

PROCEEDINGS OF SPIE

# **AOPC 2019: Optical Spectroscopy and Imaging**

**Jin Yu**  
**Zhe Wang**  
**Vincenzo Palleschi**  
**Mengxia Xie**  
**Yuegang Fu**  
*Editors*

**7–9 July 2019**  
**Beijing, China**

*Sponsored by*  
Chinese Society for Optical Engineering (China)

*Cosponsored by*  
SPIE

*Organized by*  
Chinese Society for Optical Engineering (China)  
Photoelectronic Technology Committee, Chinese Society of Astronautics (China)  
Science and Technology on Low-light-level Night Vision Laboratory (China)  
Science and Technology on Electro-Optical Information Security Control Laboratory (China)  
Academy of Opto-Electronics of Electronics Technology of China (China)  
Infrared and Laser Engineering (China)

*Published by*  
SPIE

**Volume 11337**

Proceedings of SPIE 0277-786X, V. 11337

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

AOPC 2019: Optical Spectroscopy and Imaging, edited by Jin Yu, Zhe Wang, Vincenzo Palleschi,  
Mengxia Xie, Yuegang Fu, Proc. of SPIE Vol. 11337, 1133701 · © 2019 SPIE  
CCC code: 0277-786X/19/\$21 · doi: 10.1117/12.2564824

Proc. of SPIE Vol. 11337 1133701-1

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 *AOPC 2019: Optical Spectroscopy and Imaging*, edited by Jin Yu, Zhe Wang, Vincenzo Palleschi, Mengxia Xie, Yuegang Fu, Proceedings of SPIE Vol. 11337 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X  
ISSN: 1996-756X (electronic)

ISBN: 9781510634466  
ISBN: 9781510634473 (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 © 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 \$21.00 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/19/\$21.00.

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.

**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

iii	<i>Authors</i>
vi	<i>Conference Committee</i>
viii	<i>Introduction</i>

---

## OPTICAL SPECTROSCOPY AND IMAGING

---

11337 02	<b>Simultaneous inversion of methyl thiol, methane and water vapor concentration from wavelength modulation spectroscopy using neural network [11337-3]</b>
11337 03	<b>Brillouin light scattering uncertainty preliminary estimation [11337-5]</b>
11337 04	<b>Analysis and suppression of stray radiation in infrared spectral radiation measurement [11337-7]</b>
11337 05	<b>Error analysis of field of view registration accuracy of hyper-resolution spatial heterodyne spectrometer for hydroxyl radical OH [11337-8]</b>
11337 06	<b>Improvement of CDU in implant level lithography with high topography [11337-9]</b>
11337 07	<b>Monte Carlo simulation of integrated blackbody infrared emissivity and verification [11337-11]</b>
11337 08	<b>A high-precision wavelength calibration method based on Fourier transform imaging spectrometer [11337-12]</b>
11337 09	<b>Influence of surface roughness of ice crystal particles on bulk scattering properties of cirrus clouds [11337-13]</b>
11337 0A	<b>3-D surface morphology measurement of plasma-facing materials using laser speckle interferometry in presence of periodic vibration [11337-15]</b>
11337 0B	<b>A novel knife-edge method for measuring the lateral resolution of confocal Raman microscopes [11337-18]</b>
11337 0C	<b>Photoacoustic detection and glucose concentration prediction of solutions mixed glucose with salt based on OPO pulsed laser excitation [11337-19]</b>
11337 0D	<b>Measurement of the deposition morphology using temporal phase-shifting laser speckle interferometry [11337-20]</b>

- 11337 0E **Study on the data processing method applied to improve spectral stability of laser induced breakdown spectroscopy in soil analysis** [11337-21]
- 11337 0F **Study on the intensive submillimeter interlayer structures based on THz-TDS** [11337-22]
- 11337 0G **Hyper-spectral computer tomographic detection of OH radicals in the upper and middle atmosphere** [11337-23]
- 11337 0H **Laser remote sensing of air pollution clouds** [11337-24]
- 11337 0I **Optical system design of high resolution centering instrument based on switchable lenses** [11337-25]
- 11337 0J **Supercontinuum generation in graded index multimode fiber pumped by superluminescent pulse amplification** [11337-26]
- 11337 0K **The identification of tea variety and producing area using laser-induced breakdown spectroscopy combined with neural network** [11337-27]
- 11337 0L **Study on the mineral composition detection in bone by spatially offset Raman spectroscopy** [11337-28]
- 11337 0M **Study on shortwave infrared multispectral horizontal imaging performance under haze weather condition** [11337-31]
- 11337 0N **Tool path planning for aspheric five-axis machine tools** [11337-32]
- 11337 0O **Study of the influence of several nonmetal sheets to 100GHz millimeter wave active imaging** [11337-34]
- 11337 0P **Research on LIBS quantitative analysis of heavy metal concentration in polluted water-based on Fourier self-deconvolution method** [11337-35]
- 11337 0Q **Simulation study of a computational spectrometer based on a disordered medium** [11337-36]
- 11337 0R **Design of dual-band infrared lens with multilayer diffractive optical element** [11337-37]
- 11337 0S **Study on spectral transfer characteristics of double AOTF imaging spectrometer acoustooptic crystals** [11337-38]
- 11337 0T **Dual-color quantum dot structured illumination microscopy using single LED** [11337-39]
- 11337 0U **Study on the spectral imaging technology of adaptive classification** [11337-42]
- 11337 0V **A method of real-time monitoring the cyanobacterial bloom in inland waters based on ground-based multi-spectral imaging** [11337-45]
- 11337 0W **Design of optical system for micro multispectral camera** [11337-47]

- 11337 0X **Efficient full field of view polarimetric calibration method for simultaneous imaging polarimeter** [11337-48]
- 11337 0Y **Establishing diffuse speckle contrast signal relationship with blood flow** [11337-49]
- 11337 0Z **Performance analysis of DDR SDRAM in high speed image data acquisition** [11337-50]
- 11337 10 **Design of portable resonant photoacoustic cell based on ray-tracing software TracePro** [11337-51]
- 11337 11 **Wide band infrared spectral engine based on digital micro-mirror device** [11337-52]
- 11337 12 **Quantitative determination of hydrogen isotope in titanium using LIBS** [11337-53]
- 11337 13 **A review of soil nutrient detection by laser induced breakdown spectroscopy** [11337-54]
- 11337 14 **Single-layer graphene-based surface plasmon resonance biosensors for immunization study** [11337-56]
- 11337 15 **Research on high resolution micro-scan technology in infrared imaging system** [11337-57]
- 11337 16 **Research on classification and recognition method of coal and coal gangue based spectral imaging micro-system** [11337-58]
- 11337 17 **Remote sense for environment pollution gases in wide infrared spectral range** [11337-59]
- 11337 1A **Yuqiao Reservoir unmanned airborne spectral imaging monitoring system** [11337-62]
- 11337 1B **Dynamic population of infrared radiation in dysprosium-doped different host materials** [11337-64]
- 11337 1C **Spatially offset Raman spectroscopy detection for food additives components** [11337-65]
- 11337 1D **Recent progress on laser illuminating 2D materials** [11337-67]
- 11337 1E **Automatic outlier detection based on PLS-MMD model** [11337-69]
- 11337 1F **A portable miniature microscope for biomedical applications** [11337-70]
- 11337 1G **Modeling and simulation of hyperspectral imaging system based on ray tracing** [11337-73]
- 11337 1H **Spectral domain optical coherence tomography setup and small artery detection based on it** [11337-74]



## 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.

Bai, Caixun, 08  
Bo, Zhang, 0R  
Bu, Yang, 0P  
Cai, Zhijian, 0Q  
Cao, Yi, 0P  
Chang, Lingying, 0S  
Chen, Dihu, 05  
Chen, Guoqing, 0W  
Chen, H., 1D  
Chen, Qian, 1E  
Chen, Xi, 0N  
Chen, Xiaolai, 0Z  
Chen, Xiaomei, 1G  
Chen, Yong, 0H  
Chen, Yu, 0H  
Cheng, Lejian, 0O  
Chun-li, Chen, 0H  
Cui, Qingfeng, 0R  
Cui, Xiaoqian, 0A, 0D  
Cui, Xutai, 12  
Dai, Caihong, 04  
Deng, Decai, 0J  
Ding, Hongbin, 0A, 0D  
Ding, Xiang, 0B  
Ding, Yiwen, 1G  
Dong, Fan, 0H  
Dong, Liqun, 1H  
Dong, Wei, 07  
Dong, Wenjie, 0O  
Du, Yang, 12  
Du, Zhenhui, 02  
Duan, Mingliang, 08  
Duan, Xuejiao, 1E  
Duanmu, Qing-duo, 07  
Fan, Hang, 06  
Fan, Hongqing, 02  
Feng, Chunlei, 0D  
Feng, Guojin, 04  
Feng, Xiaocheng, 11  
Feng, Zhen-zhong, 0H  
Fu, Yanzhe, 0B  
Gao, Ming, 09  
Gao, Xiaohui, 0U  
Gao, Zhixing, 0L, 1C  
Gong, Mali, 0J  
Guo, Peiji, 0N  
Guo, Xiang-dong, 14  
He, Linlu, 0J  
He, Shufang, 04  
Hong, Jin, 0X  
Hu, M. J., 1D  
Huang, Xingyong, 1B  
Hui, Mei, 1H  
Huo, Li, 0E  
Jia, Xiaodong, 16, 1A  
Jiang, Bin, 13  
Jiang, Xunpeng, 13  
Jin, Mengzhu, 0S  
Lan, Tian, 1G  
Lei, Xuefeng, 0X  
Lei, Zhenggang, 17  
Li, Dan, 0J  
Li, Honglian, 02  
Li, J. B., 1D  
Li, Jia, 13  
Li, Jiangchao, 0B  
Li, Jianxin, 08  
Li, Jing, 0L, 1C  
Li, Jinyi, 02  
Li, Kefei, 0F  
Li, Shuhua, 0A, 0D  
Li, Ting, 15  
Li, Wu, 0Q  
Li, Xiao-feng, 0H  
Li, Yan, 09  
Li, Ying, 1E  
Li, Yuanbo, 0A, 0D  
Li, Yuchen, 0L, 1C  
Li, Zhi-bin, 07  
Li, Zhiwei, 05, 0G  
Libo, Li, 0U  
Liu, Diwei, 0F  
Liu, Guodong, 0C  
Liu, Jialin, 0Y  
Liu, Jianhui, 1A  
Liu, Jie, 08  
Liu, Jinyuan, 04  
Liu, Ming, 1H  
Liu, Qiu-shi, 0L, 1C  
Liu, Shengrun, 0V  
Liu, Shuyang, 16, 1A  
Liu, Xiaohua, 1H  
Liu, Yanxiang, 09  
Liu, Yuzhe, 0W  
Liu, Zesheng, 0E, 0K  
Liu, Zhilong, 0O  
Lü, Chengxu, 13  
Luo, Donggen, 0X

Luo, Haiyan, 05, 0G  
Lv, Chong, 0L, 1C  
Lv, Jinwei, 1A  
Ma, Tao, 0I  
Ma, Xiaohong, 0E, 0K  
Meng, Q. B., 1D  
Meng, Xianghao, 0L, 1C  
Mosset, Alexis, 03  
Niu, Kang, 13  
Niu, Wenjing, 0I  
Pan, Yi-jie, 07  
Pavlyuchenko, Ekaterina, 03  
Peng, Ren, 0H  
Piao, Mingxu, 0R  
Qi, Li, 1I  
Qi, Zhi-mei, 14  
Qin, R. Z., 1D  
Qiu, Yuehong, 0S  
Ren, Shenhe, 09  
Ren, Zhong, 0C  
Ruan, Ping, 0V  
Salzenstein, Patrice, 03  
Shan, G. C., 1D  
Shao, Chun-feng, 07  
She, Xiaoyu, 1H  
Shen, Bizhou, 1B  
Shen, Tao, 1I  
Shi, Hailiang, 05, 0G  
Song, Hai-Zhi, 1B  
Song, Jingjing, 0S  
Song, Maoxin, 0X  
Song, Xu-yao, 07  
Song, Yang, 1F  
Su, Lijuan, 0M  
Sun, Xiaobing, 0X  
Tan, H. Y., 1D  
Tao, Fei, 0X  
Tao, Jinyou, 0V  
Tian, Xinli, 02  
Wan, Jiaxin, 02  
Wang, Chi, 1F  
Wang, Hongwei, 17  
Wang, Jing-hui, 07  
Wang, Ping, 15  
Wang, Qianqian, 12  
Wang, Qiaoyun, 10  
Wang, Rui, 0E, 0K  
Wang, Tianhe, 1A  
Wang, Wei, 0F  
Wang, Xiangzhao, 0P  
Wang, Xuanyu, 0O  
Wang, Yan, 0Z  
Wang, Yanfei, 04  
Wang, Yuanhang, 0P  
Wei, Xiong, 05  
Wei, Xiong, 0G  
Wu, Chenyu, 0U  
Wu, Ding, 0D  
Wu, Fang, 0P  
Wu, Jianhong, 0Q

Wu, Shuai, 0J  
Wu, Yinhua, 0U  
Xie, Wenyong, 1E  
Xie, Xiumin, 1B  
Xin, Wu, 0U  
Xiong, Da-xi, 0Y, 1F  
Xu, Baoteng, 0Y  
Xu, Qiang, 1B  
Xu, Tianhui, 0F  
Xu, Ying, 14  
Xu, Yixuan, 08  
Xue, Bin, 0V, 0W  
Yan, Bing, 1F  
Yang, Huaidong, 0T  
Yang, Jie, 0I  
Yang, Ruizhu, 12  
Yang, Xi-bin, 0Y, 1F  
Yang, Yang, 1I  
Yang, Ze-hou, 0H  
Yang, Zhixiong, 17  
Yao, Dawei, 0S  
Ye, Wangquan, 1E  
Ye, Zimu, 0M  
Yi, Ru-meng, 14  
Yi, Tian, 1I  
Yu, Chunchao, 17  
Yu, Jirui, 0V  
Yu, Xu-dong, 15  
Yu, Yingjie, 0P  
Yuan, Yan, 0M  
Yuan, Zun-dong, 07  
Zai, Houming, 1I  
Zeng, Hui, 0T  
Zhan, Liuyang, 0K  
Zhang, Chen, 16, 1A  
Zhang, Guo-juan, 0H  
Zhang, Haitao, 0J  
Zhang, Jiyan, 0B  
Zhang, Junning, 13  
Zhang, Lai, 0M  
Zhang, Peizhong, 17  
Zhang, Taiyu, 0E, 0K  
Zhang, Weifeng, 17  
Zhang, Xiaohua, 0L, 1C  
Zhang, Xiaowei, 1I  
Zhang, Zhe, 14  
Zhang, Zhi-qiang, 15  
Zhao, Anna, 16, 1A  
Zhao, Baozhen, 0L, 1C  
Zhao, Dongye, 0A, 0D  
Zhao, Pi-e, 0H  
Zhao, Xinxin, 0X  
Zhao, Yiyi, 0W  
Zhao, Yuejin, 1H  
Zhao, Zhanyu, 10  
Zheng, Weijian, 17  
Zhou, Wei, 0Y, 1F  
Zhou, Yu-mei, 15  
Zhu, Fusheng, 06  
Zhu, Yongxiang, 0N



Zhuang, Run-tao, 14  
Zong, Yi, 08



## Conference Committees

### *Conference Chairs*

**Guangjun Zhang**, Southeast University (China)  
**Byoungho Lee**, Seoul National University (Korea, Republic of)  
**John Greivenkamp**, The University of Arizona (United States)

### *Conference Review Committee*

**Desheng Jiang**, Wuhan University of Technology (China)  
**Dianyuan Fan**, Shenzhen University (China)  
**Huilin Jiang**, Changchun University of Science and Technology (China)  
**Junhao Chu**, Shanghai Institute of Technical Physics, Chinese Academy of Sciences (China)  
**Jianguo Wang**, Chinese Academy of Sciences, Shanghai Branch (China)  
**Jianquan Yao**, Tianjin University (China)  
**Jiancheng Fang**, Beihang University (China)  
**Jiubin Tan**, Harbin Institute of Technology (China)  
**Lin Li**, University of Manchester (United Kingdom)  
**Lijun Wang**, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences (China)  
**Min Gu**, University of Shanghai for Science and Technology (China)  
**Qionghai Dai**, Tsinghua University (China)  
**Shibin Jiang**, AdValue Photonics, Inc. (United States)  
**Shenggang Liu**, University of Electronic Science and Technology of China (China)  
**Shouhuan Zhou**, North China Research Institute of Electro-Optics (China)  
**Toyohiko Yatagai**, Utsunomiya University (Japan)  
**Wenqing Liu**, Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences (China)  
**Wei Wang**, Beijing Institute of Aerospace Control Device of CASC (China)  
**Yueguang Lv**, Chinese Academy of Engineering (China)  
**Zuyan Xu**, The Technical Institute of Physics and Chemistry of the Chinese Academy of Sciences (China)

### *Conference Program Committee*

**Chaoyang Lu**, University of Science and Technology of China (China)  
**Daoxin Dai**, Zhejiang University (China)  
**Dong Liu**, Zhejiang University (China)  
**Haimei Gong**, Shanghai Institute of Technical Physics, Chinese Academy of Sciences (China)  
**Hongbo Sun**, Tsinghua University (China)  
**Jin Lu**, Tianjin Jinhang Institute of Technical Physics (China)  
**Jinxue Wang**, SPIE

**Jin Yu**, Shanghai Jiao Tong University (China)  
**Jian Zhang**, Shanghai Institute of Ceramics, Chinese Academy of Sciences (China)  
**Min Gu**, University of Shanghai for Science and Technology (China)  
**Min Qiu**, Westlake University (China)  
**Michelle Sander**, Boston University (United States)  
**Mengxia Xie**, Beijing Normal University (China)  
**Pu Zhou**, National University of Defense Technology (China)  
**Sven Hofling**, Universität Würzburg (Germany)  
**Shibin Jiang**, AdValue Photonics, Inc. (United States)  
**Suijian Xue**, National Astronomical Observatories, Chinese Academy of Sciences (China)  
**Takunori Taira**, RIKEN SPring-8 Center (Japan)  
**Vincenzo Pallechi**, Institute of Chemistry of Organic Metallic Compounds (Italy)  
**Wenxue Li**, East China Normal University (China)  
**Xiaocong Yuan**, Shenzhen University (China)  
**Xuejun Zhang**, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences (China)  
**Yadong Jiang**, University of Electronic Science and Technology of China (China)  
**Yongtian Wang**, Beijing Institute of Technology (China)  
**Yuegang Fu**, Changchun University of Science and Technology (China)  
**Zhiping Zhou**, Peking University (China)  
**Zhe Wang**, Tsinghua University (China)  
**Ziyang Zhang**, Westlake University (China)

#### *Session Chairs*

- 1 New Frontiers in Laser-Induced Breakdown Spectroscopy  
**Vincenzo Pallechi**, Applied and Laser Spectroscopy Laboratory, Institute of Chemistry of Organometallic Compounds (Italy)
- 2 Applications of Optical Spectroscopy and Imaging  
**Zhe Wang**, Tsinghua University (China)
- 3 Ultrafast Spectroscopy and Molecular Dynamics  
**Yi Lv**, Sichuan University (China)
- 4 Advanced Spectroscopic Techniques, Nanoparticles and Surface Enhancement  
**Mengxia Xie**, Beijing Normal University (China)
- 5 Raman Spectroscopy and Biomedical Applications  
**Mohamad Sabsabi**, National Research Council Canada (Canada)
- 6 Elemental Analysis and Spectroscopic Data Processing  
**Jin Yu**, Shanghai Jiao Tong University (China)

## Introduction

AOPC 2019, the Annual Conference of Chinese Society of Optical Engineering (CSOE), was one of the largest academic and industrialization activities in the field of optical and optoelectronic technology in China. The Organizing Committee intended to build a potential platform together with academic exchanges, industry exhibitions, and cooperation negotiations in one. There were 11 technical conferences and 38 conference sessions, and we sincerely hope that the research and development of optoelectronic technology were promoted, and that international cooperation in industry and in the optical and optoelectronic fields were enhanced.

AOPC 2019 was sponsored by SPIE and the Chinese Society for Optical Engineering; the Optical Society of Korea (OSK), Optics and Photonics Society of Singapore (OPSS), European Optical Society (EOS), Optical Society of Japan (OSJ) were the technical co-sponsors. There were also 48 Cooperative Organizations that supported the conference.

We received over 930 total contributions from more than 15 countries, including United States, United Kingdom, Germany, France, Spain, Australia, Canada, Mexico, Brazil, Japan, the Republic of Korea, Thailand, Singapore, the Russian Federation, China, and so on. There were 554 contributions published in SPIE Proceedings.

After careful discussion, we suggested four keynote speeches which were presented by famous scientists from Germany, Australia, Japan, and China. There were 110 excellent invited talks, 45 of them are from overseas, their inclusion represented a first-class level in the field of optics and photonics technology. On behalf of the Organizing Committee of AOPC, I express the thanks to all the invited speakers and authors for their contributions and supports to the conference.

Finally, on behalf of the Chairmen and the Organizing Committee of AOPC, I would like to heartily thank for our sponsors and Cooperating Organizations for all they have done for the conference, to all of the participants and friends for their interests and efforts in helping us to make the conference success. Also, thanks to the Program Committee for their effective work and valuable advice; especially the AOPC 2019 Secretariat and SPIE for their tireless effort and outstanding services in preparing the conference and publishing the Proceedings.

We are glad that AOPC 2019 had great success! Hope to see you next year!

**Guofan Jin**

