

# Guest Editorial

**A**S GUEST EDITORS, we are pleased to introduce this fifth Joint Special Issue of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES and the JOURNAL OF LIGHTWAVE TECHNOLOGY devoted to microwave and millimeter-wave photonics.

The scope of microwave photonics can be generally defined as the study of the interactions between optical signals and high-frequency ( $>1$  GHz) electrical signals. The field has progressed rapidly over the last several decades from the numerous ground-breaking experiments in the 1970's to now include a wide range of associated topics. For example, microwave photonics covers the generation of radio-frequency (RF) signals using optical techniques, photonic and optoelectronic devices and components operating at microwave frequencies and beyond, photonic control of microwave devices, the use of photonics to implement a variety of functions in microwave systems (photonic signal processing), photonic techniques for high-speed measurement, and optical transmission links operating at microwave and millimeter-wave frequencies. There is also now a number of emerging applications of increasing commercial importance. These include antenna fiber remoting, optical delay lines, frequency conversion, high-performance oscillators, analog-to-digital conversion, optical control of phased arrays, and fiber-wireless communication systems. The ongoing development of photonic devices and technologies, which can be applied to microwave and millimeter-wave systems, leads to an ever-increasing interest in this cross-disciplinary field and the continuing acceptance of the use of photonics in microwave system applications.

The strength of the microwave-photonics area is evidenced in the number of papers being published in these special collections. The May 1990 Joint Special Issue of this TRANSACTIONS, for which Prof. Peter Herczfeld, Drexel University, Philadelphia, PA, was guest editor, was comprised of 33 papers. In September 1995, the second Joint Special Issue of this TRANSACTIONS again had Prof. Peter Herczfeld as guest editor in conjunction with four international co-guest editors (Dr. Hiroyo Ogawa, Dr. Alvaro de Salles, Prof. Alwyn Seeds, and Prof. Rodney Tucker), and contained 38 papers. The third Joint Special Issue of this TRANSACTIONS, published in August 1997, included 41 papers and had Prof. Alwyn Seeds, University College London, London, U.K., and Dr. Ronald Esman, Naval Research Laboratory, Washington, DC, as co-guest editors. In July 1999, the fourth Joint Special Issue of this TRANSACTIONS was published, and contained 33 papers (including three invited papers), which were selected from a total of 65 submitted

manuscripts. The co-guest editors for that issue were Dr. Ronald Esman, Naval Research Laboratory, Washington, DC, and Prof. Ulrik Gliese, Technical University of Denmark, Lyngby, Denmark. For this Joint Special Issue, we received 67 papers for consideration, of which two were invited. Research activities in microwave photonics are now truly global: papers were received from over 15 countries covering four continents. In selecting the 35 papers presented here, we received the assistance of a large number of international expert reviewers. In carrying out the paper review process, we took care to ensure that any paper that involved one of the editors was handled entirely by the other guest editor.

We have divided the papers into six general subject areas. The first three groupings describe a variety of enabling microwave photonic technologies and cover topics such as optical microwave interactions in materials (including photonic-bandgap structures), microwave photonic devices and components (including lasers, modulators, filters, phototransistors, and photodetectors), as well as enabling techniques for microwave photonic links (including intensity modulation and heterodyne methods, optoelectronic mixing, and RF optical links). The second collection of topics report primarily on applications of microwave photonics: photonic signal processing (covering frequency conversion and tunable optical filters), fiber-radio systems, and other applications such as wavelength division multiplexing (WDM) networks, lidar-radar, and optical beam-forming. These contributed manuscripts are complemented by two invited papers, one by Juodawlkis *et al.* and the other by Nagatsuma *et al.* These two papers represent truly novel applications of microwave photonics by authors who are internationally renowned for their work.

In preparing this Joint Special Issue, we have benefited from the advice of former editors Dr. Ronald Esman, Dr. Ulrik Gliese, Prof. Peter Herczfeld, and Prof. Alwyn Seeds and also Prof. David Rutledge, Editor-in-Chief of this TRANSACTIONS, his assistant, Carol Sosnowski, as well as Christina M. Rezes, staff senior editor of this TRANSACTIONS. We are also very grateful to the large team of reviewers who undertook the detailed review of the submitted manuscripts. We are indebted to this special group of people who gave up their valuable time to carry out their reviews within a very tight time schedule while providing detailed technical comments to the authors. Finally, we would like to thank all of the authors for the quality of the submitted manuscripts, and their cooperation in making paper-length adjustments in order to meet this TRANSACTIONS' page budget, and meeting deadlines so as to allow this Joint Special Issue to meet its publication date. These efforts have all contributed to making this Joint Special Issue a resounding success and enabled us to achieve a rapid time from paper submission (January 2001) to publication.

The field of microwave photonics is now well established and has a variety of dedicated forums for dissemination of work, including the International Topical Meeting on Microwave Photonics (MWP), the IEEE Microwave Theory and Techniques Society International Microwave Symposium (IEEE MTT-S IMS), and this biannual Joint Special Issue. As we enter the new millennium, it is exciting to survey how this field has blossomed since its inception. We hope that this Joint Special Issue will provide readers with a thorough picture of

the current state-of-the-art and serve as an inspiration for future developments in the field.

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**Paul J. Matthews** (M'99) received the B.S. degree in physics (*summa cum laude*) from Loyola University, Chicago, IL, in 1986, and the M.S. and Ph.D. degrees in electrical engineering from the University of Colorado at Boulder, in 1988 and 1991, respectively. His Ph.D. dissertation concerned the fabrication and characterization of LiNbO<sub>3</sub> and LiTaO<sub>3</sub> integrated optical devices for microwave applications.

From January 1992 to October 1992, he was with CAI/Recon Optical, a manufacturer of high-resolution infrared imaging systems. In October 1992, he joined the staff of the Advanced Photon Source, Argonne National Laboratory (ANL), where he was engaged in efforts to design, model, and fabricate a millimeter-wave linear accelerator using deep-etch X-ray lithography techniques and electroplating. While with ANL, he was also involved in the investigation of novel undulator designs, accurate magnetic field measurement techniques, and the design of higher order mode dampers for the Advanced Photon Source. In September 1995, he joined the Optical Sciences Division, Naval Research Laboratory (NRL), Washington, DC, where he served as Head of the

Microwave Photonics Technology Section from October 1998 to September 2000. His research activities at the NRL included optical control schemes for phased-array antenna applications, photonic analog-to-digital conversion, high-performance fiber-optic links, and microwave signal processing. In October 2000, he joined Optinel Systems Inc., Elkridge, MD, where he currently serves as Technical Director. He has authored or co-authored over 80 publications in his areas of interest.

Dr. Matthews is a member of the Optical Society of America. He has served on the Lightwave Communications Subcommittee of the Conference on Lasers and Electro-Optics (CLEO) from 1998 to 2000 and the Technical Program Committee for the International Microwave Symposium (Subcommittee on Lightwave Communications) from 1999 to 2000.



**Dalma Novak** (S'90–M'91–SM'01) received the B.E. (with first-class honors) and Ph.D. degrees in electrical engineering from the University of Queensland, Brisbane, Australia, in 1987 and 1992, respectively. Her doctoral dissertation investigated the dynamic behavior of directly modulated semiconductor lasers.

From January 1992 to August 1992, she was a Lecturer in the Department of Electrical and Computer Engineering, University of Queensland. In September 1992, she joined the Photonics Research Laboratory (PRL) [a member of the Australian Photonics Cooperative Research Centre (CRC)], Department of Electrical and Electronic Engineering, University of Melbourne, Melbourne, Australia, where she is currently an Associate Professor and Reader. Her responsibilities have included Deputy Director and Research Director of the PRL, CRC Key Researcher, Director of the CRC Melbourne Division, and CRC Education Director. From December 1999 to March 2001, she was a Director of Australian Photonics Pty Ltd. In July–October 2000 and October 2000–January 2001, she was a Visiting Researcher in the Department of Electrical Engineering,

University of California at Los Angeles (UCLA) and the Naval Research Laboratory, Washington, DC. In June 2001, she joined Dorsál Networks Inc., Columbia, MD. Her research interests include fiber-radio communication systems and high-speed opto-electronic devices and circuits. She has authored or co-authored over 150 papers in these areas.

Dr. Novak is a member of the Microwave Photonics Technical Subcommittee of the IEEE Lasers and Electro-Optics Society (IEEE LEOS) and was chair of the IEEE LEOS Victorian Chapter from 1998 to 2001. She is a former chair of the International Topical Meeting on Microwave Photonics (MWP) Steering Committee and was general co-chair of MWP'99, Melbourne, Australia, November 1999.