PROCEEDINGS OF SPIE

Optical Technologies for Telecommunications 2019

Vladimir A. Andreev
Anton V. Bourdine
Vladimir A. Burdin
Oleg G. Morozov
Albert H. Sultanov
Editors

19–21 November 2019
Kazan, Russian Federation

Organized by
Kazan National Research Technical University (Russian Federation)
Povolzhskiy State University of Telecommunications and Informatics (Russian Federation)
Ufa State Aviation Technical University (Russian Federation)

Published by
SPIE

Volume 11516

Proceedings of SPIE 0277-786X, V. 11516

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 *Optical Technologies for Telecommunications 2019*, edited by Vladimir A. Andreev, Anton V. Bourdine, Vladimir A. Burdin, Oleg G. Morozov, Albert H. Sultanov, Proceedings of SPIE Vol. 11516 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510638396
ISBN: 9781510638402 (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

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.

SPIEDigitalLibrary.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

ONE-DIMENSION AND MULTI-DIMENSION OPTICAL SIGNALS DATA PROCESSING

OPTICAL NETWORKS MAINTENANCE, CONTROL AND RESTORATION

ADVANCED TECHNOLOGIES FOR OPTICAL TELECOMMUNICATIONS