique** [7767-19]  
W. T. Wu, H. C. Hsieh, Y. L. Chen, W. Y. Chang, D. C. Su, National Chiao-Tung Univ. (Taiwan)
- 7767 OK **Readjusting image sharpness by numerical parametric lenses in Forbes-representation and Halton sampling for selective refocusing in digital holographic microscopy** [7767-20]  
S. Stuerwald, Fraunhofer-Institut für Produktionstechnologie (Germany); R. Schmitt, Fraunhofer-Institut für Produktionstechnologie (Germany) and RWTH Aachen Univ. (Germany)

---

## INSTRUMENTATION AND METROLOGY III

---

- 7767 OL **Limits of IR-spectrometers based on linear variable filters and detector arrays** [7767-21]  
B. R. Wiesent, D. G. Dorigo, A. W. Koch, Technische Univ. München (Germany)
- 7767 OM **Spectral response of photopic instruments with traceability to lamps** [7767-22]  
J. G. Suarez-Romero, Instituto Tecnológico de Querétaro (Mexico); R. Salas-Zuñiga, Ctr. de Ingeniería y Tecnología S. C. (Mexico); J. B. Hurtado-Ramos, Ctr. de Investigación en Ciencia Aplicada y Tecnología Avanzada (Mexico)
- 7767 ON **Applications of Mueller polarimetry in the Fourier space for overlay characterization in microelectronics** [7767-23]  
C. Fallet, S. Manhas, A. de Martino, T. Novikova, Lab. de Physique des Interfaces et des Couches Minces, CNRS, Ecole Polytechnique (France)
- 7767 OO **3D metrology system with internal calibration** [7767-24]  
D. Härter, C. Müller, H. Reinecke, Univ. of Freiburg (Germany)

---

## POSTER SESSION

---

- 7767 OP **Using chromatic confocal apparatus for in situ rolling thickness measurement in hot embossing process** [7767-06]  
Y.-C. Chen, S.-P. Dong, C.-C. Wang, S.-H. Kuo, W.-C. Wang, H.-M. Tai, Industrial Technology Research Institute (Taiwan)
- 7767 OQ **Magnetic measurement of pulsed laser-induced nanomagnetic arrays using Surface Magneto-Optic Kerr Effect** [7767-25]  
N. Shirato, The Univ. of Tennessee (United States); H. Krishna, A. K. Gangopadhyay, Washington Univ. in St. Louis (United States); R. Kalyanaraman, The Univ. of Tennessee (United States)
- 7767 OR **A proposal to solve the problem of lack of concordance in the measurement of temperature when using different radiators** [7767-26]  
J. C. Solorio-Leyva, Instituto Tecnológico de La Piedad, Av. (Mexico); J. G. Suarez-Romero, Instituto Tecnológico de Querétaro, Av. (Mexico); J. B. Hurtado-Ramos, Ctr. de Investigación en Ciencia Aplicada y Tecnología Avanzada (Mexico)

- 7767 OS    **An overlapping technique to measure the parallelism of surface elements in a large area based on comparison goniometer** [7767-27]  
 Z. Wang, Beijing Institute of Technology (China) and Henan Univ. of Technology (China);  
 Y. Zhao, Z. Li, L. Dong, X. Chu, Beijing Institute of Technology (China)
- 7767 OU    **Linewidth control for optical heterodyne beat of 850-nm vertical cavity surface emitting lasers** [7767-29]  
 A. Konishi, T. Ohara, W. Sasaki, Doshisha Univ. (Japan)
- 7767 OV    **Investigation of the metrological properties of a 3D microprobe with optical detection system** [7767-30]  
 F. G. Balzer, N. Hofmann, N. Dorozhovets, T. Hausotte, E. Manske, G. Jäger, Ilmenau Univ. of Technology (Germany)

*Author Index*



# Conference Committee

## *Symposium Chairs*

**David L. Andrews**, University of East Anglia Norwich (United Kingdom)  
**James G. Grote**, Air Force Research Laboratory (United States)

## *Conference Chair*

**Michael T. Postek**, National Institute of Standards and Technology  
(United States)

## *Conference Cochair*

**John A. Allgair**, International SEMATECH Manufacturing Initiative  
(United States)

## *Program Committee*

**Shaochen Chen**, National Science Foundation (United States)  
**Victoria A. Coleman**, National Measurement Institute of Australia  
(Australia)  
**Henri-Jean M. Drouhin**, Ecole Polytechnique (France)  
**Daniel J. C. Herr**, Semiconductor Research Corporation (United States)  
**Mark D. Hoover**, The National Institute for Occupational Safety and  
Health (United States)  
**Kevin W. Lyons**, National Institute of Standards and Technology  
(United States)  
**Jeffrey D. Morse**, National Nanomanufacturing Network (United States)  
**Ndubuisi G. Orji**, National Institute of Standards and Technology  
(United States)  
**John Small**, National Institute of Standards and Technology (United  
States)

## *Session Chairs*

### Keynote Session

**Michael T. Postek**, National Institute of Standards and Technology  
(United States)  
**John A. Allgair**, International SEMATECH Manufacturing Initiative  
(United States)

Instrumentation and Metrology I

**Ndubuisi G. Orji**, National Institute of Standards and Technology  
(United States)

**Henri-Jean M. Drouhin**, Ecole Polytechnique (France)

Nanometrology: Standards

**Shaochen Chen**, National Science Foundation (United States)

**Michael T. Postek**, National Institute of Standards and Technology  
(United States)

Instrumentation and Metrology II

**Kevin W. Lyons**, National Institute of Standards and Technology  
(United States)

**Ndubuisi G. Orji**, National Institute of Standards and Technology  
(United States)

Instrumentation and Metrology III

**Ndubuisi G. Orji**, National Institute of Standards and Technology  
(United States)