PROCEEDINGS OF SPIE

Carbon Nanotubes, Graphene, and Emerging 2D Materials for Electronic and Photonic Devices VIII

Manijeh Razeghi Maziar Ghazinejad Can Bayram Jae Su Yu Editors

9–12 August 2015 San Diego, California, United States

Sponsored and Published by SPIE

Volume 9552

Proceedings of SPIE 0277-786X, V. 9552

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

Carbon Nanotubes, Graphene, and Emerging 2D Materials for Electronic and Photonic Devices VIII, edited by Manijeh Razeghi, Maziar Ghazinejad, Can Bayram, Jae Su Yu, Proc. of SPIE Vol. 9552, 955201 ⋅ © 2015 SPIE ⋅ CCC code: 0277-786X/15/\$18 ⋅ doi: 10.1117/12.2205074

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 this book:

Author(s), "Title of Paper," in Carbon Nanotubes, Graphene, and Emerging 2D Materials for Electronic and Photonic Devices VIII, edited by Manijeh Razeghi, Maziar Ghazinejad, Can Bayram, Jae Su Yu, Proceedings of SPIE Vol. 9552 (SPIE, Bellingham, WA, 2015) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN:1996-756X (electronic) ISBN: 9781628417180

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 © 2015, 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/15/\$18.00.

Printed in the United States of America.

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



Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print. Papers are published as they are submitted and meet publication criteria. A unique 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.

Contents

- v Authors
- vii Conference Committee
- ix Nano-bio-optomechanics: nanoaperture tweezers probe single nanoparticles, proteins, and their interactions (Plenary Paper) [9544-501]

SESSION 1	SYNTHESIS AND CHARACTERIZATION I
9552 04	Lithographically defined 3-dimensional graphene scaffolds (Invited Paper) [9552-2]
9552 06	Engineering catalytic activity via ion beam bombardment of catalyst supports for vertically aligned carbon nanotube growth (Invited Paper) [9552-4]
SESSION 2	DEVICES I
9552 09	Capturing the effect of long low-temperature anneals on the sub-bandgap defect structure of CZTSSe (Invited Paper) [9552-8]
9552 OB	Thermal instability of field emission from carbon nanotubes studied using multi-physics simulation by considering space charge effect [9552-10]
SESSION 3	EMERGING 2D MATERIALS FOR ELECTRONIC AND PHOTONIC DEVICES
9552 ON	Tin disulfide thin films via soft chalcogenization [9552-23]
SESSION 4	DEVICES II
9552 OR	A graphene-based non-volatile memory [9552-26]
9552 OV	Photodetector based on carbon nanotubes [9552-31]
SESSION 5	SYNTHESIS AND CHARACTERIZATION II
9552 OY	Graphene growth on SiC(000-1): optimization of surface preparation and growth conditions (Invited Paper) [9552-34]
9552 OZ	Theoretical insights into multibandgap hybrid perovskites for photovoltaic applications (Invited Paper) [9552-35]
9552 11	Synthesis of large-size graphene by chemical vapor deposition [9552-37]

9552 12 Nanoscale thermocapillarity enabled purification for horizontally aligned arrays of single walled carbon nanotubes (Invited Paper) [9552-38]

POSTER SESSION

- 9552 13 Study of single walled carbon nanotube functionalization by means of surface enhanced Raman spectroscopy [9552-6]
- 9552 15 Synthesis and characterization of covalently bound benzocaine graphite oxide derivative [9552-42]

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.

Adamov, Y., 0V Amama, P. B., 06 Beck, Alexandre, 0Z Bishop, Doug, 09 Burckel, D. Bruce, 04 Bussmann, Konrad M., OY Ceponkus, Justinas, 13 Cojocaru, Costel-Sorin, OR

Ding, Yao, 11 Dunham, Simon, 12 Durand, Olivier, 0Z Eddy, Jr., Charles R., 0Y Erford, M., 06 Even, Jacky, 0Z

Fairchild, S. B., OB Gan, Lin, 11 Garces, Nelson Y., 0Y Gaskill, D. Kurt, 0Y Gershon, Talia, 09

Gordon, Reuven, ix Haight, Richard, 09 Huang, Yong, 0Z Huffman, D., 06 Islam, A. E., 06, 0B Jernigan, Glenn G., 0Y

Jin, Sung Hun, 12 Kabbani, Ahmad, 15 Kabbani, Mohamad, 15

Katan, C., 0Z

Kepenekian, Mikael, 0Z

Kitsyuk, E., OV

Lebental, Bérengère, OR

Loisel, Loïc, OR Luo, Zhengtang, 11 Maruyama, B., 06, 0B Maurice, Ange, OR

McCandless, Brian, 09

Mutlu, Zafer, ON

Myers-Ward, Rachael L., 0Y

Nath, Anindya, 0Y Nikolaev, P., 06

Nyakiti, Luke O., 0Y

Ozkan, Cenaiz S., 0N

Ozkan, Mihrimah, 0N

Pavlov, A., 0V

Pedesseau, Laurent, OZ

Polsky, Ronen, 04

Pucetaite, Milda, 13

Robinson, Zachary R., 0Y

Robles, Roberto, OZ Rogers, John A., 12 Rolland, Alain, 0Z Ryazanov, R., 0V

Saber, S., 06

Sablinskas, Valdas, 13 Safadi, Khadija, 15

Sapori, Daniel, 0Z

Sargent, G., 06 Semiatin, S. L., 06 Stach, E. A., 06

Tay, Beng Kang, OR Timoshenkov, V., 0V

Velicka, Martynas, 13 Vezzoli, Stefano, OR

Wang, Shijian, OZ Wang, Wei, 09

Wheeler, Virginia D., 0Y

Wu, Ruizhe, 11 Xiao, Xiaoyin, 04 Xie, Xu, 12

Zakharov, D., 06

Proc. of SPIE Vol. 9552 955201-6

Conference Committee

Symposium Chairs

Satoshi Kawata, Osaka University (Japan) **Manijeh Razeghi**, Northwestern University (United States)

Symposium Co-chairs

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

Conference Chairs

Manijeh Razeghi, Northwestern University (United States)
 Maziar Ghazinejad, California State Univ., Fresno (United States)
 Can Bayram, University of Illinois at Urbana-Champaign (United States)
 Jae Su Yu, Kyung Hee University (Korea, Republic of)

Conference Program Committee

(United States)

Seunghyun Baik, Sungkyunkwan University (Korea, Republic of)
Paolo Bondavalli, Thales Research & Technology (France)
Markus Buehler, Massachusetts Institute of Technology (United States)
Costel-Sorin Cojocaru, Ecole Polytechnique (France)
Ertugrul Cubukcu, University of Pennsylvania (United States)
Christos D. Dimitrakopoulos, University of Massachusetts Amherst (United States)

Charles M. Falco, College of Optical Sciences, The University of Arizona (United States)

Talia Gershon, IBM Thomas J. Watson Research Center (United States)Kenji Hata, National Institute of Advanced Industrial Science and Technology (Japan)

Mark C. Hersam, Northwestern University (United States)

Seong Chan Jun, Yonsei University (Korea, Republic of)

Jeehwan Kim, IBM Thomas J. Watson Research Center (United States)

Horacio Lamela Rivera, Universidad Carlos III de Madrid (Spain)

Seung Hee Lee, Chonbuk National University (Korea, Republic of)

Young Hee Lee, Sungkyunkwan University (Korea, Republic of)

Xiuling Li, University of Illinois at Urbana-Champaign (United States)

Annick Loiseau, ONERA (France)

Jean-Pierre Luberton, University of Illinois at Urbana-Champaign

Masud Mansuripur, College of Optical Sciences, The University of Arizona (United States)

Ryan McClintock, Northwestern University (United States)

William I. Milne, University of Cambridge (United Kingdom)

Sedat Nizamoglu, Ozyegin University (Turkey)

Cengiz S. Ozkan, University of California, Riverside (United States)

Hongsik Park, Kyungpook National University (Korea, Republic of)

Philip W. T. Pong, The University of Hong Kong (Hong Kong, China)

Fengnian Xia, Yale University (United States)

Wenjuan Zhu, University of Illinois at Urbana-Champaign (United States)

Session Chairs

- Synthesis and Characterization I
 Xiuling Li, University of Illinois at Urbana-Champaign (United States)
- 2 Devices I.

Ahmad E. Islam, Air Force Research Laboratory (United States) **Jean-Pierre Leburton**, University of Illinois at Urbana-Champaign (United States)

3 Emerging 2D Materials for Electronic and Photonic Devices **Wenjuan Zhu**, University of Illinois at Urbana-Champaign (United States)

Zachary R. Robinson, U.S. Naval Research Laboratory (United States)

Keynote Session

Manijeh Razeghi, Northwestern University (United States)

4 Devices II

Norma E. Sosa, IBM Thomas J. Watson Research Center (United States)

Sung Hun Jin, Incheon National University (Korea, Republic of)

5 Synthesis and Characterization II

Jacky Even, Institut National des Sciences Appliquées de Rennes (France)

D. Bruce Burckel, Sandia National Laboratories (United States)