PROCEEDINGS OF SPIE

Metamaterials VI

Vladimir Kuzmiak
Peter Markos
Tomasz Szoplik
Editors

20–21 April 2011
Prague, Czech Republic

Sponsored and Published by
SPIE

Cooperating Organisations
ELI Beamlines
HiPER

Volume 8070

Proceedings of SPIE, 0277-786X, v. 8070

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 *Metamaterials VI*, edited by Vladimir Kuzmiak, Peter Markos, Tomasz Szoplik, Proceedings of SPIE Vol. 8070 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X
ISBN 9780819486608

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

POSTER SESSION

Conference Committee

Symposium Chairs

Miroslav Hrabovský, Palacký University Olomouc (Czech Republic)
Wolfgang Sandner, Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie (Germany) and Laserlab Europe
Bahaa Saleh, CREOL, The College of Optics and Photonics, University of Central Florida (United States)
Jan Řídký, Institute of Physics of the ASCR, v.v.i. (Czech Republic)

Symposium Honorary Chair

Jan Peřina, Sr., Palacký University Olomouc (Czech Republic)

Conference Chairs

Vladimir Kuzmiak, Institute of Photonics and Electronics of the ASCR, v.v.i. (Czech Republic)
Peter Markos, Slovak University of Technology (Slovakia)
Tomasz Szoplik, University of Warsaw (Poland)

Programme Committee

Jirí Čtyroký, Institute of Photonics and Electronics of the ASCR, v.v.i. (Czech Republic)
Nader Engheta, University of Pennsylvania (United States)
Didier Felbacq, Université Montpellier 2 (France)
Francisco Javier García de Abajo, Consejo Superior de Investigaciones Científicas (Spain)
Harald W. Giessen, Universität Stuttgart (Germany)
Nigel P. Johnson, University of Glasgow (United Kingdom)
Maria Kafesaki, Foundation for Research and Technology-Hellas (Greece)
Yuri S. Kivshar, The Australian National University (Australia)
Didier Lippens, Institut d'Electronique, de Microélectronique, et de Nanotechnologie (France)
Dorota Pawlak, Institute of Electronic Materials Technology (Poland)
Concita Sibilia, Università degli Studi di Roma La Sapienza (Italy)
Costas M. Soukoulis, Iowa State University (United States)
Sergei Tretyakov, Aalto University School of Science and Technology (Finland)
Martin Wegener, Karlsruher Institut für Technologie (Germany)
Nikolay I. Zheludev, University of Southampton (United Kingdom)
Richard W. Ziolkowski, University of Arizona (United States)

Session Chairs

1 Plasmonics I
Vladimir Kuzmiak, Institute of Photonics and Electronics of the ASCR, v.v.i. (Czech Republic)

2 Metamaterials I
Ekmel Ozbay, Bilkent University (Turkey)

3 Plasmonics II: Advanced Experimental Techniques
William L. Barnes, The University of Exeter (United Kingdom)

4 Light Concentrators
Nigel P. Johnson, University of Glasgow (United Kingdom)

5 Fabrication of Metamaterials
Arkadi Chipouline, Friedrich-Schiller-Universität Jena (Germany)

6 Metamaterials II
Andrei V. Lavrinenko, Technical University of Denmark (Denmark)

7 Plasmonics III: Applications
Tomasz Szoplik, University of Warsaw (Poland)

8 Nanophotonics and Magnetoplasmonic Structures
Vladimir Kuzmiak, Institute of Photonics and Electronics of the ASCR, v.v.i. (Czech Republic)

Introduction

Unique electromagnetic features of metamaterials that have been demonstrated over the past two decades have created prospects of advancement in new photonics and nanophotonics applications including negative index engineering, superlensing, optical cloaking, and passive and active integrated photonic circuitry.

This sixth conference (the third one held in Prague) in a series of SPIE conferences on metamaterials has brought together the scientific communities of metamaterials, plasmonics, and nanomagnetics. It has provided an overview of recent activities in the field artificial nanomaterials with tailored electromagnetic properties. The conference provided a forum to stimulate interaction among people involved in both fundamental research and those interested in future applications of metamaterials and also took advantage of the synergy arising from other 20 parallel conferences held at the SPIE Congress on Optics and Optoelectronics organized in Prague by the Institute of Physics, Academy of Science of the Czech Republic, and SPIE.

The speakers presented recent achievements in the investigation of emission properties and plasmon-mediated energy transfer of metallic nanoparticles, ultrafast and nonlocal effects in metallic metamaterials, in analytical description of metal-insulator-metal structures, novel techniques for retrieval effective parameters of metametarials, and description of quantum metamaterials with gain. New concepts of plasmonic devices for light transport in the subwavelength scale such as plasmonic nanorod and nanoparticle arrays that may potentially considerably surpass the optical field confinement of silicon waveguide were discussed in several interesting presentations. In the field of nanophotonic magneto-optical plasmonic structures there have been reported a large variety of strongly enhanced magneto-optical phenomena or even entirely novel nonreciprocal and unidirectional effects.

The chairs of this conference we would like to thank all participants who contributed to the meeting, the SPIE team, and the program committee members.

Vladimir Kuzmiak
Peter Markos
Tomasz Szoplik