

PROCEEDINGS OF SPIE

# ***Sensing for Agriculture and Food Quality and Safety IX***

**Moon S. Kim**  
**Kuanglin Chao**  
**Bryan A. Chin**  
**Byoung-Kwan Cho**  
*Editors*

**13 April 2017**  
**Anaheim, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 10217**

Proceedings of SPIE 0277-786X, V. 10217

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

Sensing for Agriculture and Food Quality and Safety IX, edited by  
M. S. Kim, K. L. Chao, B. A. Chin, B.-K. Cho, Proc. of SPIE Vol. 10217, 1021701  
© 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2280870

Proc. of SPIE Vol. 10217 1021701-1

The papers 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. Additional papers and presentation recordings may be available online in the SPIE Digital Library at [SPIDigitalLibrary.org](http://SPIDigitalLibrary.org).

The papers 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 these proceedings:

Author(s), "Title of Paper," in *Sensing for Agriculture and Food Quality and Safety IX*, edited by Moon S. Kim, Kuanglin Chao, Bryan A. Chin, Byoung-Kwan Cho, Proceedings of SPIE Vol. 10217 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510609358

ISBN: 9781510609365 (electronic)

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](http://SPIE.org)

Copyright © 2017, 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/17/\$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**

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of 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 and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five 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.

# Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

<b>SESSION 1</b>	<b>BIOSENSORS</b>
10217 02	<b>Phage-based biomolecular filter for the capture of bacterial pathogens in liquid streams [10217-1]</b>
10217 03	<b>Highly sensitive surface-scanning detector for the direct bacterial detection using magnetoelastic (ME) biosensors [10217-2]</b>
10217 04	<b>Automated surface-scanning detection of pathogenic bacteria on fresh produce [10217-3]</b>
<b>SESSION 2</b>	<b>CHEMICAL IMAGING APPLICATIONS FOR FOOD CONTAMINANTS DETECTION</b>
10217 06	<b>Raman spectroscopy method for subsurface detection of food powders through plastic layers [10217-5]</b>
10217 07	<b>Detecting benzoyl peroxide in wheat flour by line-scan macro-scale Raman chemical imaging [10217-6]</b>
<b>SESSION 3</b>	<b>OPTICAL SENSING FOR FOOD QUALITY AND SAFETY</b>
10217 08	<b>NIR spectroscopic sensing for point-of-need freshness assessment of meat, fish, vegetables and fruits [10217-7]</b>
10217 09	<b>In-motion optical sensing for assessment of animal well-being [10217-8]</b>
10217 0A	<b>Detection of artificially ripened mango using spectrometric analysis [10217-9]</b>
10217 0B	<b>Finite element simulation of light transfer in turbid media under structured illumination [10217-10]</b>
10217 0C	<b>Monitoring of vegetation drying by Brillouin and Raman spectroscopies [10217-11]</b>
<b>SESSION 4</b>	<b>SPECTRAL IMAGING FOR FOOD QUALITY AND SAFETY</b>
10217 0D	<b>Near infrared hyperspectral imaging system for root phenotyping [10217-12]</b>
10217 0E	<b>Fish freshness estimation using eye image processing under white and UV lightings [10217-13]</b>

- 10217 OG     **Phase analysis for three-dimensional surface reconstruction of apples using structured-illumination reflectance imaging** [10217-15]
- 10217 OI     **Detecting peanuts inoculated with toxigenic and atoxigenic *Aspergillus flavus* strains with fluorescence hyperspectral imagery** [10217-17]
- 10217 OK     **Analysis of pork and poultry meat and bone meal mixture using hyperspectral imaging** [10217-19]
- 10217 OL     **Development of a multichannel hyperspectral imaging probe for food property and quality assessment** [10217-20]

---

**POSTER SESSION**

---

- 10217 ON     **Classification of *Peronospora* infected grapevine leaves with the use of hyperspectral imaging analysis** [10217-22]
- 10217 OO     **Non-destructive quality control of kiwi fruits by hyperspectral imaging** [10217-23]
- 10217 OP     **Detection of pesticide (Cyantraniliprole) residue on grapes using hyperspectral sensing** [10217-24]
- 10217 OR     **A portable nondestructive detection device of quality and nutritional parameters of meat using Vis/NIR spectroscopy** [10217-26]
- 10217 OS     **Nondestructive detection of total viable count changes of chilled pork in high oxygen storage condition based on hyperspectral technology** [10217-27]
- 10217 OT     **A portable device for detecting fruit quality by diffuse reflectance Vis/NIR spectroscopy** [10217-28]
- 10217 OU     **Improvement of the Raman detection system for pesticide residues on/in fruits and vegetables** [10217-29]
- 10217 OV     **Specificity tests of an oligonucleotide probe against food-outbreak salmonella for biosensor detection** [10217-30]
- 10217 OX     **Characterization of E coli biofilm formations on baby spinach leaf surfaces using hyperspectral fluorescence imaging** [10217-32]

# Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Arnold, Thomas, 0D	Liu, Yuzhe, 02, 03, 04
Atkins, Colton A., 09	Lu, Renfu, 0B, 0G, 0L
B.S., Mithun, 0A	Lu, Xu, 02
Bae, Abigail, 06	Lu, Yuzhen, 0G
Baek, Insuck, 0X	Luciani, V., 0N, 0O
Barbaree, J. M., 0V	Madsen, Christi K., 09
Best, Steve R., 04	Mohite, Jayantrao, 0P
Bhatnagar, Deepak, 0I	Mondal, Milton, 0A
Bodner, Gernot, 0D	Noh, Tae Gyoan, 08
Bonifazi, G., 0N, 0O	Ogawa, Yuichi, 0E
Brown, Robert L., 0I	Oh, Mirae, 0K, 0X
Bukasov, Rostislav, 0C	Pappula, Srinivasu, 0P
Chan, Diane E., 06	Park, Yongjong, 08
Chao, Kuanglin, 06, 07, 0S, 0U	Peng, Yankun, 0R, 0S, 0T, 0U
Chen, I-Hsuan, 02, 03, 04, 0V	Pérez Marín, Dolores, 0K
Chen, Kunjie, 0L	Pond, Kevin R., 09
Chin, Bryan A., 02, 03, 04, 0V	Qin, Jianwei, 06, 07, 0S, 0U
Cho, Byoung-Kwan, 07	Rakymzhan, Adiya, 0C
Cho, Hyunjeong, 0X	Sawant, S. D., 0P
Choi, Jun Hoe, 08	Schmidt, Walter F., 06
Crumpler, Michael S., 04	Serranti, S., 0N, 0O
D'Aniello, L., 0N	Shabeer T. P., Ahammed, 0P
Dhakal, Sagar, 06	Shinde, Sujit, 0A
Du, Songtao, 02, 03, 04	Shirataki, Yuri, 0E
Garrido Varo, Ana, 0K	Sirois, Donald L., 04
Gonzalez, Maria, 07	Suh, Sang-Jin, 02, 03
Ha, Joo Young, 08	Sun, Hongwei, 0R, 0T
Han, Jeongsu, 08	Suzuki, Tetsuhito, 0E
Hingmire, Sandip, 0P	Torres, Irina, 0K
Horikawa, Shin, 02, 03, 04, 0V	Utegulov, Zhandos N., 0C
Hruska, Zuzana, 0I	Vishwakarma, Harsh, 0A
Hu, Dong, 0B	Wang, Fan, 0R
Huang, Yuping, 0L	Wang, Wenxiu, 0R, 0T
Kanamori, Katsuhiko, 0E	Wikle, Howard C., 02, 03, 04, 0V
Karale, Yogita, 0P	Xi, Janguo, 04, 0V
Kim, Moon S., 06, 07, 0K, 0X	Xing, Fuguo, 0I
Kim, Sungyoun, 0X	Yakovlev, Vladislav V., 0C
Kimbahune, Sanjay, 0A	Yakupov, Talgat, 0C
Kincaid, Russell, 0I	Yao, Haibo, 0I
Kondo, Naoshi, 0E	Yelemessova, Zarina, 0C
Lee, Hoonsoo, 0K, 0X	Ying, Yibin, 0B
Lee, Ji Young, 08	Zhai, Chen, 0U
Lee, Seoho, 08	Zheng, Xiaochun, 0S
Leitner, Raimund, 0D	Zhu, Fengle, 0I
Li, Peng, 0T	
Li, Yan, 0U	
Li, Yongyu, 0S	
Liao, Qiuhong, 0E	
Liu, Yang, 0I	



# Conference Committee

## *Symposium Chair*

**Majid Rabbani**, Rochester Institute of Technology (United States)

## *Symposium Co-chair*

**Robert Fiete**, Harris Corporation (United States)

## *Conference Chairs*

**Moon S. Kim**, USDA Agricultural Research Service (United States)

**Kuanglin Chao**, USDA Agricultural Research Service (United States)

**Bryan A. Chin**, Auburn University (United States)

**Byoung-Kwan Cho**, Chungnam National University  
(Korea, Republic of)

## *Conference Program Committee*

**Arun K. Bhunia**, Center for Food Safety Engineering, Purdue University  
(United States)

**Suming Chen**, National Taiwan University (China)

**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 Graduate School of Agriculture  
(Japan)

**Kurt C. Lawrence**, USDA Agricultural Research Service (United States)

**Kangjin Lee**, National Academy of Agricultural Science  
(Korea, Republic of)

**Alan M. Lefcourt**, USDA Agricultural Research Service (United States)

**Changying (Charlie) Li**, The University of Georgia (United States)

**Renfu Lu**, USDA Agricultural Research Service (United States)

**Bosoon Park**, USDA Agricultural Research Service (United States)

**Yang Tao**, University of Maryland, College Park (United States)

**Yankun Peng**, China Agricultural University (China)

**Gang Yao**, University of Missouri-Columbia (United States)

**Haibo Yao**, Mississippi State University (United States)

**Yibin Ying**, Zhejiang University (China)

**Seung-Chul Yoon**, USDA Agricultural Research Service (United States)

*Session Chairs*

- 1 Biosensors  
**Clyde Wikle III**, Auburn University (United States)
- 2 Chemical Imaging Applications for Food Contaminants Detection  
**Jianwei Qin**, Agricultural Research Service (United States)
- 3 Optical Sensing for Food Quality and Safety  
**Renfu Lu**, USDA Agricultural Research Service (United States)
- 4 Spectral Imaging for Food Quality and Safety  
**Seung-Chul Yoon**, USDA Agricultural Research Service (United States)