PROCEEDINGS OF SPIE

Micro- and Nanotechnology Sensors, Systems, and Applications V

Thomas George
M. Saif Islam
Achyut K. Dutta
Editors

29 April–3 May 2013
Baltimore, Maryland, United States

Sponsored and Published by
SPIE

Volume 8725

Proceedings of SPIE 0277-786X, V. 8725

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

Micro- and Nanotechnology Sensors, Systems, and Applications V, edited by Thomas George, M. Saif Islam, Achyut K. Dutta, Proc. of SPIE Vol. 8725, 872501 · © 2013 SPIE
CCC code: 0277-786X/13/$18 · doi: 10.1117/12.2031937

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 *Micro- and Nanotechnology Sensors, Systems, and Applications V*, edited by Thomas George, M. Saif Islam, Achyut K. Dutta, Proceedings of SPIE Vol. 8725 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X
ISBN: 9780819495167

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.

SPIE Digital Library
SPIEDigitalLibrary.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

POSTER SESSION

Conference Committee

Symposium Chair

Kenneth R. Israel, Major General (USAF Retired) (United States)

Symposium Cochair

David A. Whelan, Boeing Defense, Space, and Security (United States)

Conference Chairs

Thomas George, Zyomed Corporation (United States)
M. Saif Islam, University of California, Davis (United States)
Achyut K. Dutta, Banpil Photonics, Inc. (United States)

Conference Program Committee

Debjyoti Banerjee, Texas A&M University (United States)
Scott D. Collins, University of Maine (United States)
Nibir K. Dhar, Defense Advanced Research Projects Agency (United States)
Ronald G. Dixson, National Institute of Standards and Technology (United States)
Ernest J. Garcia, Sandia National Laboratories (United States)
Joan A. Hoffmann, Johns Hopkins University Applied Physics Laboratory (United States)
Muhammad M. Hussain, King Abdullah University of Science and Technology (Saudi Arabia)
Christopher M. Kroninger, U.S. Army Research Laboratory (United States)
William D. Nothwang, U.S. Army Research Laboratory (United States)
Shinji Nozaki, University of Electro-Communication (Japan)
Takeshi Ohshima, Japan Atomic Energy Research Institute (Japan)
Stergios J. Papadakis, Johns Hopkins University Applied Physics Laboratory (United States)
Gernot S. Pomrenke, Air Force Office of Scientific Research (United States)
Michael T. Postek, National Institute of Standards and Technology (United States)
Michael K. Rafailov, The Reger Group (United States)
Bilge Saruhan-Brings, Deutsches Zentrum für Luft- und Raumfahrt (Germany)
Noriko Satake M.D., UC Davis Medical Center (United States)

Andre U. Sokolnikov, Visual Solutions and Applications (United States)
Kyung-Ah Son, HRL Laboratories, LLC (United States)
Thomas G. Thundat, University of Alberta (Canada)
Christopher C. Wilcox, U.S. Naval Research Laboratory (United States)
Jongseung Yoon, The University of Southern California (United States)

Session Chairs

1 Frontiers in Nanoelectronics Research
Thomas George, Zyomed Corporation (United States)

2 Multifunctional and Adaptive Structural Materials I
Andre U. Sokolnikov, Visual Solutions and Applications (United States)

3 Multifunctional and Adaptive Structural Materials II
Andre U. Sokolnikov, Visual Solutions and Applications (United States)

4 Micro-/Nanosensing for Harsh Environment Energy Applications and Environmental Control
Bilge Saruhan-Brings, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)

5 Scanning Probe-Based Nanopatterning and Dip-Pen Nanolithography: Joint Session with Conferences 8725 and 8729
Ronald G. Dixson, National Institute of Standards and Technology (United States)
Debjyoti Banerjee, Texas A&M University (United States)

6 Novel Adaptive Optics Techniques and Applications
Christopher C. Wilcox, U.S. Naval Research Laboratory (United States)

7 Nano-/Microstructured Materials for Photovoltaic and Photoelectrochemical Energy Harvesting: Joint Session with Conferences 8725 and 8728
Jongseung Yoon, The University of Southern California (United States)

8 Micro- and Nanotechnology for Health Care: Joint Session with Conferences 8725 and 8719
Brian M. Cullum, University of Maryland, Baltimore County (United States)
Eric S. McLamore, University of Florida (United States)
Noriko Satake, UC Davis Medical Center (United States)
Scott D. Collins, University of Maine (United States)
Thomas George, Zyomed Corporation (United States)

Introduction

The 2013 Micro- and Nanotechnology Sensors, Systems, and Applications V Conference continued its trailblazing approach to showcasing a diverse range of MEMS and Nanotechnology topics that are a testament to the practically limitless applications of these exciting technologies. The sheer breadth of potential MEMS and Nanotechnology applications was also strongly validated by the synergy we were able to establish between our conference and other, equally diverse, and broad set of conferences within the DSS symposium. Successful joint sessions were conducted with the Scanning Microscopies (8729), Energy Harvesting and Storage (8728), Smart Biomedical and Physiological Sensor Technology (8719), Unmanned Systems Technology (8741), Flexible Electronics (8730), Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing (8710) and the Passive and Active Millimeter-Wave Imaging (8715) Conferences. Exciting new sessions that were introduced in 2013 were sessions on Frontiers in Nanoelectronics Research (showcasing Dr. Anupama Kaul's program at the NSF), Multifunctional and Adaptive Structural Materials, Flexible and Wearable Electronics for Defense Applications, Novel Transparent Conductors and Carbon-based Technologies, Devices, Nano-/Microstructured Materials for Photovoltaic and Photoelectrochemical Energy Harvesting, and Interaction of Semiconductors and High-Energy Particles.

As in previous years, each session was designed by the session chairs to address three "cornerstones" of our conference philosophy namely, describing programmatic investments that set the overall context for the cutting-edge research and development being presented, and the challenges involved in transitioning these exciting concepts to applications in defense, homeland security and space. A wide variety of advanced micro and nanoscale research being conducted by the Defense Advanced Research Projects Agency, Air Force Office of Scientific Research, National Institutes of Health, Department of Energy, Office of Naval Research and the Naval Research Laboratory, Army Research Laboratory, NASA, and the Japanese Atomic Energy Agency was presented.

Thanks to our distinguished contributors, in this proceedings volume, you will find papers covering a breathtaking range of topics from "How adaptive optics may have won the cold war" to "Nano-electro-mechanical-systems (NEMS) and Energy-efficient Electronics and The Emergence of Two-dimensional Layered Materials Beyond Graphene." Enjoy!

Thomas George
M. Saif Islam
Achyut K. Dutta