PROCEEDINGS OF SPIE

Nanoimaging and Nanospectroscopy IV

Prabhat Verma Alexander Egner Editors

28–31 August 2016 San Diego, California, United States

Sponsored and Published by SPIE

Volume 9925

Proceedings of SPIE 0277-786X, V. 9925

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

Nanoimaging and Nanospectroscopy IV, edited by Prabhat Verma, Alexander Egner, Proc. of SPIE Vol. 9925, 992501 · © 2016 SPIE · CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2258077

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 *Nanoimaging and Nanospectroscopy IV*, edited by Prabhat Verma, Alexander Egner, Proceedings of SPIE Vol. 9925 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-786X (electronic)

ISBN: 9781510602410

ISBN: 9781510602427 (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.ora

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.

 $\hbox{Publication of record for individual papers is online in the SPIE Digital Library.}$



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 vii	Authors Conference Committee
	SUPER RESOLUTION MICROSCOPY
9925 05	Study of biological reaction in cancer cell with spectroscopic imaging ellipsometry [9925-4]
9925 06	Photoacoustic tomography of unlabelled red blood cell at the nanoscale [9925-6]
	TIP-ENHANCED RAMAN SPECTROSCOPY/MICROSCOPY
9925 09	High-efficiency and high-resolution apertureless plasmonic near-field probe under internal illumination [9925-9]
9925 0A	TERS at work: 2D materials, from graphene to 2D semiconductors [9925-10]
	NEAR-FIELD SPECTROSCOPY/MICROSCOPY
9925 OG	Multichannel near-field nanoscopy of circular and linear dichroism at the solid-state [9925-17]
	PLASMONICS FOR NANOSPECTROSCOPY II
9925 OJ	Sub-one-nanometer gap (SONG) for nanogap-enhanced Raman scattering (NERS) (Invited Paper) [9925-20]
9925 OL	Surface phonon coupling within boron nitride resolved by a novel near-field infrared pump-probe imaging technique [9925-22]
9925 ON	Electron energy-loss spectroscopy of coupled plasmonic systems: beyond the standard electron perspective $[9925\text{-}24]$
	NANOSPECTROSCOPY
9925 00	3D SERS imaging based on chemically-synthesized highly-symmetric nanoporous silver microparticles (Invited Paper) [9925-25]
9925 0Q	Tip-enhanced Raman spectroscopy of nanostructures on epitaxial graphene and graphene microisland [9925-27]

Proc. of SPIE Vol. 9925 992501-4

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.

Alexander, D. T. L., 0N Allegrini, M., 0G Bando, Yoshio, 0L Bashkirov, Sergey, 0A Bernasconi, G. D., 0N Brugger, J., 0N Butet, J., 0N Castriciano, M., 0G Chaigneau, Marc, 0A Chang, Yia-Chung, 05 Chen, C., 09

Chang, Yia-Chung, O. Chen, C., 09 Chen, Jian, 06 Chen, Yu-Da, 05 Chou, H. C., 09 Chu, J. Y., 09 Daichi, Doujima, 0Q de Beer, Sissi, 0L Ekgasit, Sanong, 00 Flauraud, V., 0N Fuso, F., 0G

Gavrilyuk, Vasily, 0A Gilburd, Leonid, 0L Golberg, Dmitri, 0L Hsu, Hao Yun, 05 Ji, Wei, 0O Jiang, R. H., 09 Kaneko, Tadaaki, 0Q Khaleel, Mai Ibrahim, 05 Kitahama, Yasutaka, 0O, 0Q Krayev, Andrey, 0A

Krayev, Andrey, 0A
Lazzini, G., 0G
Lee, Haemi, 0J
Lee, Jung-Hoon, 0J
Martin, O. J. F., 0N
Micali, N., 0G
Monsù Scolaro, L., 0G
Nam, Jwa-Min, 0J
Ozaki, Yukihiro, 0O, 0Q
Patanè, S., 0G
Robinson, A. Edward, 0A
Samant, Pratik, 06
Shanmugasundaram, Maruda, 0A

Suh, Yung Doug, OJ Suzuki, Toshiaki, OQ Tanaka, Yoshito, OO, OQ

Tantussi, F., 0G Trapani, M., 0G Uemura, Shohei, 0Q Vantasin, Sanpon, 0O, 0Q Walker, Gilbert C., 0L Wongrawee, Kanet, 0O Wu, Chien-Hsun, 05 Wu, Han-Chung, 05 Xiang, Liangzhong, 06 Xu, Xiaoji G., 0L Yen, T. J., 09

Zhizhimontov, Vladimir, 0A

Proc. of SPIE Vol. 9925 992501-6

Conference Committee

Symposium Chairs

Harry A. Atwater, Jr., California Institute of Technology (United States)
Nikolay I. Zheludev, Optoelectronics Research Centre
(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

Prabhat Verma, Osaka University (Japan) **Alexander Egner**, Laser-Laboratorium Göttingen e.V. (Germany)

Conference Program Committee

Balpreet Singh Ahluwalia, University of Tromsø (Norway)
Joerg Bewersdorf, Yale School of Medicine (United States)
Alberto Diaspro, Istituto Italiano di Tecnologia (Italy)
Christian Eggeling, University of Oxford (United Kingdom)
Joerg Enderlein, Georg-August-Universität Göttingen (Germany)
Katsumasa Fujita, Osaka University (Japan)
Stefan W. Hell, Max-Planck-Institut für Biophysikalische Chemie
(Germany)

Samuel Hess, University of Maine (United States)

Bo Huang, University of California, San Francisco (United States)

Satoshi Kawata, Osaka University (Japan)

Thomas A. Klar, Johannes Kepler Universität Linz (Austria)

Alfred J. Meixner, Eberhard Karls Universität Tübingen (Germany)

Peter Nordlander, Rice University (United States)

Bruno Pettinger, Fritz-Haber-Institut der Max-Planck-Gesellschaft (Germany)

Markus B. Raschke, University of Colorado Boulder (United States) Bin Ren, Xiamen University (China)

Vahid Sandoghdar, Max-Planck-Institut für die Physik des Lichts (Germany)

Markus Sauer, Julius-Maximilians-Universität Würzburg (Germany) Yung Doug Suh, Korea Research Institute of Chemical Technology (Korea, Republic of) **Din Ping Tsai**, National Taiwan University (Taiwan) **Renato Zenobi**, ETH Zürich (Switzerland) **Xiaowei Zhuang**, Harvard University (United States)

Session Chairs

- Super Resolution Microscopy
 Prabhat Verma, Osaka University (Japan)
- 2 Tip-enhanced Raman Spectroscopy/Microscopy Remo Proietti Zaccaria, Istituto Italiano di Tecnologia (Japan)
- 3 Plasmonics for Nanospectroscopy I Nicholas J. Borys, The Molecular Foundry (United States)
- 4 Near-field Spectroscopy/Microscopy Natalia Martín Sabanés, Max-Planck-Institut für Polymerforschung (Germany)
- Plasmonics for Nanospectroscopy II
 Alexander Egner, Laser- Laboratorium Göttingen e.V. (Germany)
- 6 Nanospectroscopy **Haemi Lee**, Korea Research Institute of Chemical Technology

 (Korea, Republic of)