# Optical Fibers and Sensors for Medical Diagnostics and Treatment Applications XIX

**Israel Gannot** 

Editor

2–3 February 2019 San Francisco, California, United States

Sponsored and Published by SPIE

**Volume 10872** 

Proceedings of SPIE, 1605-7422, V. 10872

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

Optical Fibers and Sensors for Medical Diagnostics and Treatment Applications XIX, edited by Israel Gannot Proc. of SPIE Vol. 10872, 1087201 · © 2019 SPIE · CCC code: 1605-7422/19/\$18 · doi: 10.1117/12.2531753

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 SPIEDigitalLibrary.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 Optical Fibers and Sensors for Medical Diagnostics and Treatment Applications XIX, edited by Israel Gannot, Proceedings of SPIE Vol. 10872 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 1605-7422

ISSN: 2410-9045 (electronic)

ISBN: 9781510623866

ISBN: 9781510623873 (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

Copyright © 2019, 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 1605-7422/19/\$18.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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



**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**

vii ix	Authors Conference Committee
	SENSORS DETECTORS AND TREATMENT TOOLS I
10872 02	Distributed strain sensing optical guidance for epidural anesthesia [10872-1]
10872 03	A multimodal optical catheter for diagnosing obstructive sleep apnea [10872-2]
10872 06	Two-photon imaging and selective laser ablation of cochlea hair cells through a multimode fiber probe [10872-5]
	SENSORS DETECTORS AND TREATMENT TOOLS II
10872 0A	Non-invasive blood glucose measurement using fixed-wavelength quantum cascade lasers [10872-9]
10872 OB	Effects of e-beam and gamma sterilization on attenuation of selected single-mode and mutimode optical fibers [10872-10]
10872 OC	Vision sensor for precise control of the pneumatic heart assist pump [10872-11]
	SENSORS DETECTORS AND TREATMENT TOOLS III
10872 0E	Optical fiber-based sensing method for nanoparticles detection through back-scattering signal analysis [10872-13]
10872 OF	Silicon ATR crystal with subwavelength structures optimized for blood analysis [10872-14]
10872 0G	Non-dispersive infrared (NDIR) sensor for real-time nitrate monitoring in wastewater treatment [10872-15]
	SENSORS DETECTORS AND TREATMENT TOOLS IV
10872 OJ	Fabrication of 75-µm-bore hollow optical fibers for infrared transmission [10872-19]

10872 OK	Fabrication of imaging microstructured optical fibers [10872-20]
10872 OM	Super-elastic multi-material optical fibers for healthcare applications [10872-22]
	SENSORS DETECTORS AND TREATMENT TOOLS V
10872 0N	Fabrication and analysis of the fiber optic probe for tumor treatment using PDT [10872-23]
10872 OP	Performance of a terbium doped gadolinium oxyshulphide plastic optical fibre sensor in a flattening filter free setting: measurements and Monte Carlo simulation [10872-25]
10872 0Q	Fiber optic radioluminescent probes for radiation therapy dosimetry (Invited Paper) [10872-26]
10872 OR	Fast and accurate Monte Carlo simulations of subdiffusive spatially resolved reflectance for a complex probe-sample interface [10872-27]
10872 OS	Parallel multiplexing in optical backscatter reflectometry by the use of nano-particles doped optical fiber [10872-28]
	SENSORS DETECTORS AND TREATMENT TOOLS VI
10872 OT	Applications of tapered flat silver halide fibers chemically modified by 12-mercaptododecanoic acid NHS ester for infrared biospectroscopy with prospects for medical diagnostics [10872-18]
10872 0V	Photonic crystal fiber temperature sensor filled with liquid and silver nanowires [10872-30]
	SENSORS DETECTORS AND TREATMENT TOOLS VII
10872 OZ	Disposable and versatile optical sensors for real-time SERS analysis of liquid samples by fiber-based spectroscopy [10872-34]
10872 10	Detection of cervical cancer from evoked tissue fluorescence images using 2- and 3-way methods (Invited Paper) [10872-35]
10872 11	Fiber-enhanced Raman spectroscopy as a tool for an early detection of Alzheimer's disease biomarkers [10872-36]
	SENSORS DETECTORS AND TREATMENT TOOLS VIII
10872 13	Multimode-interference-based spatio-spectral encoder for scanner-free endoscopic imaging [10872-38]

Simultaneous measurement of concentration and temperature in liquid sample using multi-mode interference fiber comb [10872-40]

#### **POSTER SESSION**

Liquid crystal based optical pH sensor for esophageal monitoring [10872-45]
 Polymer fiber analysis and performance evaluation for short distance applications and medical sensing applications [10872-46]

### **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.

Abdolazimi, Vahideh, 19 Alharbi, Majed, 0P Arkwright, J. W., 03 Artyushenko, V., 0Z Banchelli, M., 11 Bartolomei, Nicola, 0M Beisenova, Aidana, 02, 0S

Beisenova, Aidana, O: Bibikova, O., OZ Blanc, Wilfried, OS Bürmen, Miran, OR Carney, A. S., O3 Catcheside, P., O3 Centi, S., OZ Chabal, Y. J., OG Cicchi, R., OZ Clark, K. P., OG Credi, C., OZ Cunha, João P. S., OE Dallari, C., OZ

Darafsheh, Arash, OQ Das Gupta, Tapajyoti, OM De Angelis, M., 11 Delbeck, S., OT Dowler, Alastair, OK Duan, Liangcheng, OV Eastwood, P., 03

D'Andrea, C., 11

Ebendorff-Heidepriem, Heike, 0K

Eravuchira, P. J., 11 Fehr, Axel, 0F Foley, Mark, 0P

Fontecchio, Adam K., 19
Fukano, Hideki, 15
Gannot, I., 11
Gerwert, K., 0T
Gillespie, Sean, 0P
Habermehl, A., 0T
Heise, H. M., 0T
Hinojos, D., 0G
Hodges, K., 0G
Hokansson, Adam S., 0B

Hokansson, Adam S., 0B Hosni, Mohamed I., 1A Issatayeva, Aizhan, 02, 0S Iwai, Katsumasa, 0J Jorge, Pedro A. S., 0E Jung, Chang Hyun, 0N Jung, Derek Minwoo, 0N Kakkava, Eirini, 06 Katagiri, T., 13 Katzir, A., 0G Kim, Jaehan, 0B Kim, Jaesun, 0N Kino, S., 0A

Kondratiev, Alexander, OF Korganbayev, Sanzhar, OS

Koyama, T., 0A Leber, Andreas, 0M Lee, HyeYeon, 0N Lee, Junho, 0N Lemmer, U., 0T Li, Jie, 0B Likar, Boštjan, 0R Loterie, Damien, 06 Lu, Ying, 0V

Martyn, Michael, OP Matsuura, Yuji, OA, OJ, 13 McEvoy, D., 03 Minamikawa, Takeo, 15 Minoshima, Kaoru, 15 Miyagi, Mitsunobu, OJ Mokhtar, Ayman M., 1A Molardi, Carlo, 02, 08

Mozin, Vitalii, 0F Müller, Anja, 0F Murawski, Krzysztof, 0C Nabers, A., 0T Naglic, Peter, 0R Nakajima, Yoshiaki, 15 Nguyen Dang, Tung, 0M

Moser, Christophe, 06

Oe, Ryo, 15 O'Keeffe, Sinead, 0P Omari, T., 03 Ouh, ChiHwan, 0N Page, Alexis G., 0M Paiva, Joana S., 0E Paolo, M., 11 Park, Gaye, 0N

Pavone, Francesco S., OZ

Pernuš, Franjo, OR Pini, R., OZ Psaltis, Demetri, O6 Qu, Yunpeng, OM Ratto, F., OZ Reynolds, K., O3 Rhee, Yun-Hee, ON Ribeiro, Rita S. R., OE Robbins, D., OG Romito, Marilisa, 06

Roodenko, K., 0G

Rosa, Carla C., 0E

Roth, Andreas, OF

Ruiz-Vargas, A., 03

Sampaio, Paula, 0E

Sasaki, Yasuhiro, OJ

Schmitz, B., OT

Shaver, Jeremy M., 10

Shi, Yi-Wei, 0J

Smith, William P., OB

Sorin, Fabien, 0M

Stankovich, Konstantina M., 06

Stolov, Andrei A., 0B

Sulej, Wojciech, 0C

Sykora, Lorenz, OF

Takaku, Hiroyuki, OJ

Takizawa, Y., 13

Taue, Shuji, 15

Tiribilli, B., OZ

Tosi, Daniele, 02, 0S

Veyan, J.-F., 0G

Wall, A. J., 03

Warren-Smith, Stephen C., 0K

Wise, Barry M., 10

Woulfe, Peter, 0P

Yan, Man F., OB

Yan, Wei, 0M

Yang, Xianchao, 0V

Yao, Jianquan, 0V

Yasui, Takeshi, 15

Zelinskyi, Yevhen, OR

Zhang, Haiwei, 0V

Zhu, Xiao-Song, 0J

Zörnack, Gloria, 0F

## **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 Medical School (United States)

#### Symposium Co-chairs

**Jennifer K. Barton**, The University of Arizona (United States) **Wolfgang Drexler**, Medical University of Vienna (Austria)

#### Program Track Chairs

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

Anita Mahadevan-Jansen, Vanderbilt University (United States)

#### Conference Chair

**Israel Gannot**, Johns Hopkins University (United States) and Tel Aviv University (Israel)

#### Conference Program Committee

James P. Clarkin, Polymicro Technologies, A Subsidiary of Molex Incorporated (United States)

**Ilko llev**, U.S. Food and Drug Administration (United States)

Jin U. Kang, Johns Hopkins University (United States)

Karl-Friedrich Klein, Technische Hochschule Mittelhessen (Germany)

Pierre Lucas, The University of Arizona (United States)

Yuji Matsuura, Tohoku University (Japan)

Katy Roodenko, MAX IR Laboratories (United States)

**Angela B. Seddon**, The University of Nottingham (United Kingdom)

#### Session Chairs

- Sensors Detectors and Treatment Tools I Katy Roodenko, MAX IR Laboratories (United States)
- 2 Sensors Detectors and Treatment Tools II Pierre Lucas, The University of Arizona (United States)

- 3 Sensors Detectors and Treatment Tools III Yuji Matsuura, Tohoku University (Japan)
- 4 Sensors Detectors and Treatment Tools IV Angela B. Seddon, The University of Nottingham (United Kingdom)
- Sensors Detectors and Treatment Tools V James P. Clarkin, Polymicro Technologies, A Subsidiary of Molex Incorporated (United States)
- 6 Sensors Detectors and Treatment Tools VI Olga Bibikova, art photonics GmbH (Germany)
- 7 Sensors Detectors and Treatment Tools VII Israel Gannot, Johns Hopkins University (United States) and Tel Aviv University (Israel) Pinkie Jacob Eravuchira, Tel Aviv University (Israel)
- 8 Sensors Detectors and Treatment Tools VIII Karl-Friedrich Klein, Technische Hochschule Mittelhessen (Germany)