

# ***Biomedical Vibrational Spectroscopy 2016: Advances in Research and Industry***

**Anita Mahadevan-Jansen  
Wolfgang Petrich**  
*Editors*

**13–14 February 2016  
San Francisco, California, United States**

*Sponsored and Published by*  
SPIE

**Volume 9704**

Proceedings of SPIE 1605-7422, V. 9704

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

Biomedical Vibrational Spectroscopy 2016: Advances in Research and Industry, edited by  
Anita Mahadevan-Jansen, Wolfgang Petrich, Proc. of SPIE Vol. 9704, 970401  
© 2016 SPIE · CCC code: 1605-7422/16/\$18 · doi: 10.1117/12.2229264

Proc. of SPIE Vol. 9704 970401-1

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 *Biomedical Vibrational Spectroscopy 2016: Advances in Research and Industry*, edited by Anita Mahadevan-Jansen, Wolfgang Petrich, Proceedings of SPIE Vol. 9704 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 1605-7422

ISSN: 2410-9045 (electronic)

ISBN: 9781628419382

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 © 2016, 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 1605-7422/16/\$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 six-digit CID article numbering system structured as follows:

- 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.

# Contents

v *Authors*  
vii *Conference Committee*

---

## **SESSION 1 ANALYSIS METHODS**

---

- 9704 03 **A quantum cascade laser-based goniometer for the determination of tissue optical properties in the mid-infrared** [9704-3]
- 9704 04 **UV-resonance Raman spectroscopy of amino acids** [9704-4]
- 9704 05 **Raman spectroscopy for highly accurate estimation of the age of refrigerated porcine muscle** [9704-5]
- 9704 06 **Discrete frequency infrared imaging using quantum cascade lasers for biological tissue analysis** [9704-37]

---

## **SESSION 2 CANCER APPLICATIONS I**

---

- 9704 08 **Raman-based identification of circulating tumor cells for cancer diagnosis** [9704-7]
- 9704 0B **The road map towards providing a robust Raman spectroscopy-based cancer diagnostic platform and integration into clinic** [9704-40]

---

## **SESSION 3 CANCER APPLICATIONS II**

---

- 9704 0C **Biophysical basis for noninvasive skin cancer detection using Raman spectroscopy** [9704-10]
- 9704 0D **Endoscope-based beveled and volume fiber-optic Raman probes for in vivo diagnosis of gastric dysplasia: a comparative study** [9704-11]
- 9704 0E **Intra-operative on-line discrimination of kidney cancer from normal tissue by IR ATR spectroscopy of extracellular fluid** [9704-13]
- 9704 0G **Evaluation of a multi-fibre needle Raman probe for tissue analysis** [9704-39]

---

## **SESSION 4 NOVEL METHODOLOGIES**

---

- 9704 0J **Real-time quantum cascade laser-based infrared microspectroscopy in-vivo** [9704-18]
- 9704 0L **CARS hyperspectral imaging of cartilage aiming for state discrimination of cell** [9704-15]

9704 0M **Dental caries imaging using hyperspectral stimulated Raman scattering microscopy**  
[9704-16]

---

**SESSION 5 NON-CANCER APPLICATIONS I**

---

9704 0P **In vivo confocal Raman spectroscopy study of the vitamin A derivative perfusion through human skin** [9704-20]

9704 0R **Combination of micro-dialysis and infrared spectroscopy: a multianalyte assay for accurate biofluid analysis and patient monitoring** [9704-1]

9704 0S **Detection of advanced glycation end products (AGEs) on human skin by in vivo confocal Raman spectroscopy** [9704-23]

---

**SESSION 6 NON-CANCER APPLICATIONS II**

---

9704 0T **Raman and surface-enhanced Raman spectroscopy for renal condition monitoring**  
[9704-25]

9704 0U **Identification of bacteria causing acute otitis media using Raman microspectroscopy**  
[9704-26]

9704 0W **Discrimination of inflammatory bowel disease using Raman spectroscopy and linear discriminant analysis methods** [9704-24]

9704 0X **Translation of infrared chemical imaging for cardiovascular evaluation** [9704-38]

---

**POSTER SESSION**

---

9704 0Z **FT-IR spectroscopy characterization of schwannoma: a case study** [9704-32]

9704 10 **Biomarkers of chronic kidney disease in the urine of diabetic/hypertensive patients by means of Raman spectroscopy** [9704-34]

9704 11 **Development of an optical biosensor based on surface-enhanced Raman scattering for DNA analysis** [9704-35]

9704 14 **Towards optical fibre based Raman spectroscopy for the detection of surgical site infection**  
[9704-22]

9704 15 **Quantitative Raman characterization of cross-linked collagen thin films as a model system for diagnosing early osteoarthritis** [9704-36]

# Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four 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.

Akdogan, Ebru, 11  
Ali, S. M., 0S  
Ateshian, Gerard A., 15  
Ayala, Oscar D., 0U  
Beleites, Claudia, 08  
Bell, Ian M., 0B  
Bhargava, Rohit, 06, 0X  
Bi, Xiaohong, 0W  
Bispo, Jeyse Aliana Martis, 10  
Budde, Janpeter, 0R  
Cao, Ming, 0W  
Carvalho, Luís Felipe C. S., 0Z  
Ceponkus, J., 0E  
Clement, Joachim H., 08  
da Silva, V. V., 0S  
das Chagas, Maurilio José, 0Z  
Dawson, Miranda, 0X  
Day, John C. C., 0G  
Delbeck, Sven, 0R  
Ding, Hao, 0W  
Dorney, Jennifer, 0B  
dos Santos, Laurita, 0P, 0S, 0Z  
Du, Yong, 0T  
Dudgeon, Alexander P., 0G  
DuPont, Andrew W., 0W  
Durney, Krista M., 15  
Elson, Daniel S., 14  
Favero, Priscila P., 0P, 0S  
Feng, Xu, 0C  
Fernandes, Adriana Barrinha, 10  
Ferreira, Isabelle, 0Z  
Fomovsky, Gregory, 15  
Fox, Matthew C., 0C  
Fullwood, Leanne M., 0G  
Gaifulina, Riana, 0B  
Glasmacher, Mathias, 03  
Guha, Sushovan, 0W  
Haase, K., 0J  
Hall, Charlie, 0G  
Heise, H. Michael, 0R  
Herline, Alan, 0W  
Ho, Khok Yu, 0D  
Höhl, Martin, 04  
Huang, Zhiwei, 0D, 0M  
Ihrig, Dieter, 0R  
Iping Petterson, Ingeborg E., 0G  
Isabelle, Martin, 0B  
Izumisawa, Junko, 0L  
Jankevicius, F., 0E  
Jian, Lin, 0M  
Kahraman, Mehmet, 11  
Karagoz, Isik Didem, 11  
Kendall, Catherine, 0B, 0G  
Koziej, Lukasz, 14  
Krafft, Christoph, 08  
Kröger-Lui, Niels, 03, 0J  
Lau, Katherine, 0B  
Lenarz, Thomas, 04  
Lewis, Aram, 0B  
Li, Jingting, 0T  
Li, Ming, 0T  
Lin, Kan, 0D  
Lloyd, Gavin R., 0B, 0G  
Loddi, Vinicius, 0Z  
Mahadevan-Jansen, Anita, 0U, 0W  
Markey, Mia K., 0C  
Martin, Airtan A., 0P, 0S, 0Z  
Meinhardt-Wollweber, Merve, 04  
Mohan, Chandra, 0T  
Morgner, Uwe, 04  
Moy, Austin J., 0C  
Neto, Lazaro P. M., 0Z  
Old, Oliver, 0B  
Pence, Isaac, 0W  
Pereira, L., 0S  
Petrich, Wolfgang, 03, 0J  
Pitris, Costas, 05  
Pizzol, C. D., 0S  
Popp, Jürgen, 08  
Praes, C. E. O., 0S  
Pucci, Annemarie, 03, 0J  
Pucetaite, M., 0E  
Raman, Jai, 0X  
Reddy, Vijaya, 0X  
Reece, David, 0B  
Reichenberg, Jason S., 0C  
Ribas, Marcelo, 0Z  
Rodriguez-Justo, Manuel, 0B  
Sablinskas, V., 0E  
Santos, Gregory M., 0T  
Schie, Iwan W., 08  
Schmitt, Heike, 04  
Schönhals, Arthur, 03, 0J  
Schwartz, David, 0W  
Scott, Larry D., 0W  
Shepherd, Neil, 0B  
Shih, Wei-Chuan, 0T  
Shiozawa, Manabu, 0L

Shirai, Masataka, 0L  
Silveira, Landulfo, Jr., 10  
Singhal, Shashideep, 0W  
Skaar, Eric P., 0U  
Steiner, G., 0E  
Stone, Nicolas, 0B, 0G  
Tanabe, Maiko, 0L  
Teh, Ming, 0D  
Télez Soto, Claudio A., 0P, 0S  
Tholl, Hans, 03  
Thomas, Geraint, 0B  
Thompson, Alex J., 14  
Timinis, Constantinos, 05  
Tiwari, Saumya, 0X  
Tunnell, James W., 0C  
Urbaniene, V., 0E  
Vahlsing, Thorsten, 0R  
Velicka, M., 0E  
Vieira, Elzo Everton de Sousa, 10  
Vukelic, Sinisa, 15  
Wakeman, Catherine A., 0U  
Wang, Chao, 15  
Wang, Jianfeng, 0D  
Wang, Zi, 0M  
Watanabe, Koichi, 0L  
Williams, Huw D., 14  
Xu, Hua, 0W  
Yang, Guang-Zhong, 14  
Yeh, Kevin, 06  
Yeoh, Khay Guan, 0D  
Yigit, Tugce, 11  
Younes, Mamoun, 0W  
Zheng, Wei, 0D, 0M

# Conference Committee

## *Symposium Chairs*

**James G. Fujimoto**, Massachusetts Institute of Technology  
(United States)

**R. Rox Anderson**, Wellman Center for Photomedicine,  
Massachusetts General Hospital (United States) and Harvard  
School of Medicine (United States)

## *Program Track Chairs*

**Tuan Vo-Dinh**, Fitzpatrick Institute for Photonics, Duke University  
(United States)

**Anita Mahadevan-Jansen**, Vanderbilt University (United States)

## *Conference Chairs*

**Anita Mahadevan-Jansen**, Vanderbilt University (United States)

**Wolfgang Petrich**, Roche Diagnostics GmbH (Germany)

## *Conference Program Committee*

**Andrew J. Berger**, University of Rochester (United States)

**Rohit Bhargava**, University of Illinois at Urbana-Champaign  
(United States)

**Airton Abrahão Martin**, Universidade do Vale do Paraíba (Brazil)

**Michael D. Morris**, University of Michigan (United States)

**Dieter Naumann**, Robert Koch-Institut (Germany)

**Jürgen Popp**, Institut für Photonische Technologien e.V. (Germany)

**Nicholas Stone**, Gloucestershire Royal Hospital (United Kingdom)

## *Session Chairs*

1 Analysis Methods

**Wolfgang Petrich**, Roche Diagnostics GmbH (Germany)

2 Cancer Applications I

**Zachary J. Smith**, University of Science and Technology of China  
(China)

3 Cancer Applications II

**Christoph Krafft**, Leibniz-Institut für Photonische Technologien e.V.  
(Germany)

- 4 Novel Methodologies  
**Aírton Abrahão Martin D.D.S.**, Universidade do Vale do Paraíba  
(Brazil)
- 5 Non-Cancer Applications I  
**Wolfgang Petrich**, Roche Diagnostics GmbH (Germany)
- 6 Non-Cancer Applications II  
**Zhiwei Huang**, National University of Singapore (Singapore)