# PROCEEDINGS OF SPIE

# Fiber Lasers and Glass Photonics: Materials through Applications III

Maurizio Ferrari Angela B. Seddon Stefano Taccheo Editors

3–7 April 2022 Strasbourg, France

9–20 May 2022 ONLINE

Sponsored by SPIE

Cosponsored by
City of Strasbourg (France)
IdEx University of Strasbourg (France)
CNRS (France)
iCube (France)
Université de Strasbourg (France)

Cooperating Organisations
Photonics 21 (Germany)
EOS—European Optical Society (Germany)
Photonics Public Private Partnership (Belgium)
Photonics France (France)

Published by SPIE

Volume 12142

Proceedings of SPIE 0277-786X, V. 12142

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 *Fiber Lasers and Glass Photonics: Materials through Applications III*, edited by Maurizio Ferrari, Angela B. Seddon, Stefano Taccheo, Proc. of SPIE 12142, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510651609

ISBN: 9781510651616 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time)

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. 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.



**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

ix Conference Committee

|          | MATERIALS AND COMPONENTS I: NANOCRYSTALS, NANOPARTICLES, AND PLASMONICS   |
|----------|---|
| 12142 02 | Glass powder doping of nanocrystal-doped fibres: challenges and results (Invited Paper)                         |
| 12142 03 | Planar and rectangular ceramic Yb:YAG laser waveguides [12142-3]  |
| 12142 04 | Exploiting surface plasmon resonance for integrated optics [12142-4]  |
|          | MATERIALS AND COMPONENTS II: FILMS, NOVEL CONCEPTS, AND PROCESSES   |
| 12142 05 | Tungsten oxide films for near-infrared photonics and sensing (Invited Paper) [12142-7]                          |
| 12142 06 | RF-sputtering fabrication of flexible glass-based 1D photonic crystals [12142-9]                                |
| 12142 07 | Gas sensing using xerogel coated whispering gallery mode resonators [12142-10]                                  |
| 12142 08 | $SiO_2$ - $TiO_2$ hybrid coatings applied on polymeric materials for flexible photonics applications [12142-11] |
|          | SPECIAL SESSION HONORING ANNE-MARIE JURDYC: EARLY STAGE RESEARCHERS AND WOMAN SCIENTISTS                        |
| 12142 09 | Double-doped borate glass light guide with high luminance [12142-13]  |
|          | SPECIAL SESSION ON THE INTERNATIONAL YEAR OF GLASS I  |
| 12142 OB | Alkali-germanate glass-ceramics doped with manganese and chromium ions [12142-18]                               |

## SPECIAL SESSION ON THE INTERNATIONAL YEAR OF GLASS II 12142 0C Spectral properties of cesium lead iodide perovskite nanocrystals in borogermanate glass at different temperatures [12142-22] 12142 0D Shaping nanoparticles in optical fibers through thermal engineering [12142-23] SPECIAL SESSION HONORING ANTONIO LUCIANETTI. MATERIALS AND COMPONENTS III: FIBERS, **COMPONENTS, FABRICATION, AND PROPERTIES** 12142 OE Tellurite-germanate ZnTe: glass-ceramics doped with EuF3 for optical fiber application [12142-27] 12142 OF High power laser-induced damage investigations of mirrors with several substrate materials in combination with heat transfer simulations [12142-28] 12142 0G Investigation of NIR emission in Yb3+/Er3+ - doped fluoroindate glasses for optical fiber **application** [12142-38] MATERIALS AND COMPONENTS IV: SOURCES 12142 OH Laser gain characterization and CW laser operation in Nd:CaF<sub>2</sub> co-doped with Gd<sup>3+</sup> and Y<sup>3+</sup> **buffer ions** [12142-33] MATERIALS AND COMPONENTS V: ACTIVE MATERIALS AND GLASS CERAMICS 12142 01 Spectroscopy of Ho<sup>3+</sup>-doped fluoride glasses for green double-clad fiber lasers [12142-35] 12142 OJ Synthesis and mid-infrared luminescence of "mixed" Er:(Lu,Y,La)<sub>2</sub>O<sub>3</sub> transparent ceramic [12142-36] MID-INFRARED LASER SOURCES: SPECIAL SESSION 12142 OK High-power middle IR and long-wave IR frequency comb generators based on mode-locked polycrystalline Cr:ZnS lasers (Invited Paper) [12142-43] 12142 OL Growth and spectroscopy of $Er^{3+}$ -doped $Na_5Y_9F_{32}$ ( $5NaF \cdot 9YF^3$ ) crystal [12142-46] 12142 OM Large mode area fibers for single-mode transmission near 2µm [12142-48]

|          | FIBERS AND WAVEGUIDE SOURCES I: TWO-MICRON LASERS   |
|----------|---|
| 12142 ON | Tunable wavelength-stabilized mode-locked thulium-doped fiber laser beyond 2000 nm [12142-50]   |
| 12142 00 | 2 μm Raman laser based on CO <sub>2</sub> -filled hollow-core silica fiber (Invited Paper) [12142-51]   |
|          | FIBER LASERS, INFRARED, AND VISIBLE LASERS  |
| 12142 OP | Study of periodic amplitude fluctuations in a mode-lock Ytterbium fiber laser delivering 1 MHz pulse train [12142-55]   |
| 12142 0Q | Quasi-CW and pulsed generation in coupled Raman fiber lasers with PT symmetry [12142-57]  |
|          | FIBERS AND WAVEGUIDE SOURCES II: FIBERS AND MATERIALS   |
| 12142 OR | Laser-induced damages in silica multimode optical fibers [12142-62]   |
| 12142 OS | Er-doped tapered fiber amplifier for high peak power sub-ns pulse amplification [12142-63]  |
|          | APPLICATIONS I  |
| 12142 OT | Whispering gallery modes silica resonators: a platform for optical sensing (Invited Paper) [12142-65]   |
|          | APPLICATIONS II   |
| 12142 OU | Enhancing photocatalysis by means of up-conversion photonics materials for pollutant degradation and hydrogen generation: "bridge the gap" (Invited Paper) [12142-70] |
| 12142 OV | Laser energy delivery method and apparatus using multiple beam interference [12142-71]  |
| 12142 OW | lonizing radiation profiling through the induced refractive index change in backscattering-enhanced optical fibers [12142-72]   |
|          | FIBER LASERS: NOVEL CONCEPTS  |
| 12142 0X | Broadband NIR luminescence in double-core germanate optical fiber (Invited Paper) [12142-74]  |

| 12142 OY | Effect of bi-directional excitation and external feedback on the mode structure of distributed-feedback lasers [12142-75]                      |
|----------|--|
| 12142 OZ | Design of an Er <sup>3+</sup> : InF <sub>3</sub> fiber laser pumped with red light [12142-76]  |
| 12142 10 | Feasibility investigation of Ho: Nd codoped $InF_3$ fibers pumped at 808 nm wavelength [12142-77]  |
| 12142 11 | Generation of modulation instability-induced high-repetition-rate pulse train with high-phase modulation depth [12142-78]                      |
| 12142 12 | Giant pulse generation in the fibers with inscribed Bragg gratings [12142-79]  |
|          |  |
|          | POSTER SESSION   |
| 12142 13 | Photoluminescence of Er/Yb-doped zinc-silicate glass and glass ceramics with ZnO and Zn <sub>2</sub> SiO <sub>4</sub> nanoparticles [12142-80] |
| 12142 14 | Supermode noise suppression in harmonically mode-locked fiber laser by continuous wave injection [12142-81]                                    |
| 12142 15 | Harmonically mode-locked fiber laser with fine repetition rate tuning through continuous wave injection [12142-82]                             |
| 12142 16 | Surface roughness optimization during femtosecond UV laser ablation [12142-83]   |
| 12142 17 | Evaluation of the uncertainty on phase noise for optoelectronic oscillators [12142-84]   |
| 12142 18 | Fiber to resonator coupling multicriteria optimization with COMSOL multiphysics [12142-85]   |
| 12142 19 | Numerical simulations and experimental analysis of scanning techniques for low-roughness surfaces using UV femtosecond pulses [12142-86]       |
| 12142 1A | Accuracy of Brillouin frequencies for material characterization by light scattering [12142-87]   |
| 12142 1B | Integration of Mach-Zehnder interferometer on optical fiber using UV femtosecond laser pulses [12142-88]                                       |
| 12142 1C | Spectroscopic properties of fluoroindate glass and glass-ceramics doped with Eu³+ ions [12142-89]  |
| 12142 1D | Colour tuneable upconversion photonic materials for anti-counterfeiting security inks [12142-90]   |
| 12142 1E | High intense UV-blue upconversion luminescence in NaYbF4:Tm³+ based nanostructured materials to boost photocatalysis [12142-91]                |

| 2142 1F | Composite ZnO-Yb $_2$ O $_3$ -Er $_2$ O $_3$ transparent ceramics: structure and spectral-luminescent properties [ $12142-93$ ]   |
|---------|---|
| 2142 1G | Transparent glass-ceramics based on Ti³+-doped ZnAl $_2$ O $_4$ nanocrystals: synthesis, structure and optical properties [12142-94]  |
| 2142 1H | SiO <sub>2</sub> —CaO—ZnO nanoglass as multifunctional material [12142-95]  |
| 2142 11 | All-fiber high-peak power chirped pulse amplifier based on a triple-cladding fiber for pulse stretching and a highly-Yb-doped pedestal fiber for pulse amplification [12142-96] |
| 2142 1J | Amorphous WO <sub>3</sub> as transparent conductive oxide in the near-IR [12142-97]   |
| 2142 1K | Production of optical waveguide in planar glass substrate fabricated with femtoprint [12142-98]   |

## **Conference Committee**

#### Symposium Chairs

Francis Berghmans, Vrije University Brussel (Belgium)
Thierry Georges, Oxxius SA (France)
Paul C. Montgomery, Université de Strasbourg (France)

Programme Track Chair

**Kyriacos Kalli**, Cyprus University of Technology (Greece)

#### Conference Chairs

Maurizio Ferrari, CNR-Istituto di Fotonica e Nanotecnologie (Italy)
Angela B. Seddon, The University of Nottingham (United Kingdom)
Stefano Taccheo, Politecnico di Torino (Italy) and Swansea University (United Kingdom)

### Conference Programme Committee

Lidia Armelao, CNR-DSCTM (Italy)

Rolindes Balda, Universidad del País Vasco (Spain)

**John M. Ballato**, Clemson University (United States)

**Wilfried Blanc**, Laboratory de physique de la matière condensée (France)

Monica Bollani, CNR-Istituto di Fotonica e Nanotecnologie (Italy)
Patrice Camy, Center de Recherche sur les Ions, les Matériaux et la
Photonique (France)

**Amol Choudhary**, Indian Institute of Technology Delhi (India)

Cosimo D'Andrea, Politecnico di Milano (Italy)

Miroslav Dramicanin, University of Belgrade (Serbia)

**Matthias L. Jäger**, Leibniz-Institut für Photonische Technologien e.V. (Germany)

**Shibin Jiang**, AdValue Photonics, Inc. (United States)

Maria Losurdo, Istituto di Nanotecnologia (Italy)

**Anna Lukowiak**, Institute of Low Temperature and Structure Research PAN (Poland)

**Jacob I. Mackenzie**, University of Southampton (United Kingdom)

**Christos Markos**, Technical University of Denmark (Denmark)

Virginie Nazabal, L'Université de Rennes 1 (France)

**Laeticia C. Petit**, Tampere University (Finland)

**Nasser N. Peyghambarian**, College of Optical Sciences, The University of Arizona (United States)

Francesco Prudenzano, Politecnico di Bari (Italy)

**Alexander Quandt**, University of the Witwatersrand (South Africa)

**Gediminas Račiukaitis**, Center for Physical Sciences and Technology (Lithuania)

Roberto Scotti, Università degli Studi di Milano-Bicocca (Italy)
Akira Shirakawa, The University of Electro-Communications (Japan)

**Lukasz Sojka**, Wrocław University of Science and Technology (Poland)

**Irina T. Sorokina**, Norwegian University of Science and Technology (Norway)

Claudia Wickleder, Universität Siegen (Germany)