# PROCEEDINGS OF SPIE

# 24th National Laser Conference & Fifteenth National Conference on Laser Technology and Optoelectronics

Jianqiang Zhu Weibiao Chen Zhenxi Zhang Minlin Zhong Pu Wang Jianrong Qiu Editors

### 17–20 October 2020 Shanghai, China

Organized by Chinese Academy of Engineering Chinese Institute of Electronics Chinese Optical Society Chinese Laser Press

Published by SPIE

Volume 11717

Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 11717

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

24th National Laser Conference & Fifteenth National Conference on Laser Technology and Optoelectronics, edited by Jianqiang Zhu, Weibiao Chen, Zhenxi Zhang, Minlin Zhong, Pu Wang, Jianrong Qiu, Proc. of SPIE Vol. 11717, 1171701 · © 2020 SPIE · CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2589936 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 24th National Laser Conference & Fifteenth National Conference on Laser Technology and Optoelectronics, edited by Jianqiang Zhu, Weibiao Chen, Zhenxi Zhang, Minlin Zhong, Pu Wang, Jianrong Qiu, Proceedings of SPIE Vol. 11717 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510642690 ISBN: 9781510642706 (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 © 2020, 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. 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/20/\$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.



**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

- xi Conference Committee
- xiii Introduction

### Part One

# 24TH NATIONAL LASER CONFERENCE & FIFTEENTH NATIONAL CONFERENCE ON LASER TECHNOLOGY AND OPTOELECTRONICS

11717 02 Fast alignment of the Offner imaging spectrometer with spherical autostigmatic method [11717-2] 11717 03 Analysis of performance of FSO communication system based on EW turbulence and pointing errors under aperture averaging [11717-3] 11717 04 Hydrodynamic and thermal simulation for high energy large size Nd:YAG liquid-cooled laser amplifier [11717-4] 11717 05 Research on pulse stretching of underwater bubbles echo signal of lidar [11717-5] 11717 06 Effect of laser shock processing on the surface morphology and microstructure of metal material [11717-7] 1171707 Analysis of dynamics stability of a twisted fiber external cavity semiconductor laser [11717-8] 11717 08 Experimental studies on laser paint striping of high-speed railway carriages [11717-9] 11717 09 Prediction of atmospheric turbulence refractive index structure constant based on deep learning [11717-10] 11717 OA Experimental research on LD pumped trapezoidal Nd:YAG laser [11717-11] 11717 OB Study on the interaction mechanism of pulsed laser and normal shock [11717-12] 11717 OC A band Mura detection method based on a new generative adversarial network [11717-13] 11717 OD Photon tunneling and transmittance through composite layers of negative- and positive-index media with sinusoidal interface [11717-14] 11717 OE The research progress on strengthen property and mechanism of warm laser shock peening [11717-17] 11717 OF Analysis of beam waist on temporal characteristic from electron driven by intense linearly polarized laser pulses [11717-19]

11717 0G	AlGaAs Bragg reflection waveguide design optimization for photon pair generation [11717-20]
11717 OH	Narrow bandwidth metamaterial sensor based on periodic grating structure for temperature sensing [11717-21]
11717 01	Initial phase-sensitivity of spatial characteristics in the tightly and non-tightly focused linearly polarized few-cycle region [11717-22]
11717 OJ	Chaos-control leads to semi-frequency locking or frequency locking, or double-dynamics in a dual-ring erbium-doped fiber laser using an anti-parameter pair modulation [11717-23]
11717 OK	Study on Mueller matrix of random rough surface [11717-24]
11717 OL	Influence of laser intensity on pulse width of nonlinear Thomson scattering in circularly polarized tightly focused laser pulses [11717-25]
11717 OM	Study of two-mode coexistence in 1550-nm vertical-cavity surface-emitting lasers subject to variable polarization optical feedback [11717-26]
11717 ON	On-line detection method for porosity defects in high power fiber laser welding [11717-27]
11717 00	A high-precision automatic phase shifting algorithm with wavelength tuning [11717-28]
11717 OP	Efficiency enhancement of GaN based light-emitting diodes with an n-i-p type last quantum barrier [11717-29]
11717 0Q	Effects of detection distance on the photoacoustic detection of glucose and concentration prediction [11717-30]
11717 OR	A band-shaped Mura detection method based on unsupervised deep learning [11717-31]
11717 OS	Three-dimensional dynamic compressive imaging system [11717-32]
11717 OT	Design of PPM modulation and demodulation module in optical communication [11717-33]
11717 OU	Fiber optic wrist pulse sensor for health monitoring in the home [11717-34]
11717 0V	Performance evaluation of calcium atom beam vacuum system [11717-35]
11717 OW	Integrating design of a compact optical system for ultra-stable laser system [11717-36]
11717 OX	Analysis of statistical characteristics for quantum noise stream cipher [11717-37]
11717 OY	Analysis of defect induced light intensification due to second-order effect in high power laser systems [11717-38]
11717 OZ	Analysis of pulse widths on the spatial characteristics of electron motion and radiation driven by linearly polarized tightly focused laser pulses [11717-39]

11717 10	Tunable terahertz metasurface resonator based on phase transition of VO2 crosses [11717-40]
11717 11	Research on image stabilization control algorithm of UAV Gm-APD lidar PID [11717-41]
11717 12	Experimental study on obtaining visible hollow light of 532nm based on conical refraction of biaxial crystal [11717-42]
11717 13	Microstructural and electrochemical characterization of aluminum / steel joints conducted by dual-beam laser [11717-43]
1171714	Single multimode fiber focused spot scanning based on a liquid crystal spatial light modulator [11717-44]
11717 15	High-speed focusing and scanning light through multimode fiber [11717-45]
11717 16	Pulse width stretched Q-switched Nd:YAG green laser based on a multi-pass cavity [11717-46]
11717 17	Specificity of saturated absorption spectroscopy on Cs D2 line induced by a multi-wavelength laser [11717-49]
11717 18	Design of multiwavelength confocal plane multifocal metalens based on CGH in visible band [11717-51]
11717 19	A hybrid suspended core fiber with improved nonlinearity and dispersion characteristics [11717-52]
11717 1A	Research on the interaction between pulsed laser and brain tissue based on COMSOL [11717-53]
11717 1B	High order mode evolution in large mode area fiber lasers with suppressing strategies [11717-54]
11717 IC	Effect of laser texture fitting grooves on plasma-sprayed filling coating model [11717-55]
11717 ID	Fiber optic acoustic emission sensing system using a SOA-based fiber ring laser [11717-56]
11717 1E	Design of high precision single channel TDC based on FPGA [11717-57]
11717 1F	Performance comparison of Mach-Zehnder interferometer and Fabry- Perot interferometer as the spectral discriminator in high-spectral-resolution-lidar [11717-59]
11717 IG	Passively Q-switched mode-locked Tm,Ho:CaYAlO4 laser at 2089 nm [11717-60]
11717 IH	Influence of model characteristic parameters on thermal effect analysis of solid-state laser [11717-62]
11717 11	Beam combiner with single gradient index lens [11717-63]

- 11717 1J Research on the single event effect of CCD analog front-end for satellite-borne directional polarization camera [11717-64]
- 11717 1K Effect of LiNbO<sub>3</sub> crystals temperature on ultra-fast laser induced periodic surface structures [11717-65]
- 11717 1L A novel and simple heterodyne interferometer scheme [11717-66]
- 11717 1M Laboratory demonstration of a precise laser ranging system for future China's satellite gravity mission [11717-67]
- 11717 1N Diode-pumped passively Q-switched Yb:Lu<sub>3</sub>Al<sub>5</sub>O<sub>12</sub> ceramic laser operating at 1031 nm or 1047 nm [11717-68]
- 11717 10 Detection and compensation of micro deformation in pulsed laser beam welding [11717-69]
- 11717 1P **2H-MoTe**<sub>2</sub> based noise-like pulse erbium-doped fiber laser [11717-70]
- 11717 1Q Experimental study on new crystal used in repetition frequency laser device of laser terminal guidance system [11717-71]
- 11717 1R Experimental research on light emission time of laser terminal guidance irradiator [11717-72]
- 11717 1S Constant ring width of the Laguerre–Gaussian vortex beams [11717-74]
- 11717 17 Quantitative analysis of boron in ceramics by laser-induced breakdown spectroscopy [11717-75]
- 11717 10 **Tunable vortex laser based on intra-cavity aspheric lens** [11717-77]
- 11717 1V Filtered back-projection photoacoustic denoising reconstruction based on empirical mode decomposition [11717-78]
- High corrosion resistance micro-structure of AI alloy fabricated by laser [11717-79]

### Part Two

- 11717 1X Comparison of half-wave phase retarder and quarter-wave phase retarder [11717-80]
- Assembly and error analysis of back focal plane-typed apertometer [11717-81]
- 11717 1Z Multiple laser scattering of dust haze in low visibility [11717-82]
- 11717 20 Influence of laser beam oscillation on welding stability and molten pool dynamics [11717-83]
- 11717 21 Ultra-wide bandstop filter based on nested square resonant ring [11717-86]

11717 22	Analysis of the influence of skull on photon transmission based on Monte Carlo method [11717-89]
11717 23	Propagation characteristics of high-average-power tube laser in hemisphere turret at sonic speeds [11717-90]
11717 24	Spectral control of the joule level broadband laser amplifier system based on ASE source [11717-91]
11717 25	Endoscopic photoacoustic micro-imaging technology based on microcavity detection [11717-92]
11717 26	Research on UV femtosecond pulsed laser cutting carbon fiber composite materials [11717-93]
11717 27	1x2 optofluidic few-mode waveguide optical switch [11717-94]
11717 28	Experimental research of supercontinuum generation in a 1030nm fiber amplifier [11717-95]
11717 29	External cavity spectrum beam combining based on quantum cascade laser array [11717-96]
11717 2A	Research on optically pumped vertical-external-cavity-surface-emitting-semiconductor laser at 1178 nm [11717-97]
11717 2B	Fabrication of high-power 2µm GaSb-based laser [11717-98]
11717 2C	Satellite laser altimeter pointing and ranging calibration algorithm based on simulated annealing [11717-99]
11717 2D	Research on ultraviolet femtosecond pulsed laser cutting 4H-SiC [11717-100]
11717 2E	Model of three-dimensional thermal stress applied in cleaning of black crusts on granite [11717-101]
11717 2F	Research on the performance comparison of three HACO-OFDM systems [11717-102]
11717 2G	New residual neural network for rapid imaging of scattering [11717-103]
11717 2H	Structural design of mode propagation interface for tapered laser diodes [11717-104]
11717 21	Study on laser induced forming process parameters of aluminum alloy thermotube [11717-105]
11717 2J	Long-distance underwater optical wireless communication with PPLN wavelength conversion [11717-106]
11717 2L	Simulation of the influence of gain parameters on pulse formation process for VECSELs [11717-108]
11717 2M	Femtosecond laser controlling of filaments inside PMMA and its fabrication [11717-109]

11717 2N	Fabrication of large-scale silicon nitride resonator by femtosecond laser [11717-110]
11717 20	Design and implementation of a miniaturized beam emitting and tracking system [11717-111]
11717 2P	Nanometer-accuracy two-dimensional targets detection by orthogonal self-mixed laser interferometry [11717-112]
11717 2Q	Programmable vascular targeted photodynamic therapy device for animal experiment [11717-113]
11717 2R	The light modulation of scratches on the surface of fused silica glass [11717-114]
11717 2S	Photo-acoustic detection of laser-induced damage on optical component based on PVDF electrospinning [11717-115]
11717 2T	Polarization evolution and propagation properties of the circular Airy vector vortex beams [11717-116]
11717 20	All stokes vector polarization spectral imaging based on the focal plane method [11717-117]
11717 2V	Goos-Hänchen shifts at the anisotropic two-dimensional atomic crystals interface [11717-118]
11717 2W	Modal inspection technology based on transverse second harmonic generation in single nonlinear micro/nanowaveguide [11717-119]
11717 2X	Research on high precision laser phase measurement technology for space-based precision ranging [11717-120]
11717 2Y	Effects of laser polishing on surface morphology and mechanical properties of additive manufactured TiAl components [11717-121]
11717 2Z	Strong coupling numerical simulation study on nanosecond pulsed laser ablation of K4002 superalloy [11717-123]
11717 30	Design of receiver circuit in pulse laser range [11717-124]
11717 31	Polarization correlation of optical microfiber particle sensor system [11717-125]
11717 32	Circular polarization shift-keying and amplitude shift-keying hybrid modulation method based on orbital angular momentum division multiplexing [11717-126]
11717 33	Evaluation method for laser spot quality [11717-127]
11717 34	A miniature high temperature fiber optics sensor based on tapered dual-core photonic crystal fiber [11717-128]
11717 35	<b>2 kW monolithic fiber amplifier based on constant-cladding tapered-core Yb-doped fiber</b> [11717-130]

11717 36	The latest developments of HgCdTe e-APDs at SITP [11717-131]
11717 37	Dark current mechanism of medium wave HgCdTe avalanche photodiode [11717-132]
11717 38	Research on laser precision cutting of carbon fiber reinforced polymer for satellite [11717-133]
11717 39	Ablation threshold behavior of femtosecond laser twin double-pulse processing of solids [11717-134]
11717 3A	Temperature measurement of single point through uniform fiber Bragg grating [11717-136]
11717 3B	Study on the detection ability of laser ultrasonic SAFT technology for lead internal defects [11717-137]
11717 3C	Surface forming mechanism and process in laser milling of 7075 aluminum alloy with inclination [11717-138]
11717 3D	Research on laser cleaning process of 907 steel for marine instruments based on parallel multi- beam by SLM [11717-139]
11717 3E	Research advances about opto-electrical properties of Si-based blocked impurity band terahertz detectors [11717-140]
11717 3F	Simulation and experimental investigation on energy distribution of water column in waterjet guided laser processing [11717-142]
11717 3G	Theoretical research on optimizing the output power of double-ended output fiber laser [11717-143]
11717 3H	2kW narrow linewidth all fiber laser [11717-145]
11717 31	Size-controllable synthesis of silver nanoparticles by femtosecond laser pulse train [11717-146]
11717 3J	Experimental study on waterjet guided laser processing of 7075 aluminum alloy [11717-149]
11717 3K	Preliminary study on the polarization characteristics of volume scattering from planktonic algae [11717-150]
11717 3L	Study difference between fog and haze based on laser ceilometer [11717-151]
11717 3M	Experimental study of rear surface damage of BK7 glass under irradiation of the millisecond laser assisted by the nanosecond laser [11717-153]
11717 3N	Effects of seed filtering in a narrow line-width Yb-Raman fiber amplifier [11717-154]
11717 30	Study on the scattering characteristics of ice crystal particles containing nuclei [11717-156]
11717 3P	Effect of non-contact electrostatic field on controlling the microstructure of 316L during laser additive manufacturing process [11717-159]

- 11717 3Q Experimental study on cracks and chippings during the ablation of sapphire crystal [11717-160]
- 11717 3R Photonic jet generated by a dielectric spheroid with Bessel beam excitation [11717-161]
- 11717 3SResearch on water-assisted laser processing of CFRP [11717-167]
- 11717 31 Study on laser cleaning technology of epoxy on the surface of ceramic relics [11717-172]
- 11717 30 Theoretical research on rotating doppler effect based on fringe model [11717-173]

### **Conference Committee**

#### Session Chairs

- Advanced solid-state lasers and new lasers Kuanshou Zhang, Shanxi University (China) Minglie Hu, Tianjin University (China) Huailiang Xu, Jilin University (China) Hong Zhang, Sichuan University (China)
- Advanced laser materials, films and components, new functional fibers and devices
  Jianrong Qiu, Zhejiang University (China)
  Shixun Dai, Ningbo University (China)
  Haohai Yu, Shandong University (China)
  Hao Zhou, Sichuan University (China)
- Laser light field regulation, transmission and application
  Yangjian Cai, Shandong Normal University (China)
  Kebin Shi, Peking University (China)
- Advanced laser processing and manufacturing technology
  Feng Chen, Xi'an Jiaotong University (China)
  Lingfei Ji, Beijing University of Technology (China)
  Guoliang Deng, Sichuan University (China)
- Biomedical Photonics and laser medicine
  Zhenxi Zhang, Xi'an Jiaotong University (China)
  Buhong Li, Fujian Normal University (China)
  Chao Yang, Sichuan University (China)
- 6 Laser detection and laser communication
  Yongchao Zheng, Institute of Space and Electromechanical Research (China)
   Dengxin Hua, Xi'an University of Technology (China)
   Lin Geng, CETC (China)
   Hongru Li, Sichuan University (China)
- Semiconductor lasers and advanced optoelectronic devices
  Shijie Xu, University of Hong Kong (China)
  Wanhua Zheng, Institute of Semiconductors, Chinese Academy of Sciences (China)
  Jun Wang, Suzhou Everbright Photonics Company, Ltd (China)

- 8 Terahertz technology and application
  Juncheng Cao, Shanghai Institute of Microsystem and Information
  Technology (China)
  Min Hu, University of Electronic Science and Technology of China (China)
- Nonlinear optics and quantum optics
  Xiaolong Su, Shanxi University (China)
  Lijian Zhang, Nanjing University (China)
  Jianwen Dong, Sun Yat-sen University (China)
- High field laser and its applications
  Baifei Shen, Shanghai Normal University (China)
  Shutong Wang, Sichuan University (China)

## Introduction

Optics Frontier — The National Conference on Laser Technology and Optoelectronics (LTO) was initiated by the Chinese Laser Press in 2006. LTO has been held in Shanghai for 15 years successively. The conference aims at promoting academic progress and development of lasers and related fields in China, providing a professional platform for domestic laser academic exchanges, and building a bridge between laser technology and laser industry by collaborating with the Laser World of Photonics China. This year the 24th National Laser Conference and 15th National Conference on Laser Technology and Optoelectronics (LTO 2020) were held together on 17-20 October, 2020.

Jianqiang Zhu Weibiao Chen Zhenxi Zhang Minlin Zhong Pu Wang Jianrong Qiu