PROCEEDINGS OF SPIE

Photonic Applications for Aerospace, Transportation, and Harsh Environment III

Alex A. Kazemi
Nicolas Javahiraly
Allen S. Panahi
Simon Thibault
Bernard C. Kress
Editors

23–24 April 2012
Baltimore, Maryland, United States

Sponsored and Published by
SPIE

Volume 8368

Proceedings of SPIE, 0277-786X, v. 8368

Photonic Applications for Aerospace, Transportation, and Harsh Environment III,
edited by Alex A. Kazemi, Nicolas Javahiraly, Allen S. Panahi, Simon Thibault, Bernard C. Kress,
Proc. of SPIE Vol. 8368, 836801 · © 2012 SPIE · CCC code: 0277-786X/12/$18 · doi: 10.1117/12.979022

The papers included 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. The papers published in these proceedings 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 this book:
Author(s), "Title of Paper," in *Photonic Applications for Aerospace, Transportation, and Harsh Environment III*, edited by Alex A. Kazemi, Nicolas Javahiraly, Allen S. Panahi, Simon Thibault, Bernard C. Kress, Proceedings of SPIE Vol. 8368 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X
ISBN 9780819490469

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.

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, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

Conference Committee

Symposium Chair

Kevin P. Meiners, Office of the Secretary of Defense (United States)

Symposium Cochair

Kenneth R. Israel, Lockheed Martin Corporation (United States)

Conference Chairs

Alex A. Kazemi, The Boeing Company (United States)
Nicolas Javahiraly, InESS, Ecole Nationale Supérieure de Physique de Strasbourg (France)
Allen S. Panahi, ARK International (United States)
Simon Thibault, Université Laval (Canada)

Conference Cochair

Bernard C. Kress, USI Photonics Inc. (United States)

Program Committee

Frank Abdi, AlphaSTAR Corporation (United States)
Mathieu Aubailly, University of Maryland, College Park (United States)
Bernard Dam, Technische Universiteit Delft (Netherlands)
Peit De Pauw, Melexis N.V. (Belgium)
James E. Fesmire, NASA Kennedy Space Center (United States)
Leo R. Gauthier, Jr., The Johns Hopkins University Applied Physics Laboratory (United States)
Harold E. Hager, The Boeing Company (United States)
Zuyuan He, The University of Tokyo (Japan)
Robert T. Johnson, The Boeing Company (United States)
Timo Kahlmann, ETH Zurich (Switzerland)
Lothar U. Kempen, Hochschule Ruhr West (Germany)
Peter Kiesel, Palo Alto Research Center, Inc. (United States)
Dennis G. Koshinz, The Boeing Company (United States)
Jocelyn Lauzon, Esterline CMC Electronics (Canada)
Hai Lin, Intelligent Optical Systems, Inc. (United States)
Jony Jiang Liu, U.S. Army Research Laboratory (United States)
Mark A. Messer, Carlisle Interconnect Technologies (United States)
Patrick P. Meyrueis, Ecole Nationale Supérieure de Physique de Strasbourg (France)

Jean-Pierre Moeglin, Institut Franco-Allemand de Recherches de Saint-Louis (France)
Nezih Mrad, Defence Research and Development Canada, Ottawa (Canada)
Juock S. Namkung, Naval Air Warfare Center Aircraft Division (United States)
Robert A. Nye, The Boeing Company (United States)
Mike O'Farrell, Deutsch UK (United Kingdom)
Douglas Parker, Deutsch UK (United States)
Saeed Rehman, Fibertronix AB (Sweden)
Nabeel A. Riza, University College Cork (Ireland)
Indu F. Saxena, Intelligent Optical Systems, Inc. (United States)
William St. Cyr, NASA Stennis Space Center (United States)
Martin Slaman, Delft University of Technology (Netherlands)
Dmitry S. Starodubov, Physical Optics Corporation (United States)
Henry J. White, BAE Systems (United Kingdom)

Session Chairs

1 Sensors for Transportation/Aerospace Applications
Alex A. Kazemi, The Boeing Company (United States)

2 Polymer Optical Fiber Sensors, Bragg Gratings
Simon Thibault, Université Laval (Canada)

3 Photonics in Harsh Environment, Signal Processing
Allen S. Panahi, ARK International (United States)

4 Wireless Optical Link, Optical Satellite Communication
Juock S. Namkung, Naval Air Warfare Center Aircraft Division (United States)
Indu F. Saxena, Intelligent Optical Systems, Inc. (United States)

5 Vision-Based, Imaging and High Temperature Sensors
Henry J. White, BAE Systems (United Kingdom)
Bernard C. Kress, USI Photonics Inc. (United States)

6 Photonics Materials
Nicolas Javahiraly, Ecole Nationale Supérieure de Physique de Strasbourg (France)
Jocelyn Lauzon, Esterline CMC Electronics (Canada)

Introduction

In the future smart sensors will internally integrate most of the functions of sensing in aerospace and transportation industry applications. Today a great proportion of the world's communications are carried by fiber optic cables. Fiber optic technology has revolutionized the telecommunication market and is rapidly becoming a major player in information technology. Now even digital television is carried over fiber optic.

The fiber optic sensor greatly benefitted from low-cost telecommunications industries. Due to this synergy, an enormous amount of new technologies have been introduced in the form of smart sensors, biomedical sensors, pressure, temperature, speed, see through, materials health monitoring, and collisions avoidance, to name a few.

Over the past 45 years, the field of fiber optic sensors has undergone a remarkable change. Fiber optic sensors development has gone through a quantum leap. I have been greatly impressed over the past few years by the tremendous progress in photonics in the transportation industry. More information, intelligence, and data are transferred from one point to another more quickly and precisely than ever thought possible thanks to the miracle of optical fibers. Fiber optics shall become as common as wire, easy to construct to precise tolerances, and accurate and perfect in operation.

We are fortunate to be among pioneers and the thrill of technical achievement can be just as tangible to those of us involved with engineering, innovation, and science as the thrill of lifetime accomplishment. This book contains a series of papers which contains state-of-the-art fiber optic sensor technologies for photonics in aerospace and transportation industries such as advanced technologies for cryogenic leak detection of hydrogen and oxygen for space applications to a new generation of smart fiber optic sensors, a novel implementation a wearable see through display, high speed laser communication network for satellite systems, and wireless strain monitoring systems.

On behalf of SPIE and myself, I would like to thank the individual authors for their valuable contributions, particularly Dr. Bernard Kress of USI Photonics, Professor Simon Thibault of University of Laval, Professor Nicolas Javahiraly of University of Strasbourg, Dr. Allen Panahi of ARK International, Dr. Frank Abdi of AlphaStar, Mr. Henry White of BAS Systems, Dr. Justin Lauzon of Esterline-CMC Electronics, and Dr. Nezih Mrad of Defense R&D of Canada for outstanding papers they presented in this book.

I also would like to thank my management at The Boeing Co. and the SPIE personnel for their diligent support in publication of this book.

Alex A. Kazemi