PROCEEDINGS OF SPIE

Next Generation Technologies for Solar Energy Conversion VII

Oleg V. Sulima Gavin Conibeer Editors

29–31 August 2016 San Diego, California, United States

Sponsored and Published by SPIE

Volume 9937

Proceedings of SPIE 0277-786X, V. 9937

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

Next Generation Technologies for Solar Energy Conversion VII, edited by Oleg V. Sulima, Gavin Conibeer, Proc. of SPIE Vol. 9937, 99370Z · © 2016 SPIE CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2262169

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 Next Generation Technologies for Solar Energy Conversion VII, edited by Oleg V. Sulima, Gavin Conibeer, Proceedings of SPIE Vol. 9937 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-786X (electronic)

ISBN: 9781510602656

ISBN: 9781510602663 (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
	NEW CONCEPTS AND APPROACHES I
9937 03	Concentrating light in Cu(In,Ga)Se ₂ solar cells [9937-1]
9937 04	Solar-thermophotovoltaic systems using spectrally selective absorber/emitter based on metal-dielectric multilayer [9937-2]
9937 05	High-efficiency solar energy conversion with spectrum splitting prismatic lens and multiple independent PV cells [9937-3]
9937 07	Metal hydrides as hot carrier solar cell absorber materials [9937-5]
	QUANTUM DOTS, WIRES, AND WELLS
9937 08	Type II GaSb/GaAs quantum rings with extended photoresponse for efficient solar cells [9937-6]
9937 09	Evidence of suppressed hot carrier relaxation in type-II InAs/AlAs _{1-x} Sb _x quantum wells $[9937-7]$
	PHOTON MANAGEMENT
9937 OE	Broadband-sensitive upconverters co-doped with Er³+ and Ni²+ for crystalline silicon solar cells [9937-12]
9937 OF	Up-conversion equivalent circuit to boost current in Si cells [9937-13]
	NEW CONCEPTS AND APPROACHES II
9937 OK	Comparison of holographic lens and filter systems for lateral spectrum splitting [9937-19]
9937 OL	Segmented holographic spectrum splitting concentrator [9937-20]
9937 OM	Three junction holographic micro-scale PV system [9937-21]
9937 ON	Environmental stability study of holographic solar spectrum splitting materials [9937-22]
9937 00	Concept of a methodical process for the design of concentrating photovoltaic systems according to the context of use [9937-23]

9937 OP	Tuning the colors of c-Si solar cells by exploiting plasmonic effects [9937-24]
	NEW CONCEPTS AND APPROACHES III
9937 OR	Measurement of photoluminescence from a twisted-nematic liquid crystal/dye cell for an application in an energy-harvesting display [9937-26]
9937 OS	Performance assessment and transient optimization of multi-stage solid desiccant air conditioning systems with building PV/T integration [9937-27]
9937 OT	Energy storage capability of the dye sensitized solar cells via utilization of highly porous carbon electrodes [9937-28]
9937 OU	Photoelectrochemical reaction in conducting polymers for solar energy harvesting and charge storage [9937-29]
9937 OV	Selecting a proper design period for heliostat field layout optimization using Campo code [9937-30]
	POSTER SESSION
9937 OX	Enhancement of a-Si:H solar cell efficiency by Y_2O_3 : Yb^{3+} , Er^{3+} near infrared spectral upconverter [9937-34]
9937 OY	Fluorescent simulation and experimental verification of luminescent solar concentrators [9937-36]

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.

Aguey-Zinsou, Kondo-Francois, 07

Antony, Aldrin, 0X Apostoleris, Harry, 05

Ayala Pelaez, Silvana, OL, OM, ON Binti M. Azmi, Nada Dianah, OR

Botha, J. R., 08 Carrington, P. J., 08 Chan, Kai Yuen, 0F Chao, Pin-Jen, 0Y Chiesa, Matteo, 05

Chrysler, Benjamin D., OK, OL, ON

Conibeer, Gavin, 07, 0F

Duan, S., 03 Esmaielpour, H., 09 Fujieda, Ichiro, 0R Fujita, H., 08

Gadalla, Mohamed, 0S, 0V González-Correa, David, 0O

Großchädl, B., OP Heidmann, B., 03 Huang, Shujuan, OF Itaya, Shunsuke, OR James, J., 08 Jayaraj, M. K., 0X Kämmer, S., 03 Kohiyama, A., 04 Köhler, T., 03

Kostuk, Raymond K., OK, OL, OM, ON

Krier, A., 08 Liao, Wen-Yih, 0Y Luitel, Hom Nath, 0E Lux-Steiner, M. Ch., 03

Manley, P., 03 Maragliano, Carlo, 05 Markose, Kurias K., 0X Marshall, A. R. J., 08

Mejía-Gutiérrez, Ricardo, 00

Mishima, T. D., 09 Mizuno, Shintaro, 0E Montesdeoca, D., 08 Ohta, Masamichi, 0R Osorio-Gómez, Gilberto, 0O Ozawa, Shintaro, 0R

P., Subha P., OX Peharz, G., OP Prietl, C., OP

Puthen-Veettil, Binesh, OF

R., Anjana, 0X

Rahimi, Fatemeh, OT, OU

Saghafifar, Mohammad, OS, OV

Sancho-Martinez, D., 03

Santos, M. B., 09 Schmid, M., 03 Sellers, I. R., 09 Shih, Hsi-Fu, 0Y Shimizu, M., 04

Shrestha, Santosh, 07, 0F

Song, M., 03

Stefancich, Marco, 05 Takeda, Yasuhiko, 0E Takshi, Arash, 0T, 0U Tang, J., 09

Tang, J., U9 Tani, Toshihiko, 0E Tevi, Tete, 0U

Vijeyaragunathan, S., 09

Vorndran, Shelby D., OK, OL, OM, ON

Wagener, M. C., 08 Waldhauser, W., 0P Wang, B., 09 Wang, Pei, 07 Wen, Xiaoming, 07 Wenzl, F. P., 0P Whiteside, V. R., 09 Wu, Yuechen, 0L, 0M, 0N

Yang, R. Q., 09 Yin, G., 03 Yugami, H., 04

Proc. of SPIE Vol. 9937 99370Z-6

Conference Committee

Symposium Chair

Oleg V. Sulima, GE Global Research (United States)

Conference Chairs

Oleg V. Sulima, GE Global Research (United States) **Gavin Conibeer**, The University of New South Wales (Australia)

Conference Program Committee

Andrew J. Ferguson, National Renewable Energy Laboratory (United States)

Alberto Salleo, Stanford University (United States)
Sean E. Shaheen, University of Colorado at Boulder (United States)
Wilfried G. J. H. M. van Sark, Utrecht Universiteit (Netherlands)
Xianfan Xu, Purdue University (United States)

Session Chairs

- New Concepts and Approaches I
 Oleg V. Sulima, GE Global Research (United States)
- 2 Quantum Dots, Wires, and Wells Gavin Conibeer, The University of New South Wales (Australia)
- 3 Photon Management Peter Bermel, Purdue University (United States)
- 4 New Designs and Concepts for Organic PV Sean E. Shaheen, University of Colorado Boulder (United States)
- 5 New Concepts and Approaches II Andru J. Prescod, SunShot Initiative, United States Deptartment of Energy (United States) and ManTech International Corporation (United States)
- 6 New Concepts and Approaches III Andru J. Prescod, SunShot Initiative, United States Deptartment of Energy (United States) and ManTech International Corporation (United States)

Proc. of SPIE Vol. 9937 99370Z-8