

PROCEEDINGS OF SPIE

# ***Next-Generation Optical Communication: Components, Sub-Systems, and Systems XI***

**Guifang Li**  
**Kazuhide Nakajima**  
*Editors*

**22–27 January 2022**  
**San Francisco, California, United States**

**20–24 February 2022**  
**ONLINE**

*Sponsored by*  
SPIE

*Cosponsored by*  
Corning Incorporated (United States)  
NTT Electronics Corporation (Japan)

*Published by*  
SPIE

**Volume 12028**

Proceedings of SPIE 0277-786X, V. 12028

Next-Generation Optical Communication: Components, Sub-Systems, and Systems XI,  
edited by Guifang Li, Kazuhide Nakajima, Proc. of SPIE Vol. 12028, 1202801 ·  
© 2022 SPIE · 0277-786X · doi: 10.1117/12.2635246

Proc. of SPIE Vol. 12028 1202801-1

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 *Next-Generation Optical Communication: Components, Sub-Systems, and Systems XI*, edited by Guifang Li, Kazuhide Nakajima, Proc. of SPIE 12028, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510649279  
ISBN: 9781510649286 (electronic)

Published by  
**SPIE**  
P.O. Box 10, Bellingham, Washington 98227-0010 USA  
Telephone +1 360 676 3290 (Pacific Time)  
[SPIE.org](http://SPIE.org)  
Copyright © 2022 Society of Photo-Optical Instrumentation Engineers (SPIE).

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 fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center 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.

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:** A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE 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

v *Conference Committee*

---

## NOVEL FIBERS AND AMPLIFIERS

---

- 12028 02 **Concentric layers with heterogeneous doping for cladding-pumped L-band fiber amplifiers** [12028-11]
- 12028 03 **Towards a better understanding of light scattering in few-mode optical fibers** [12028-14]
- 12028 04 **Efficient and compact photonic lanterns through cascaded tapering** [12028-7]
- 12028 06 **Ultra-high-density uncoupled multi-core fibers (Invited Paper)** [12028-13]

---

## SHORT REACH AND OPTICAL DEVICES

---

- 12028 07 **Highly integrated optical modules for  $\geq 400$ -G coherent optical links (Invited Paper)** [12028-27]
- 12028 08 **Emulation of integrated high-bandwidth photonic AWG using low-speed electronics** [12028-29]
- 12028 09 **Analysis of the effect of jitter and non-idealities on photonic digital-to-analog converters based on Nyquist pulses** [12028-30]

---

## FREE SPACE AND UNDERWATER OPTICS

---

- 12028 0A **Scintillation robust adaptive optical signal detection in free space optical communications using CSI prediction** [12028-15]
- 12028 0B **Advanced device design for photonic optical phased arrays for laser communication systems** [12028-17]
- 12028 0C **A real-time SiPM based receiver for FSO communication** [12028-20]
- 12028 0D **Underwater turbulence on scintillating-fiber based omnidirectional underwater wireless optical communication system** [12028-21]
- 12028 0E **Underwater optical wireless sensor network for real-time underwater environmental monitoring** [12028-22]

12028 OF **Practical WDM photonic receiver based on wide-field-of-view and large-area detection scintillating fibers: a field experiment** [12028-23]

---

**LONG-HAUL TRANSMISSION AND AI NETWORKING I**

---

12028 OH **High data-rate and long-distance wideband transmission in 125  $\mu\text{m}$  diameter fibers (Invited Paper)** [12028-2]

**POSTER SESSION**

---

12028 OI **Optimal control of Beneš optical networks assisted by machine learning** [12028-32]

12028 OJ **Record gain of 300-nm broadband single-model Cr-doped crystalline fiber employing novel growth of smaller core** [12028-33]

---

**LONG-HAUL TRANSMISSION AND AI NETWORKING II**

---

12028 OK **AI-driven applications over telecom networks by distributed fiber optic sensing technologies (Invited Paper)** [12028-5]

# Conference Committee

## *Symposium Chairs*

**Sonia M. García-Blanco**, Universiteit Twente (Netherlands)  
**Bernd Witzigmann**, Friedrich-Alexander-Universität  
Erlangen-Nürnberg (Germany)

## *Symposium Co-chairs*

**Sailing He**, KTH Royal Institute of Technology (Sweden) and  
Zhejiang University (China) and  
**Yasuhiro Koike**, Keio University (Japan)

## *Program Track Chair*

**Benjamin Dingel**, Nasfine Photonics, Inc. (United States)

## *Conference Chairs*

**Guifang Li**, CREOL, The College of Optics and Photonics,  
University of Central Florida (United States)  
**Kazuhide Nakajima**, NTT - Tsukuba R&D Center (Japan)

## *Conference Program Committee*

**Kazi S. Abedin**, OFS Fitel LLC (United States)  
**Jin-Xing Cai**, TE Connectivity Ltd. (United States)  
**Ezra Ip**, NEC Labs. America, Inc. (United States)  
**Yongmin Jung**, Optoelectronics Research Center (United Kingdom)  
**Tsuyoshi Konishi**, Osaka University (Japan)  
**Ming-Jun Li**, Corning Incorporated (United States)  
**Chao Lu**, The Hong Kong Polytechnic University (Hong Kong, China)  
**Akihiro Maruta**, Osaka University (Japan)  
**Takashi Sasaki**, Innovation Core SEI, Inc. (United States)  
**Siyuan Yu**, University of Bristol (United Kingdom)  
**Xiang Zhou**, Google (United States)  
**Yanjun Zhu**, Hisense Broadband, Inc. (United States)

## *Conference Review Committee*

**Benjamin B. Dingel**, Nasfine Photonics, Inc. (United States)  
**Spiros Mikroulis**, SMART Photonics (Netherlands)

