PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9918

, "Front Matter: Volume 9918," Proc. SPIE 9918, Metamaterials, Metadevices, and Metasystems 2016, 991801 (9 December 2016); doi: 10.1117/12.2258538

SPIE.

Event: SPIE Nanoscience + Engineering, 2016, San Diego, California, United States

PROCEEDINGS OF SPIE

Metamaterials, Metadevices, and Metasystems 2016

Nader Engheta
Mikhail A. Noginov
Nikolay I. Zheludev
Editors

28 August–1 September 2016
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 9918

Proceedings of SPIE 0277-786X, V. 9918

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Metamaterials, Metadevices, and Metasystems 2016, edited by Nader Engheta,
Mikhail A. Noginov, Nikolay I. Zheludev, Proc. of SPIE Vol. 9918, 991801
© 2016 SPIE · CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2258538

Proc. of SPIE Vol. 9918 991801-1

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 *Metamaterials, Metadevices, and Metasystems 2016*, edited by Nader Engheta, Mikhail A. Noginov, Nikolay I. Zheludev, Proceedings of SPIE Vol. 9918 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-786X (electronic)

ISBN: 9781510602274

ISBN: 9781510602281 (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

Copyright © 2016, Society of Photo-Optical Instrumentation Engineers.

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 copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online 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. The CCC fee code is 0277-786X/16/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

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 six-digit CID article numbering system structured as follows:

- 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.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

STRONG COUPLING I

9918 06	Strong light-matter interactions in plasmonic lattices (Invited Paper) [9918-5]
---------	--

METADEVICES AND METASYSTEMS I

9918 0C	PMMA-based ophthalmic contact lens for vision correction of strabismus [9918-14]
---------	---

FUNDAMENTAL PHENOMENA I

9918 0P	Quantum optical effective-medium theory and transformation quantum optics for metamaterials (Invited Paper) [9918-24]
---------	--

ACTIVE AND TUNABLE METAMATERIALS I

9918 0U	Electronic and thermally tunable infrared metamaterial absorbers [9918-29]
9918 0V	A single dielectric nanolaser [9918-30]

METASURFACES I

9918 0X	Nonmagnetic metamaterial landscapes for guided electromagnetic waves [9918-68]
9918 0Y	A functional metasurface platform with unique building blocks: light manipulation and beam shaping [9918-35]

STRONG COUPLING II

9918 10	Universal local density of states for nanoplasmonics (Invited Paper) [9918-36]
9918 14	Controlled Fano resonances via symmetry breaking in metamaterials for high-sensitive infrared spectroscopy [9918-40]

METADEVICES AND METASYSTEMS II

9918 1I	Microwave focusing with uniaxially symmetric gradient index metamaterials [9918-55]
---------	--

- 9918 1J **Forked grating coupler optical vortex beam interface for silicon photonics** [9918-56]

METADEVICES AND METASYSTEMS III

- 9918 1M **Optical directional coupler and Mach-Zehnder interferometer enhanced via 4H-SiC phonons** [9918-59]
- 9918 1N **Integration of periodic structure and highly narrowband MEMS sensor to enhance crack detection ability in steel structures** [9918-60]
- 9918 1O **The effect of the triblock properties on the morphologies and photophysical properties of nanoparticle loaded with carboxylic dendrimer phthalocyanine** [9918-61]

HYPERBOLIC METAMATERIALS

- 9918 1Y **Berreman approach to electromagnetic wave and beam propagation in anisotropic metamaterials** [9918-72]
- 9918 1Z **Propagation properties of metallic dielectric cladde d waveguides** [9918-73]

EPSILON NEAR ZERO (ENZ) METAMATERIALS

- 9918 23 **High-Q terahertz reconfigurable metamaterials using graphene** [9918-78]

NONLINEAR PHENOMENA II

- 9918 2B **Accessing high-order resonances in plasmonic nanostructures (Invited Paper)** [9918-86]

POSTER SESSION

- 9918 2H **Magnetically controllable circulator based on photonic crystal unidirectional waveguide consisting of metamaterials** [9918-51]
- 9918 2J **Controlling the evanescent waves using metamaterials** [9918-94]
- 9918 2P **Inverse-designed all-dielectric optical diode** [9918-100]
- 9918 2Q **Propagation properties of silver nanowires embedded in a substrate with gain** [9918-101]
- 9918 2T **Universality and scaling in metamaterials** [9918-104]
- 9918 2V **Progress towards omnidirectional transformation optics with lenses** [9918-106]
- 9918 2X **Formation of terahertz beams produced by artificial dielectric periodical structures** [9918-108]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abramoff, Michael D., 0C	Montoya, John A., 0U
Adam, Jost, 2Q	Mortensen, N. Asger, 0P
Amooghorban, Ehsan, 0P	Mosallaei, Hossein, 0Y
Arezoomandan, Sara, 23	Nadovich, Christopher T., 1J
Asgharzadeh Shishavan, Amir, 0C	Nordin, Leland, 0C
Aydin, K., 2P	Oxburgh, Stephen, 2V
Banerjee, Partha, 1Y	Ozevin, Didem, 1N
Belin, Jakub, 2V	Padilla, Willie J., 0U
Bordo, Vladimir, 2Q	Pan, Sujuan, 1O
Brinkley, Matthew, 0U	Peng, Fenglin, 0U
Caetano da Silva, Juarez, 1Z	Peng, Yiru, 1O
Callewaert, F., 2P	Perez, Israel, 1I
Chaplain, Gregory, 2V	Rego, Davi, 2Q
Chen, Zhe, 1O	Rekola, Heikki T., 06
Chernyadiev, Alexander V., 2X	Rockway, John D., 1I
Courtial, Johannes, 2V	Rodriguez-Esquerre, Vitaly F., 1Z, 2Q
Cowie, Euan N., 2V	Salandrino, Alessandro, 2B
Crouse, David T., 1J	Saunders Filho, Claudio A. B., 1M
Danckaert, J., 0X	Sensale Rodriguez, Berardi, 23
Fan, Kebin, 0U	Shahbazyan, T. V., 10
Felbacq, Didier, 2T	Shankhwar, Nishant, 2J
Finch, Michael F., 1M	Shrekenhamer, David, 0U
Forouzmand, Ali, 0Y	Sinha, Ravindra Kumar, 2J
Gauza, Sebastian, 0U	Sternberg, Oren, 1I
Gill, Viktoria V., 2X	Symm, Eli D., 2B
Ginis, V., 0X	Tanaka, Takuo, 14
Gnawali, Rudra, 1Y	Tassin, P., 0X
Grebenchukov, Alexandr N., 2X	Tjossem, Paul, 0C
Hakala, Tommi K., 06	Toor, Fatima, 0C
Hara, Shuhei, 14	Törmä, Päivi, 06
Hayashi, Yasuhiko, 14	Tsuruta, Kenji, 14
Huang, Tsung-Yu, 0V	Tyc, Tomáš, 2V
Ishikawa, Atsushi, 14	Väkeväinen, Aaro I., 06
Jemison, William D., 1J	Viaene, S., 0X
Kabir, Minoo, 1N	Vozianova, Anna V., 2X
Kalra, Yogita, 2J	Wheeland, Sara, 1I
Keys, B., 10	White, Christopher D., 2V
Khodzitsky, Mikhail K, 2X	Wu, Shin-Tson, 0U
Kosciolek, Derek J., 1J	Wubs, Martijn, 0P
Lail, Brian A., 1M	Xie, Shusen, 1O
Liang, Wenyao, 2H	Yang, Hongqin, 1O
Lima, Joaquim, 2Q	Yen, Ta-Jen, 0V
Liu, Zhaowei, 1Z	Yu, Xinxin, 1O
Lv, Huafei, 1O	Zhang, Jingjing, 0P
Macauley, Gavin, 2V	Zhang, Tiantian, 1O
Martikainen, Jani-Petri, 06	
Minin, Igor V., 2X	
Minin, Oleg V., 2X	
Miragliotta, Joseph A., 0U	

Conference Committee

Symposium Chairs

Harry A. Atwater Jr., California Institute of Technology (United States)
Nikolay I. Zheludev, Optoelectronics Research Center
(United Kingdom) and Nanyang Technological University
(Singapore)

Symposium Co-chairs

David L. Andrews, University of East Anglia (United Kingdom)
James G. Grote, Air Force Research Laboratory (United States)

Conference Chairs

Nader Engheta, University of Pennsylvania (United States)
Mikhail A. Noginov, Norfolk State University (United States)
Nikolay I. Zheludev, Optoelectronics Research Centre
(United Kingdom) and Nanyang Technological University
(Singapore)

Conference Program Committee

Andrea Alù, The University of Texas at Austin (United States)
David L. Andrews, University of East Anglia (United Kingdom)
Pierre Berini, University of Ottawa (Canada)
Alexandra Boltasseva, Purdue University (United States)
Igal Brener, Sandia National Laboratories (United States)
Mark Brongersma, Stanford University (United States)
Joshua D. Caldwell, U.S. Naval Research Laboratory (United States)
Che Ting Chan, Hong Kong University of Science and Technology
(Hong Kong, China)
Harald W. Giessen, Universität Stuttgart (Germany)
Richard Hammond, U.S. Army Research Office (United States)
Yuri S. Kivshar, The Australian National University (Australia)
Jacob B. Khurgin, Johns Hopkins University (United States)
Uriel Levy, The Hebrew University of Jerusalem (Israel)
Natalia M. Litchinitser, University at Buffalo (United States)
Martin W. McCall, Imperial College London (United Kingdom)
Alberto Piqué, U.S. Naval Research Laboratory (United States)
Gennady B. Shvets, The University of Texas at Austin (United States)
David R. Smith, Duke University (United States)
Mark I. Stockman, Georgia State University (United States)
Philippe Tassin, Chalmers University of Technology (Sweden)

Sergei Tretyakov, Aalto University School of Science and Technology (Finland)
Din Ping Tsai, National Taiwan University (Taiwan)
Augustine M. Urbas, Air Force Research Laboratory (United States)
Martin Wegener, Karlsruher Institut für Technologie (Germany)
Jeong Weon Wu, Ewha Womans University (Korea, Republic of)
Xiang Zhang, University of California, Berkeley (United States)

Session Chairs

- 1 Quantum Phenomena
Cesare Soci, Nanyang Technological University (Singapore)
- 2 Strong Coupling I
Ekaterina Poutina, Air Force Research Laboratory (United States)
- 3 Metadevices and Metasystems I
Viktor A. Podolskiy, University of Massachusetts Lowell (United States)
- 4 Nonlinear Phenomena I
Anders Kristensen, DTU Nanotech (Denmark)
- 5 Fundamental Phenomena I
Din Ping Tsai, Research Center for Applied Sciences – Academia Sinica (Taiwan)
- 6 Active and Tunable Metamaterials I
Natalia M. Litchinitser, University at Buffalo (United States)
- 7 Metasurfaces I
Blake S. Simpkins, U.S. Naval Research Laboratory (United States)
- 8 Strong Coupling II
Hui Liu, Nanjing University (China)
- 9 Fundamental Phenomena II
Tigran V. Shahbazyan, Jackson State University (United States)
- 10 Active and Tunable Metamaterials II
Mark I. Stockman, Georgia State University (United States)
- 11 Metadevices and Metasystems II
Martin Wegener, Karlsruher Institut für Technologie (Germany)
- 12 Metadevices and Metasystems III
Mark L. Brongersma, Geballe Laboratory for Advanced Materials (GLAM) (United States)

- 13 2D Materials and Interfaces
Tal Galfsky, The City College of New York (United States)
- 14 Hyperbolic Metamaterials
Bumki Min, KAIST (Korea, Republic of)
- 15 Epsilon Near Zero (ENZ) Metamaterials
Joshua D. Caldwell, U.S. Naval Research Laboratory (United States)
- 16 Novel Materials
Ortwin Hess, Imperial College London (United Kingdom)
- 17 Nonlinear Phenomena II
Simeon Bogdanov, Purdue University (United States)
- 18 Metasurfaces II
Alessandro Salandrino, The University of Kansas (United States)