

PROCEEDINGS OF SPIE

***Terahertz Physics, Devices,  
and Systems III: Advanced  
Applications in Industry and  
Defense***

**Mehdi Anwar  
Nibir K. Dhar  
Thomas W. Crowe**  
*Editors*

**14–15 April 2009  
Orlando, Florida, United States**

*Sponsored and Published by*  
SPIE

**Volume 7311**

Proceedings of SPIE, 0277-786X, v. 7311

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 *Terahertz Physics, Devices, and Systems III: Advanced Applications in Industry and Defense*, edited by Mehdi Anwar, Nibir K. Dhar, Thomas W. Crowe, Proceedings of SPIE Vol. 7311 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 0277-786X  
ISBN 9780819475770

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 © 2009, 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/09/\$18.00.

Printed in the United States of America.

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

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a smaller, lighter font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

[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*

---

## SESSION 1 THz SPECTROSCOPY

---

- 7311 03 **Non-invasive mail inspection system with terahertz radiation (Invited Paper)** [7311-02]  
H. Hoshina, Y. Sasaki, A. Hayashi, C. Otani, The Institute of Physical and Chemical Research RIKEN (Japan); K. Kawase, Nagoya Univ. (Japan)
- 7311 04 **Development of a THz heterodyne receiver with quantum cascade laser and hot electron bolometer mixer for standoff detection of explosive material** [7311-03]  
H. Richter, A. D. Semenov, S. G. Pavlov, German Aerospace Ctr. DLR Institute of Planetary Research (Germany); L. Mahler, A. Tredicucci, Scuola Normale Superiore di Pisa (Italy); H. E. Beere, D. A. Ritchie, Univ. of Cambridge (United Kingdom); M. Ortolani, Institute for Photonics and Nanotechnologies, CNR (Italy); U. Schade, Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung GmbH (Germany); K. S. Il'in, M. Siegel, Univ. Karlsruhe (Germany); H.-W. Hübers, German Aerospace Ctr. DLR Institute of Planetary Research (Germany)
- 7311 05 **Terahertz standoff identification: influence of environment and sample properties** [7311-04]  
M. Herrmann, S. Wohnsiedler, C. Wiegand, M. Theuer, J. Jonuscheit, R. Beigang, Fraunhofer-Institut für Physik Messtechnik (Germany)
- 7311 06 **Terahertz frequency generation by frequency mixing in semiconductor optical amplifiers** [7311-05]  
E. Donkor, Univ. of Connecticut (United States)

---

## SESSION 2 ADVANCED CONCEPTS IN THz I

---

- 7311 08 **Fabrication of Bi-material MEMS detector arrays for THz imaging** [7311-07]  
D. Grbovic, G. Karunasiri, Naval Postgraduate School (United States)
- 7311 09 **The potential of wide band-gap semiconductor materials in laser-induced semiconductor switches** [7311-08]  
D. J. Phillips, E. R. Smith, Digital Fusion, Inc. (United States); H. Luo, P. Wellenius, J. F. Muth, North Carolina State Univ. (United States); J. V. Foreman, H. O. Everitt, U.S. Army Aviation and Missile Research, Development and Engineering Ctr. (United States)

---

## SESSION 3 ADVANCED CONCEPTS IN THz II

---

- 7311 0B **THz plasmonic modes in metal-clad planar multilayer waveguides (Invited Paper)** [7311-10]  
B. G. Ghamsari, A. H. Majedi, Univ. of Waterloo (Canada)

- 7311 0D **Resonant terahertz absorption by plasmons in grating-gate GaN HEMT structures** [7311-12]  
A. V. Muravjov, D. B. Veksler, Rensselaer Polytechnic Institute (United States); X. Hu, R. Gaska, Sensor Electronic Technology, Inc. (United States); N. Pala, Florida International Univ. (United States); H. Saxena, R. E. Peale, Univ. of Central Florida (United States); M. S. Shur, Rensselaer Polytechnic Institute (United States)
- 7311 0E **Correcting the secondary focus of Fresnel zone plate antennas** [7311-13]  
J. C. Wiltse, Georgia Institute of Technology (United States)
- 7311 0F **Rapid prototyping for fabrication of GHz-THz bandgap structures** [7311-14]  
M. E. Gehm, The Univ. of Arizona (United States) and College of Optical Sciences, The Univ. of Arizona (United States); Z. Wu, H. Xin, The Univ. of Arizona (United States)
- 7311 0G **Application of a high-temperature superconducting detector to terahertz imaging** [7311-15]  
A. D. Hellicar, J. Du, S. M. Hanham, L. Li, Commonwealth Scientific and Industrial Research Organisation (Australia)

---

#### SESSION 4 THz DETECTION

---

- 7311 0I **Tunable THz plasmon resonances in InGaAs/InP HEMT (Invited Paper)** [7311-17]  
R. E. Peale, H. Saxena, Univ. of Central Florida (United States); W. R. Buchwald, Air Force Research Lab. (United States); G. C. Dyer, S. J. Allen, Jr., Univ. of California, Santa Barbara (United States)
- 7311 0J **An algorithm for the detection of handguns in terahertz images** [7311-18]  
A. J. Lingg, B. D. Rigling, Wright State Univ. (United States)
- 7311 0K **Terahertz spectroscopy of explosives and simulants: RDX, PETN, sugar, and L-tartaric acid** [7311-20]  
C. Konek, J. Wilkinson, Naval Surface Warfare Ctr. (United States); O. Esenturk, E. Heilweil, National Institute for Standards and Technology (United States); M. Kemp, Iconal Technology Ltd. (United States)
- 7311 0L **Uncooled detector, optics, and camera development for THz imaging** [7311-21]  
T. Pope, M. Doucet, F. Dupont, L. Marchese, B. Tremblay, G. Baldenberger, S. Verrault, F. Lamontagne, INO (Canada)
- 7311 0M **Terahertz backscattering behavior of various absorbing materials** [7311-22]  
C. Wu, A. J. Gatesman, L. DeRoeck, T. Horgan, R. H. Giles, Univ. of Massachusetts, Lowell (United States); W. E. Nixon, U.S. Army National Ground Intelligence Ctr. (United States)

---

#### SESSION 5 THz IMAGING

---

- 7311 0O **Active THz imaging system with improved frame rate** [7311-24]  
W. von Spiegel, C. am Weg, Johann Wolfgang Goethe-Univ. Frankfurt am Main (Germany); R. Henneberger, R. Zimmermann, Radiometer Physics GmbH (Germany); T. Loeffler, SynView GmbH (Germany); H. G. Roskos, Johann Wolfgang Goethe-Univ. Frankfurt am Main (Germany)

- 7311 OP **Hollow core fibres for THz applications** [7311-25]  
L. Vincetti, Univ. degli Studi di Modena e Reggio Emilia (Italy); A. Cucinotta, S. Selleri, Univ. of Parma (Italy)
- 7311 OQ **First demonstration of a vehicle mounted 250GHz real time passive imager** [7311-26]  
C. Mann, ThruVision Ltd. (United Kingdom)
- 7311 OR **Uncooled MEMS-based detector arrays for THz imaging applications** [7311-27]  
J. A. Cox, R. Higashi, F. Nusseibeh, K. Newstrom-Peitso, C. Zins, Honeywell ACS Sensors & Wireless Lab. (United States); R. Osiander, J. Lehtonen, E. Dodson, The Johns Hopkins Univ. Applied Physics Lab. (United States)

---

#### POSTER SESSION

---

- 7311 OU **About efficiency of identification of materials using spectrum dynamics of medium response under the action of THz radiation** [7311-30]  
V. A. Trofimov, S. A. Varentsova, Lomonosov Moscow State Univ. (Russian Federation)
- 7311 OV **Monte Carlo simulation of terahertz step well quantum cascade laser structures** [7311-32]  
W. Freeman, Naval Air Warfare Ctr. (United States); G. Karunasiri, Naval Postgraduate School (United States)
- 7311 OW **Binary mask scanning for THz imaging** [7311-33]  
D. C. Popescu, A. D. Hellicar, L. Li, Y. Li, G. C. Rosolen, G. Hislop, Commonwealth Scientific and Industrial Research Organisation (Australia)
- 7311 OX **Demonstration of enhanced emission and time delay beam steering using photoconductive terahertz source with multiple spot feed** [7311-34]  
M. E. Knotts, D. R. Denison, Georgia Tech Research Institute (United States)

*Author Index*



# Conference Committee

## *Symposium Chair*

**Ray O. Johnson**, Lockheed Martin Corporation (United States)

## *Symposium Cochair*

**Michael T. Eismann**, Air Force Research Laboratory (United States)

## *Conference Chairs*

**Mehdi Anwar**, University of Connecticut (United States)

**Nibir K. Dhar**, Army Research Laboratory (United States)

**Thomas W. Crowe**, Virginia Diodes, Inc. (United States)

## *Program Committee*

**Alexander G. Davies**, University of Leeds (United Kingdom)

**Gottfried H. Döhler**, Friedrich-Alexander-Universität Erlangen-Nürnberg  
(Germany)

**Achyut K. Dutta**, Banpil Photonics, Inc. (United States)

**M. Saif Islam**, University of California, Davis (United States)

**Hiroshi Ito**, NTT Photonics Laboratories (Japan)

**Peter U. Jepsen**, Danmarks Tekniske Universitet (Denmark)

**James Kolodzey**, University of Delaware (United States)

**Edmund H. Linfield**, University of Leeds (United Kingdom)

**Amir H. Majedi**, University of Waterloo (Canada)

**Tariq Manzur**, Naval Undersea Warfare Center (United States)

**Taiichi Otsuji**, Tohoku University (Japan)

**Azizur B. Rahman**, The City University (United Kingdom)

**Victor Ryzhii**, University of Aizu (Japan)

**Richard A. Soref**, Air Force Research Laboratory (United States)

**Simon Verghese**, MIT Lincoln Laboratory (United States)

**Richard T. Webster**, Hanscom Air Force Base (United States)

**K. Sigfrid Yngvesson**, University of Massachusetts, Amherst (United  
States)

**Weili Zhang**, Oklahoma State University (United States)

## *Session Chairs*

- 1 THz Spectroscopy  
**Nibir K. Dhar**, Army Research Laboratory (United States)  
**Thomas W. Crowe**, Virginia Diodes, Inc. (United States)

- 2    Advanced Concepts in THz I  
    **Amir H. Majedi**, University of Waterloo (Canada)  
    **Mehdi Anwar**, University of Connecticut (United States)  
    **Thomas W. Crowe**, Virginia Diodes, Inc. (United States)
  
- 3    Advanced Concepts in THz II  
    **Tariq Manzur**, Naval Undersea Warfare Center (United States)
  
- 4    THz Detection  
    **Mehdi Anwar**, University of Connecticut (United States)  
    **Tariq Manzur**, Naval Undersea Warfare Center (United States)
  
- 5    THz Imaging  
    **Tariq Manzur**, Naval Undersea Warfare Center (United States)  
    **Nibir K. Dhar**, Army Research Laboratory (United States)