PROCEEDINGS OF SPIE

Sensing for Agriculture and Food Quality and Safety

Moon S. Kim
Shu-I Tu
Kaunglin Chao
Editors

14–15 April 2009
Orlando, Florida, United States

Sponsored and Published by
SPIE

Volume 7315

Proceedings of SPIE, 0277-786X, v. 7315

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 *Sensing for Agriculture and Food Quality and Safety*, edited by Moon S. Kim, Shu-I Tu, Kaunglin Chao, Proceedings of SPIE Vol. 7315 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 0277-786X
ISBN 9780819475817

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. 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.

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 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 BIOSENSORS AND PATHOGEN DETECTION

7315 03 **Phage-based magnetoelastic biosensor for the detection of *Salmonella typhimurium*** [7315-02]
S. Li, R. S. Lakshmanan, R. Guntupalli, S. Huang, Z.-Y. Cheng, V. A. Petrenko, J. M. Barbaree, V. Vodyanoy, B. A. Chin, Auburn Univ. (United States)

7315 04 **Conducting polymer based DNA biosensor for the detection of the *Bacillus cereus* group species** [7315-03]
V. Velusamy, K. Arshak, O. Korostynska, K. Oliwa, C. Adley, Univ. of Limerick (Ireland)

7315 05 **Portable integrated capillary-electrophoresis system using disposable polymer chips with capacitively coupled contactless conductivity detection for on-site analysis of foodstuff** [7315-04]
C. Gärtner, Microfluidic ChipShop GmbH (Germany); W. Hoffmann, H. Demattio, Forschungszentrum Karlsruhe (Germany); T. Clemens, M. Klotz, Clemens GmbH (Germany); R. Klemm, H. Becker, Microfluidic ChipShop GmbH (Germany)

7315 06 **Environmental effects on the production of Shiga-like toxins by *Escherichia coli* O157:H7 as revealed by sandwiched immuno-chemiluminescence detection** [7315-05]
S. Tu, J. Uknalis, Y. He, USDA Agricultural Research Service (United States)

SESSION 2 LASER AND RAMAN APPLICATIONS

7315 07 **Recent advances in chemical imaging technology for the detection of contaminants for food safety and security (Invited Paper)** [7315-06]
R. J. Priore, O. Olkhovyk, A. Drauch, P. Treado, ChemImage Corp. (United States); M. Kim, K. Chao, USDA Agricultural Research Service (United States)

7315 08 **Microsystem technology based diode lasers and Raman sensors for in situ food quality control** [7315-07]
B. Sumpf, Ferdinand-Braun-Institut für Höchstfrequenztechnik (Germany); H. Schmidt, Technische Univ. Berlin (Germany); M. Maiwald, A. Müller, G. Erbert, Ferdinand-Braun-Institut für Höchstfrequenztechnik (Germany); H.-D. Kronfeldt, Technische Univ. Berlin (Germany); G. Tränkle, Ferdinand-Braun-Institut für Höchstfrequenztechnik (Germany)

7315 09 **In-situ characterization of meat aging with diode-laser Raman spectroscopy** [7315-08]
H. Schmidt, J. Blum, K. Sowoidnich, Technische Univ. Berlin (Germany); B. Sumpf, Ferdinand-Braun-Institut für Höchstfrequenztechnik (Germany); F. Schwägele, Max Rubner-Institut (Germany); H.-D. Kronfeldt, Technische Univ. Berlin (Germany)

7315 0A **Prediction of the light scattering patterns from bacteria colonies by a time-resolved reaction-diffusion model and the scalar diffraction theory** [7315-09]
E. Bae, N. Bai, A. Aroonnual, A. K. Bhunia, J. P. Robinson, E. D. Hirleman, Purdue Univ. (United States)

SESSION 3 OPTICAL SENSING I

7315 0B **Proactive detection of bones in poultry processing** [7315-10]
W. D. R. Daley, J. Stewart, Georgia Tech Research Institute (United States)

7315 0C **Using a 3D profiler and infrared camera to monitor oven loading in fully cooked meat operations** [7315-11]
J. Stewart, A. Giorges, Georgia Tech Research Institute (United States)

7315 0D **Nondestructive real-time monitoring of fiber formation in meat analogs** [7315-12]
J. Ranasinghesagara, F. Hsieh, H. E. Huff, G. Yao, Univ. of Missouri, Columbia (United States)

7315 0F **Identification of Thai Hom Mali rice using a refractometer** [7315-14]
S. Sumriddetchkajorn, National Electronics and Computer Technology Ctr. (Thailand);
K. Suwansukho, P. Buranasiri, King Mongkut's Institute of Technology Lakrabang (Thailand)

SESSION 4 HYPERSPECTRAL IMAGING FOR FOOD QUALITY

7315 0G **Development of algorithms for detection of mechanical injury on white mushrooms (*Agaricus bisporus*) using hyperspectral imaging** [7315-15]
A. A. Gowen, C. P. O'Donnell, Univ. College Dublin (Ireland)

7315 0I **Analysis of hyperspectral scattering characteristics for predicting apple fruit firmness and soluble solids content** [7315-17]
R. Lu, USDA Agricultural Research Service (United States); M. Huang, USDA Agricultural Research Service (United States) and Jiangnan Univ. (China); J. Qin, Univ. of Florida (United States)

7315 0J **Online high-speed NIR diffuse-reflectance imaging spectroscopy in food quality monitoring** [7315-18]
R. D. Driver, K. Didona, Headwall Photonics Inc. (United States)

7315 0K **Hyperspectral imaging for detection of black tip damage in wheat kernels** [7315-19]
S. R. Delwiche, USDA Agricultural Research Service (United States); I.-C. Yang, National Taiwan Univ. (Taiwan); M. S. Kim, USDA Agricultural Research Service (United States)

SESSION 5 HYPERSPECTRAL IMAGING APPLICATIONS

7315 0L **Quantification and threshold detection in real-time hyperspectral imaging (Invited Paper)** [7315-20]
R. D. Driver, Headwall Photonics Inc. (United States)

7315 0N **Feature level fusion for hyperspectral images** [7315-22]
C. Xu, I. Kim, Myongji Univ. (Korea, Republic of); S. G. Kong, Temple Univ. (United States)

SESSION 6 HYPERSPECTRAL IMAGING FOR FOOD SAFETY

7315 0Q **Hyperspectral scattering profiles for prediction of the microbial spoilage of beef** [7315-25]
Y. Peng, J. Zhang, J. Wu, H. Hang, China Agricultural Univ. (China)

7315 0R **Automatic detection of aflatoxin contaminated corn kernels using dual-band imagery** [7315-26]
A. E. Ononye, H. Yao, Z. Hruska, R. Kincaid, Institute for Technology Development (United States); R. L. Brown, T. E. Cleveland, USDA Agricultural Research Service (United States)

7315 0S **Detection of microbial biofilms on food processing surfaces: hyperspectral fluorescence imaging study** [7315-27]
W. Jun, M. S. Kim, K. Chao, A. M. Lefcourt, USDA Agricultural Research Service (United States); M. S. Roberts, J. L. McNaughton, AHPharma, Inc. (United States)

SESSION 7 OPTICAL SENSING II

7315 0U **Dynamic multispectral imaging remote sensor with spectral zooming capability** [7315-29]
B. Chen, Univ. of Miami (United States); J. J. Yang, New Span Opto-Technology Inc. (United States); M. R. Wang, Univ. of Miami (United States)

7315 0W **Combination of simple chemical and spectroscopic methods for the identification of Thai Hom Mali rice** [7315-32]
K. Suwansukho, King Mongkut's Institute of Technology Lakrabang (Thailand);
S. Sumriddetchkajorn, National Electronics and Computer Technology Ctr. (Thailand);
P. Buranasiri, King Mongkut's Institute of Technology Lakrabang (Thailand)

POSTER SESSION

7315 0Z **Development of a real-time system of monitoring bacterial colony growth and registering the forward-scattering pattern** [7315-37]
N. Bai, E. Bae, A. Aroonnual, A. K. Bhunia, J. P. Robinson, E. D. Hirleman, Purdue Univ. (United States)

7315 10 **Dimensionality reduction of hyperspectral images using kernel ICA** [7315-41]
A. Khan, National Univ. of Science and Technology (Pakistan); I. Kim, Myongji Univ. (Korea, Republic of); S. G. Kong, Temple Univ. (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

Moon S. Kim, USDA Agricultural Research Service (United States)
Shu-I Tu, USDA Agricultural Research Service (United States)
Kaunglin Chao, USDA Agricultural Research Service (United States)

Program Committee

Arjun Bangalor, ChemImage Corporation (United States)
Arun K. Bhunia, Purdue University (United States)
Suming Chen, National Taiwan University (Taiwan)
Stephen R. Delwiche, USDA Agricultural Research Service (United States)
Ki-Bok Kim, Korea Research Institute of Standards and Science (Korea, Republic of)
Naoshi Kondo, Kyoto University (Japan)
Kurt C. Lawrence, USDA Agricultural Research Service (United States)
Kang-Jin Lee, Rural Development Administration (Korea, Republic of)
Alan M. Lefcourt, USDA Agricultural Research Service (United States)
Renfu Lu, USDA Agricultural Research Service (United States)
Bosoon Park, USDA Agricultural Research Service (United States)
Yankun Peng, China Agricultural University (China)
Yang Tao, University of Maryland, College Park (United States)
Gang Yao, University of Missouri, Columbia (United States)
Yibin Ying, Zhejiang University (China)

Session Chairs

1 Biosensors and Pathogen Detection
Shu-I Tu, USDA Agricultural Research Service (United States)

2 Laser and Raman Applications
Arun K. Bhunia, Purdue University (United States)

3 Optical Sensing I
Gang Yao, University of Missouri, Columbia (United States)

4 Hyperspectral Imaging for Food Quality
Stephen R. Delwiche, USDA Agricultural Research Service (United States)

5 Hyperspectral Imaging Applications
Renfu Lu, USDA Agricultural Research Service (United States)

6 Hyperspectral Imaging for Food Safety
Aoife A. Gowen, University College Dublin (Ireland)

7 Optical Sensing II
Kaunglin Chao, USDA Agricultural Research Service (United States)