

# PROGRESS IN BIOMEDICAL OPTICS AND IMAGING

Vol. 13, No. 14

## ***Optical Biopsy X***

**Robert R. Alfano**  
**Stavros G. Demos**  
*Editors*

**24–25 January 2012**  
**San Francisco, California, United States**

*Sponsored by*  
SPIE

*Cosponsored by*  
Hamamatsu Corporation (United States)  
Ocean Optics, Inc. (United States)  
Intuitive Surgical Inc. (United States)  
PerkinElmer Inc. (United States)

*Published by*  
SPIE

**Volume 8220**

Proceedings of SPIE, 1605-7422, v. 8220

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 *Optical Biopsy X*, edited by Robert R. Alfano, Stavros G. Demos, Proceedings of SPIE Vol. 8220 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 1605-7422

ISBN 9780819488633

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 © 2012, 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 1605-7422/12/\$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, 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

vii	Conference Committee
ix	Introduction

---

## SCANNING, DIFFUSE REFLECTANCE, AND HYPER-SPECTRAL IMAGING

---

- 8220 02    **Screening prostate cancer using a portable near infrared scanning imaging unit with an optical fiber-based rectal probe** [8220-01]  
Y. Pu, W. Wang, G. Tang, Y. Budansky, M. Sharonov, The City College of New York (United States); M. Xu, Fairfield Univ. (United States); S. Achilefu, Washington Univ. School of Medicine in St. Louis (United States); J. A. Eastham, Memorial Sloan-Kettering Cancer Ctr. (United States); R. R. Alfano, The City College of New York (United States)
- 8220 03    **Angular domain spectroscopic imaging for breast cancer margin assessment after lumpectomy** [8220-02]  
F. Vasefi, Lawson Health Research Institute (Canada), Univ. of Western Ontario (Canada), and Simon Fraser Univ. (Canada); M. Najiminaini, Lawson Health Research Institute (Canada) and Simon Fraser Univ. (Canada); A. Chamson-Reig, Lawson Health Research Institute (Canada); M. Brackstone, London Regional Cancer Program (Canada) and Univ. of Western Ontario (Canada); B. Kaminska, Simon Fraser Univ. (Canada); J. J. L. Carson, Lawson Health Research Institute (Canada) and Univ. of Western Ontario (Canada)
- 8220 04    **Diffuse reflectance imaging: a tool for guided biopsy** [8220-03]  
J. L. Jayanthi, N. Subhash, Ctr. for Earth Science Studies (India); S. Manju, Government Dental College (India); U. G. Nisha, Ctr. for Earth Science Studies (India); V. T. Beena, Government Dental College (India)
- 8220 07    **Analysis of soft tissue near infrared spectra under dynamic pressure effects** [8220-06]  
B. Cugmas, M. Bürmen, F. Pernuš, B. Likar, Univ. of Ljubljana (Slovenia)

---

## PUMP-PROBE AND TIME-RESOLVED IMAGING

---

- 8220 09    **Time resolved optical biopsy spectroscopy of normal, benign and malignant tissues from NADH and FAD changes** [8220-08]  
V. Masilamani, King Saud Univ. (Saudi Arabia); B. B. Das, Fairfield Univ. (United States); J. Secor, The City College of New York (United States); M. AlSalhi, King Saud Univ. (Saudi Arabia); S. B. Amer, King Faisal Specialist Hospital & Research Ctr. (Saudi Arabia); K. Farhat, D. Rabah, Princess Johara Al-Ibrahim Ctr. for Cancer Research (Saudi Arabia); R. R. Alfano, The City College of New York (United States)

---

## DIAGNOSTIC SPECTROSCOPY AND ENDOSCOPY

---

- 8220 OC **In vivo imaging of bladder cancer using prototype endoscope-adaptable system providing parallel RGB and NIR autofluorescence image acquisition** [8220-11]  
M. C. Jacobson, R. deVere White, Univ. of California Davis Medical Ctr. (United States); S. G. Demos, Lawrence Livermore National Lab. (United States)
- 8220 OE **An intraoperative probe combining positron detection and OCT imaging for ovarian cancer detection and characterization** [8220-13]  
Y. Yang, T. Wang, N. Biswal, P. Kumavor, Univ. of Connecticut (United States); X. Wang, M. Karimeddini, J. Vento, M. Sanders, Univ. of Connecticut Health Ctr. (United States); M. Brewer, Univ. of Connecticut (United States) and Univ. of Connecticut Health Ctr. (United States); Q. Zhu, Univ. of Connecticut (United States)
- 8220 OH **Fibre optic fluorescence spectroscopy for monitoring fish freshness** [8220-16]  
C.-W. Wu, T.-C. Hsiao, S.-C. Chu, National Chiao Tung Univ. (Taiwan); H.-H. Hu, National Penghu Univ. of Science and Technology (Taiwan); J.-C. Chen, National Yang-Ming Univ. (Taiwan)
- 8220 OI **Compact Stokes shift and fluorescence spectroscopic diagnostics LED ratiometer unit with no moving parts for cancer detection** [8220-17]  
L. A. Sordillo, Y. Pu, Y. Budansky, R. R. Alfano, The City College of New York (United States)
- 8220 OJ **Spectral grading and Gleason grading of malignant prostate tissue using Stokes shift spectra** [8220-18]  
M. Al Salhi, V. Masilamani, King Saud Univ. (Saudi Arabia); D. Rabah, K. Farhat, Princess Johara Al-Ibrahim Ctr. for Cancer Research (Saudi Arabia); C. H. Liu, Y. Pu, R. R. Alfano, The City College of New York (United States)

---

## MULTI-MODAL SPECTROSCOPY AND IMAGING FOR CANCER DETECTION II

---

- 8220 OO **Discovery in translation: near-infrared fluorescence imaging (Invited Paper)** [8220-23]  
E. M. Sevick-Muraca, The Univ. of Texas Health Science Ctr. at Houston (United States)
- 8220 OR **Monitoring the morphochemistry of laryngeal carcinoma by multimodal imaging** [8220-26]  
T. Meyer, C. Krafft, Institute of Photonic Technology (Germany); O. Guntinas-Lichius, F. von Eggeling, G. Ernst, Univ. Hospital Jena (Germany); B. Dietzek, J. Popp, Institute of Photonic Technology (Germany) and Friedrich-Schiller-Univ. Jena (Germany)

---

## OPTICAL TISSUE AND BODY LIQUID BIOPSY

---

- 8220 OS **Profiling wound healing with wound effluent: Raman spectroscopic indicators of infection (Invited Paper)** [8220-27]  
N. J. Crane, Naval Medical Research Ctr. (United States); E. A. Elster, Naval Medical Research Ctr. (United States), Uniformed Services Univ. of Health Sciences (United States), and Walter Reed National Medical Ctr. (United States)

---

#### ADVANCED OPTICAL BIOPSY

---

- 8220 0X    **Ultrafast time-dependent fluorescence spectroscopy for human breast cancer detection**  
[8220-32]  
Y. Pu, G. Tang, The City College of New York (United States); B. B. Das, Fairfield Univ. (United States); C.-H. Liu, The City College of New York (United States); A. Pradhan, Indian Institute of Technology Kanpur (India); R. R. Alfano, The City College of New York (United States)

---

#### POSTER SESSION

---

- 8220 0Y    **Optical spectroscopic characteristics of lactate and mitochondrion as new biomarkers in cancer diagnosis: understanding Warburg effect** [8220-34]  
C.-H. Liu, X. H. Ni, Y. Pu, Y. L. Yang, F. Zhou, R. Zuzolo, W. B. Wang, The City College of New York (United States); V. Masilamani, King Saud Univ. (Saudi Arabia); A. Rizwan, Weill Cornell Medical College (United States); R. R. Alfano, The City College of New York (United States)

*Author Index*



# Conference Committee

## *Symposium Chairs*

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

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

## *Program Track Chairs*

**Tuan Vo-Dinh**, Duke University (United States)

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

## *Conference Chair*

**Robert R. Alfano**, The City College of New York (United States)

## *Conference Co-chair*

**Stavros G. Demos**, Lawrence Livermore National Laboratory  
(United States)

## *Program Committee*

**Stefan Andersson-Engels**, Lund University (Sweden)

**Christopher H. Contag**, Stanford University School of Medicine  
(United States)

**Jason M. Eichenholz**, Ocean Optics, Inc. (United States)

**Amir H. Gandjbakhche**, National Institutes of Health (United States)

**Israel Gannot**, Tel Aviv University (Israel)

**Xiao Hui Ni**, Harvard University (United States)

**Yang Pu**, The City College of New York (United States)

**Kestutis Sutkus**, The City College of New York (United States)

**Urs Utzinger**, The University of Arizona (United States)

**Wubao Wang**, The City College of New York (United States)

**Siavash Yazdanfar**, GE Global Research (United States)

## *Session Chairs*

- 1 Scanning, Diffuse Reflectance, and Hyper-Spectral Imaging  
**Wubao Wang**, The City College of New York (United States)

- 2 Pump-Probe and Time-Resolved Imaging  
**Stavros G. Demos**, Lawrence Livermore National Laboratory  
(United States)
- 3 Diagnostic Spectroscopy and Endoscopy  
**Warren S. Warren**, Duke University (United States)
- 4 Multi-Modal Spectroscopy and Imaging for Cancer Detection I  
**Singaravelu Ganesan**, Anna University Chennai (India)
- 5 Multi-modal Spectroscopy and Imaging for Cancer Detection II  
**Laura Marcu**, University of California, Davis (United States)
- 6 Optical Tissue and Body Liquid Biopsy  
**Yang Pu**, The City College of New York (United States)
- 7 Advanced Optical Biopsy  
**Stavros G. Demos**, Lawrence Livermore National Laboratory  
(United States)



## Introduction

The symposium "Optical Biopsy X," part of the SPIE Photonics West BIOS conference, was held on January 24–25, 2012, in San Francisco. The symposium consisted of six oral sessions and one poster session for a total 32 oral presentations and two poster presentations. In addition, the program included a panel discussion by representatives from Hamamatsu, Ocean Optics, General Electric, Intuitive Surgical, and Therative Inc. who provided their insight on the topic of "tools for advanced Optical Biopsy." Thanks to Dr Karl Deisseroth for giving a plenary talk on Optogenetics.

Scientists from around the world presented their most recent work in the symposium while others attended the sessions and contributed with their insightful questions and suggestions after each talk. The quality of the invited presentations within the regular sessions were very high and well attended and included the presentation of novel approaches as well as the most recent developments in well established methods. It is worth noting that a relatively larger number of representatives from the Industrial and Venture Capital communities attended many of the talks, highlighting the broad recognition and acceptance of Optical Biopsy techniques as a field with growth potential in the development of next generation medical devices.

The talks also highlighted the continuing trend of transferring basic research into clinically relevant experimental conditions. This reflects the increasing acceptance by scientist that the products of their work must be compatible with strict requirements in clinical settings as well as with the needs of the industrial and investment communities who need to satisfy a set of conditions that will enable them to become successful when engaging with these new technologies.

Among the 32 oral presentations, there were two Keynote presentations and six invited talks in the regular sessions. The papers presented encompassed several different spectral and imaging technologies extending from the macro- to the micro-scale, using fluorescence, light scattering and vibrational spectroscopies, nonlinear optics for wave mixing, and biophotonic approaches to detect disease and the functional state of the tissue in particular cancer. The presentations highlighted the potential of Optical Biopsy techniques to offer solutions in many different areas of clinical interest, from warrior wound assessment in the field to in vivo diagnosis in the operating room, and continuous monitoring during recovery.

We expect in the next conference to see a larger number of papers to deal with in vivo applications and we hope novel methods to emerge to complement the continuous advancements of the well-established and recognized Optical Biopsy methods.

We wish to thank Hamamatsu, Intuitive Surgical, Ocean Optics and Perkin Elmer for support, and the session chairs, program chairs and SPIE staff for their help in making this a successful conference.

**Stavros G. Demos**  
**Robert R. Alfano**