Energy Harvesting and Storage: Materials, Devices, and Applications VI

Nibir K. Dhar
Achyut K. Dutta
Editors

21 April 2015
Baltimore, Maryland, United States

Sponsored and Published by SPIE

Volume 9493
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:


ISSN: 0277-786X
ISBN: 9781628416091

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.

SPIESDL.org

SPIEDigitalLibrary.org

**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

<table>
<thead>
<tr>
<th>SESSION 1</th>
<th>ADVANCED FUEL CELLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9493 02</td>
<td>Micro enzymatic biofuel cells: from theoretical to experimental aspect (Invited Paper) [9493-1]</td>
</tr>
<tr>
<td>9493 03</td>
<td>Performance study of sugar-yeast-ethanol bio-hybrid fuel cells [9493-2]</td>
</tr>
<tr>
<td>9493 04</td>
<td>Synergic system between photovoltaic module and microbial fuel cell with simultaneous pollution control [9493-3]</td>
</tr>
<tr>
<td>9493 05</td>
<td>Inhomogeneous thermoelectric materials: improving overall $zT$ by localized property variations [9493-4]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 2</th>
<th>ADVANCED STORAGE AND BATTERY TECHNOLOGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>9493 07</td>
<td>Dielectric properties of low temperature nano engineered yttrium copper titanate ceramic [9493-6]</td>
</tr>
<tr>
<td>9493 08</td>
<td>Effect of organic flux on the colossal dielectric constant of CaCu$_3$Ti$<em>4$O$</em>{12}$ (CCTO) [9493-7]</td>
</tr>
<tr>
<td>9493 0A</td>
<td>Effect of temperature and thickness of graphene on the hydrogen storage properties [9493-9]</td>
</tr>
<tr>
<td>9493 0B</td>
<td>Hybridization of lithium-ion batteries and electrochemical capacitors: fabrication and challenges (Invited Paper) [9493-10]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 3</th>
<th>ADVANCED HARVESTING DEVICE AND APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9493 0C</td>
<td>Carbon microelectromechanical systems (C-MEMS) based microsupercapacitors [9493-11]</td>
</tr>
<tr>
<td>9493 0E</td>
<td>High efficiency c-Si solar cells utilizing light-trapping phenomenon [9493-13]</td>
</tr>
<tr>
<td>9493 0F</td>
<td>Pulsed microwave heating method for preparation of dye-sensitized solar cells for greener, faster, cheaper production of photovoltaic materials [9493-14]</td>
</tr>
<tr>
<td>9493 0G</td>
<td>Energy harvesting via ferrofluidic induction [9493-15]</td>
</tr>
</tbody>
</table>
Piezoelectric energy-harvesting power source and event detection sensors for gun-fired munitions [9493-16]

C-MEMS for bio-sensing applications (Invited Paper) [9493-17]

POSTER SESSION

Interconnection between tricarboxylic acid cycle and energy generation in microbial fuel cell performed by *Desulfuromonas acetoxidans* IMV B-7384 [9493-18]

Enhanced vibration energy harvesting using nonlinear oscillations [9493-25]
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.

Agrawal, Richa, 02, 0B, 0C, 0I
Arnold, Bradley, 08
Aspin, Zachary S., 0G
Beck, Jan, 05
Beidaghi, Majid, 0C
Benyamin, Marcus, 03
Berg, Matthew J., 0G
Bilyy, Oleksandr I., 0J
Blais, Timothy, 0F
Chen, Chunhui, 0B
Chen, Wei, 0C
Choo, Fow-Sen, 08
Cotta, Robert, 0F
Dhar, Nibir K., 0E
Dhere, Neelkanth G., 04
Dutta, Achyut K., 0E
Engel, Emily, 0Q
Fairley, John D., 0G
Feng, Dake, 0H
Ferensovych, Yaroslav P., 0J
Ganguli, Rahul, 03
Hall, Charles B., 0F
Hao, Yong, 0B
Hnatush, Sviltana O., 0J
Huang, Jie, 0A
Islam, Saif, 0E
Jahnke, Justin P., 03
Kelly, Lisa, 0B
Lee, Christopher L., 0Q
Mackie, David M., 03
Maddux, Joy, 05
Mandal, K. D., 07
Maslovskaya, Olga D., 0J
Mizuno, Genki, 0E
Monroe, J. Gabriel, 0G
Murphy, Clifford B., 0F
Nemir, David, 05
Oduor, Patrick, 0E
Olah, Robert, 0E
Pereira, Carlos M., 0H
Prasad, Narasimha, 05
Rastegar, Jahangir, 0H
Razdan, Vishnu, 0B
Sharma, Sunita, 07
Shrestha, Anil, 0E
Singh, Abhishek, 0B
Singh, M. M., 07
Singh, Narsingh B., 07, 0B
Song, Yin, 02, 0B, 0I

Sumner, James J., 03
Taylor, Patrick, 05
Thompson, Scott M., 0G
Vasquez, Erick S., 0G
Vasyliv, Oresta M., 04, 0J
Walters, Keisha B., 0G
Wang, Chunlei, 02, 0B, 0C, 0I
Wei, Jiaying, 0Q
Wong, C.H., 0A
Conference Committee

Symposium Chair

Wolfgang Schade, Clausthal University of Technology and Fraunhofer Heinrich-Hertz Institute (Germany)

Symposium Co-chair

Ming C. Wu, University of California, Berkeley (United States)

Conference Chairs

Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
Achyut K. Dutta, Banpil Photonics, Inc. (United States)

Conference Program Committee

Pulickel M. Ajayan, Rice University (United States)
Paul Boieriu, EPISOLAR, Inc. (United States)
Deryn Chu, U.S. Army Research Laboratory (United States)
M. Saif Islam, University of California, Davis (United States)
Nobuhiko P. Kobayashi, University of California, Santa Cruz (United States)
Pooli See Lee, Nanyang Technological University (Singapore)
Pat McGrath, Booz Allen Hamilton Inc. (United States)
Robert Olah, Banpil Photonics, Inc. (United States)
Kimberly A. Sablon, U.S. Army Research Laboratory (United States)
A. Fred Semendy, U.S. Army Research Laboratory (United States)
Sivalingam Sivananthan, EPIR Technologies (United States)
Ashok K. Sood, Magnolia Optical Technologies, Inc. (United States)
Patrick J. Taylor, U.S. Army Research Laboratory (United States)
Sudhir B. Trivedi, Brimrose Corporation of America (United States)
Rama Venkatasubramanian, RTI International (United States)
Chunlei Wang, Florida International University (United States)
Priyalal Wijewarnasuriya, U.S. Army Research Laboratory (United States)

Session Chairs

1 Advanced Fuel Cells

Nibir K. Dhar, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
Achyut K. Dutta, Banpil Photonics, Inc. (United States)
2 Advanced Storage and Battery Technologies
Chunlei Wang, Florida International University (United States)
Achyut K. Dutta, Banpil Photonics, Inc. (United States)

3 Advanced Harvesting Device and Applications
Achyut K. Dutta, Banpil Photonics, Inc. (United States)
Chunlei Wang, Florida International University (United States)