## PROCEEDINGS OF SPIE

# 2017 International Conference on Optical Instruments and Technology

# Advanced Laser Technology and Applications

Zhiyi Wei Chunqing Gao Pu Wang Franz X. Kärtner Jayanta Kumar Sahu

**Editors** 

28–30 October 2017 Beijing, China

Sponsored by
CIS — China Instrument and Control Society (China)
SPIE

Published by SPIE

**Volume 10619** 

Proceedings of SPIE 0277-786X, V. 10619

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

2017 International Conference on Optical Instruments and Technology: Advanced Laser Technology and Applications, edited by Zhiyi Wei, Chunqing Gao, Pu Wang, Franz X. Kärtner, Jayanta Kumar Sahu, Proc. of SPIE Vol. 10619, 1061901 · © 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2317179

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 2017 International Conference on Optical Instruments and Technology: Advanced Laser Technology and Applications, edited by Zhiyi Wei, Chunqing Gao, Pu Wang, Franz X. Kärtner, Jayanta Kumar Sahu, Proceedings of SPIE Vol. 10619 (SPIE, Bellingham, WA, 2018) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510617490

ISBN: 9781510617506 (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.ora

Copyright © 2018, 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 0277-786X/18/\$18.00.

Printed in the United States of America.

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	Authors
ix	Symposium Committee
xi	Conference Committee
xiii	Introduction
XV	Conference Organizers
SESSION 1	SOLID STATE LASERS AND TECHNIQUES I
10619 02	Balanced detection for self-mixing interferometry to improve signal-to-noise ratio [10619-42]
10619 03	408-fs SESAM mode locked Cr:ZnSe laser [10619-51]
CECCION O	COLID STATE LASERS AND TECHNIQUES II
SESSION 2	SOLID STATE LASERS AND TECHNIQUES II
10619 04	Theoretical analyses of a 1.617-µm laser with a MOPA configuration [10619-55]
10619 04 10619 05	Theoretical analyses of a 1.617-µm laser with a MOPA configuration [10619-55]  Theoretical evaluation of a continuous-wave Ho³+:BaY₂F8 laser with mid-infrared emission [10619-62]
	Theoretical evaluation of a continuous-wave Ho³+:BaY₂F8 laser with mid-infrared emission
10619 05	Theoretical evaluation of a continuous-wave Ho³+:BaY₂F8 laser with mid-infrared emission [10619-62]  Analysis of the thermal effect in diode end-pumped Er:YAG lasers by using Finite Element
10619 05	Theoretical evaluation of a continuous-wave Ho³+:BaY₂F8 laser with mid-infrared emission [10619-62]  Analysis of the thermal effect in diode end-pumped Er:YAG lasers by using Finite Element
10619 05	Theoretical evaluation of a continuous-wave $Ho^{3+}$ : $BaY_2F_8$ laser with mid-infrared emission [10619-62]  Analysis of the thermal effect in diode end-pumped Er:YAG lasers by using Finite Element Method [10619-67]
10619 05 10619 06 SESSION 3	Theoretical evaluation of a continuous-wave Ho³+:BaY₂F8 laser with mid-infrared emission [10619-62]  Analysis of the thermal effect in diode end-pumped Er:YAG lasers by using Finite Element Method [10619-67]  FIBER LASERS
10619 05 10619 06 SESSION 3	Theoretical evaluation of a continuous-wave Ho³+:BaY₂F₃ laser with mid-infrared emission [10619-62]  Analysis of the thermal effect in diode end-pumped Er:YAG lasers by using Finite Element Method [10619-67]  FIBER LASERS  High-power, narrow linewidth single-frequency fiber laser at 2 µm [10619-27]  Noise-like pulse generation from a Ho-doped fiber laser based on nonlinear polarization

SESSION 4	NOVEL LASERS AND APPLICATIONS
10619 OB	Biocompatibility enhancement of rare earth magnesium alloy by laser surface processing [10619-6]
10619 OC	A fast 8-channel wavelength switching DFB diode laser array based on reconstruction-equivalent-chirp technique [10619-11]
10619 0D	A 1.5-µm frequency-sweepable single frequency fiber laser [10619-75]
SESSION 5	FIBER LASERS AND TECHNIQUES
10619 OE	High-power all fiber-integrated linearly polarized picosecond ytterbium-doped master-oscillator power amplifier [10619-54]
10619 OF	Single-longitudinal mode distributed-feedback fiber laser with low-threshold and high-efficiency [10619-79]
	POSTER SESSION
10619 0G	2-kW single-mode fiber laser employing bidirectional-pump scheme [10619-2]
10619 OH	Er:YAG triangular ring laser resonantly pumped by a 1470-nm laser diode [10619-20]
10619 01	A SBG semiconductor laser with the lasing wavelength tuned by controlling the injection current ratio into its three electrodes [10619-21]
10619 OJ	Fitting relationship between the beam quality $\beta$ factor of high-energy laser and the wavefront aberration of laser beam [10619-22]
10619 OK	Dynamic exposure model analysis of continuous laser direct writing in Polar-coordinate [10619-25]
10619 OL	Simulation and analysis of spectroscopic filter of rotational Raman lidar for absolute measurement of atmospheric temperature [10619-29]
10619 OM	Research on the linewidth and threshold characteristics of 1.55-µm all-fiber external cavity laser with silver diaphragm [10619-33]
10619 ON	Investigations of different doping concentration of phosphorus and boron into silicon substrate on the variable temperature Raman characteristics [10619-38]
10619 00	Research on wind field algorithm of wind lidar based on BP neural network and grey prediction [10619-39]
10619 OP	1-MHz high power femtosecond Yb-doped fiber chirped-pulse amplifier [10619-41]
10619 0Q	Passively Q-switched mode-locked Tm,Ho:LLF laser with a reflection-type MoS <sub>2</sub> saturable absorber [10619-43]

10619 OR	Experimental study on three-longitudinal-mode CW laser output of LD-pumped Nd:YAG thin disk [10619-46]
10619 0\$	Coherent dual-frequency lidar system design for distance and speed measurements [10619-52]
10619 OT	Research progress of laterally coupled DFB-LD [10619-53]
10619 OU	Dual-frequency continuous wave optical parametric oscillator [10619-58]
10619 OV	High convergence efficiency design of flat Fresnel lens with large aperture [10619-59]
10619 OW	Analyses of absorption distribution of a rubidium cell side-pumped by a Laser-Diode-Array (LDA) [10619-63]
10619 OX	Simulation study on detection performance of eye-safe coherent Doppler wind lidar operating near 1.6 $\mu m$ [10619-69]
10619 OY	Simulation study of interaction of pulse laser with tumor-embedded gastric tissue using finite element analysis [10619-71]
10619 OZ	Theoretical investigation on the propagation and super-continuum generation of an ultrashort pulse in a highly nonlinear fiber [10619-74]
10619 10	978-nm square-wave in an all-fiber single-mode ytterbium-doped fiber laser [10619-83]
10619 11	Influence of pitting defects on quality of high power laser light field [10619-85]

#### **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.

An, Guofei, 04, 05, 0W Bi, Tiezhu, OM Bu, Xiangbao, 03 Cai, He, 04, 05, 0W Cai, Zhen, 08 Chen, Bo, 11 Chen, Chun-Li, 0O Chen, Xiangfei, 01 Chen, Yong, 0O Ding, Kai, 0N Dong, Zhong, 0Q Du, Weikang, 0C Du, Yinchao, 0C Fang, Tao, 0C Feng, Xian, 0D Gao, Chunging, 0H Gao, Junxuan, 0N Gao, Mingwei, 06, 0X Gu, Chun, 10 Gu, Xiiia, 0F Guan, Yingchun, OB Guan, Zhe, OR, OV Han, Juhong, 04, 05, 0W Hao, Yongain, 0T He, Dongbing, OR Hong, Chang, 0E

Hou, Jing, 08 Hou, Yubin, 07, 0D Hu, Xiang-Long, 0L Hu, Zhongqi, 0P Hua, Dengxin, 0L Huang, Long, 0A Ji, Zhong-Ye, 0J Jiang, Hongzhen, 11 Jiang, Man, 0F Ke, Jieyao, 0V Leng, Jinyong, 0A

Li, Bin, OZ
Li, Hui, OY
Li, Hui, OY
Li, Huijuan, O3
Li, Jinhua, OR
Li, Ke, OQ
Li, Kun, O2, O9
Li, Kun, OU
Li, Qi-Meng, OL
Li, Ruixiao, O9
Li, Shichun, OL
Li, Shujie, 10
Li, Xiaoli, ON

Li, Wei, 0C Li, Yang, OT Li, Zhifang, OY Ling, Weijun, 0Q Liu, Guangchen, 08 Liu, Haifena, OB Liu, Jian, 0N Liu, Jiang, 0E Liu, Lantian, 0Y Liu, Qin, 0Q Liu, Runze, Ol Liu, Shangjing, Ol Lu, Feiping, 0Q Lu, Jun, Ol Lu, Liang, 0M Luo, Xiong, 00 Lv, Yingjun, 0K Ma, Han, 0X Ma, Hua, 11 Mao, Wenjie, 0K Na, Quanxin, 06, 0X Nie, Shilin, OB Norgia, Michele, 02 Qi, Shuxian, 07, 0D

Ren, Huan, 11
Rong, Kepeng, 04, 05, 0W
Shi, Pengyang, 0G
Shi, Xiao-ding, 0O
Shi, Yang, 0H
Shi, Yuechun, 0I
Shi, Yuhang, 03, 0E
Shi, Zhendong, 11
Song, Yue-Hui, 0L
Sun, Bingjie, 0U
Sun, Ruoyu, 0E
Tao, Xia, 0Q
Teng, Hao, 0P

Wang, Chenchen, 0M Wang, Hongyuan, 04, 05, 0W

Wang, Lei, 00

Wang, Pu, 03, 07, 0D, 0E Wang, Qing, 06, 0H, 0X Wang, Shunyan, 04, 05, 0W

Wang, Shuo, 0H Wang, Xia, 0T Wang, Xin, 0U Wang, Yingying, 0C Wang, You, 04, 05, 0W

Wang, Yu, 0E

Wang, Yujia, 06

Wang, Yuqing, OB

Wang, Zhiwei, OT

Wei, Zhiyi, OP

Wu, Jian, 0A

Wu, Peng, 04, 05, 0W

Xiao, Hu, 0A

Xie, Jianlai, 0T

Xin, Wenhui, 0L

Xu, Jia, 03

Xu, Jiangming, 0A

Xu, Lixin, 10

Yang, Hongzhi, OS

Yang, Linyong, 08

Yang, Peilong, OP

Yang, Suhui, OU

Yang, XiaoYu, 11

Yang, Yi, 11

Yang, Ze-hou, 00

Ye, Jun, 0A

Ye, Qing, 0H

Yin, Ke, 08

You, Liangfang, 0Q

Yu, Hang, 04, 05, 0W

Yu, Qiang, 04, 05, 0W

Yue, Guangli, 0T

Zeng, Fanruiqi, OZ

Zhang, Bin, 08

Zhang, Fan, 0G

Zhang, Haiyang, OR, OS

Zhang, Hanwei, 0A

Zhang, Jiabin, 0T

Zhang, Lin, 11

Zhang, Meng, 06

Zhang, Qian, 07

Zhang, Qian, 0D

Zhang, Shan, OK

Zhang, Wei, 04, 05, 0W

Zhang, Weifeng, 0N

Zhang, Xiao-Fang, 0J

Zhang, Xin, OT

Zhang, Xinhai, 0G

Zhang, Yan, 00

Zhang, Yixuan, 06

Zhao, Changming, 02, 09, 0R, 0S, 0V

Zhao, Guowang, 0C

Zhao, Jing, OL

Zheng, Wanguo, 11

Zheng, Wenyou, 0G

Zheng, Xingyuan, OS

Zheng, Zheng, OS

Zhou, Jie, 00

Zhou, Pu, OA, OF

Zhou, Yating, Ol

Zhu, Jiangfeng, OP

Zhu, Rihong, 11

Zuo, Yingyan, 0Q

viii

#### Symposium Committee

General Chairs

**Tianchu Li**, National Institute of Metrology (China) **H. Phillip Stahl**, NASA Marshall Space Flight Center (United States)

Conference Co-Chairs

Songlin Zhuang, Shanghai University of Science and Technology (China)
Liwei Zhou, Beijing Institute of Technology (China)
Shenghua Ye, Tianjin University (China)
Yimo Zhang, Tianjin University (China)
Zheng You, Tsinghua University (China)
Guangjun Zhang, Southeast University (China)

Technical Program Chair

Guofan Jin, Tsinghua University (China)

Technical Program Co-Chairs

Jinxue Wang, SPIE Tiegen Liu, Tianjin University (China)

Local Organizing Committee Chair

Youhua Wu, China Instrument and Control Society (China)

Local Organizing Committee Co-Chairs

**Guoqiang Ni**, Beijing Institute of Technology (China) **Daoyin Yu**, Tianjin University (China)

General Secretary

Tong Zhang, China Instrument and Control Society (China)

Administrative Vice General Secretary

**Yu-nan Sun**, Beijing Institute of Technology (China)

Vice General Secretaries

**Qun Hao**, Beijing Institute of Technology (China) **Yuejin Zhao**, Beijing Institute of Technology (China) **Cunlin Zhang**, Capital Normal University (China) **Liquan Dong**, Beijing Institute of Technology (China)

#### Local Organizing Committee

Hongda Chen, Institute of Semiconductors, CAS (China)
Xuping Zhang, Nanjing University (China)
Shangzhong Jin, China Jiliang University (China)
Libo Yuan, Harbin Engineering University (China)
Yumei Wen, Chongqing University (China)
Tian Lan, Beijing Institute of Technology (China)
Cuiling Li, Beijing Institute of Technology (China)

#### **Conference Committee**

#### Conference Chairs

Zhiyi Wei, Institute of Physics, CAS (China)
Chunqing Gao, Beijing Institute of Technology (China)
Pu Wang, Beijing University of Technology (China)
Franz X. Kärtner, Massachusetts Institute of Technology (United States), DESY (Germany)
Jayanta Kumar Sahu, University of Southamptom (United Kingdom)

#### Program Committee

Feng Song, Nankai University (China)Qiang Liu, Tsinghua University (China)Stefan Weber, Institute of Physics of the ASCR, v.v.i. (Czech Republic)

Xuechun Lin, Institute of Semiconductors, CAS (China)

**Hiromitsu Kiriyama**, National Institutes for Quantum and Radiological Science and Technology (Japan)

Liangbi Su, Shanghai Institute of Ceramics (China)

**Yishan Wang**, Xi'an Institute of Optics and Precision Mechanics, CAS (China)

**You Wang**, Southwest Institute of Technical Physics (China) **Jiangfeng Zhu**, Xidian University (China)

#### Session Chairs

- Solid State Lasers and Techniques **Zhiyi Wei**, Institute of Physics, CAS (China)
- Solid State Laser and Techniques
  Chunqing Gao, Beijing Institute of Technology (China)
- Fiber Lasers
  Pu Wang, Beijing University of Technology (China)
- 4 Novel Lasers and Applications
   Chunqing Gao, Beijing Institute of Technology (China)
- Fiber Lasers and TechniquesPu Zhou, National University of Defense Technology (China)

#### Introduction

The 6th Advanced Laser Technology and Applications Conference (ALTA 2017) is one of the eight conferences in International Conference on Optical Instrument and Technology (OIT 2017) which were held 28–30 October 2017 in Beijing, China. During those days, the conference provided a technical forum for reporting and discussing about the latest research and development in laser science and technologies, as well as its promising applications.

The conference was organized into technical sessions on solid state lasers, fiber lasers and novel lasers, related technologies and applications. Up to 300 presentations to the overall symposium (including 5 invited talks, 25 regular contributions and 24 posters to ALTA 2017) reported the latest achievements in the above fields from all over the world, especially in China. Many remarkable progresses such as: KW high-power all-solid-state quasi-continuous wave laser and their applications, efficient solid-state laser for vortex and vector output, optical field manipulation of random distributed feedback fiber lasers, diode-pumped Kerr-lens mode-locked high power Yb-bulk lasers, and laser patterning technology for the manufacturing of paper-based medical diagnostic devices, etc., attracted wide interesting by participants.

As the chairs of this conference, we would like to express our gratitude to all participants and committee members who contributed to the conference through their presentations and service. We also hope to thank SPIE for editing the Proceedings publication. Without the cooperation and support by all participants and committees, the conference could not have been so successful.

Zhiyi Wei Chunqing Gao Pu Wang Franz X. Kärtner Jayanta Kumar Sahu

#### **Conference Organizers**

Organized by

Opto-Electronic-Mechanic Technology and System Integration Chapter, CIS (China)

Committee on Optoelectronic Technology, COS (China)

Committee on Optics, China Ordnance Society (China)

Optical Instrument Chapter, CIS (China)

Beijing Institute of Technology (China)

Tianjin University (China)

Tsinghua University (China)

Peking University (China)

Nanjing University (China)

Shanghai Jiao Tong University (China)

Zhejiang University (China)

Nankai University (China)

Capital Normal University (China)

Beijing University of Posts and Telecommunications (China)

Chongqing University (China)

University of Shanghai for Science and Technology (China)

Instrument Society of America (United States)

Institute of Measurement and Control (United Kingdom)

Hong Kong Institution of Engineers (Hong Kong, China)

The Society of Measurement and Control (Japan)