

PROCEEDINGS OF SPIE

***Physics, Simulation, and
Photonic Engineering of
Photovoltaic Devices II***

**Alexandre Freundlich
Jean-Francois Guillemoles**
Editors

**3–7 February 2013
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 8620

Proceedings of SPIE 0277-786X, V.8620

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

Physics, Simulation, and Photonic Engineering of Photovoltaic Devices II, edited by Alexandre Freundlich,
Jean-Francois Guillemoles, Proc. of SPIE Vol. 8620, 862001 · © 2013 SPIE
CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2022454

Proc. of SPIE Vol. 8620 862001-1

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:

Author(s), "Title of Paper," in *Physics, Simulation, and Photonic Engineering of Photovoltaic Devices II*, edited by Alexandre Freundlich, Jean-Francois Guillemoles, Proceedings of SPIE Vol. 8620 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819493897

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 © 2013, 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/13/\$18.00.

Printed in the United States of America.

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



SPIEDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent 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. Numbers in the index correspond to the last two digits of the six-digit CID Number.

Contents

- xi Conference Committee
- xiii *Introduction*
- xv *Group IV photonics for the mid infrared (Plenary Paper) [8629-1]*
R. Soref, The Univ. of Massachusetts at Boston (United States)
- xxxi *Light in a twist: optical angular momentum (Plenary Paper) [8637-2]*
M. J. Padgett, Univ. of Glasgow (United Kingdom)

PLASMONICS APPROACHES TO PV

- 8620 03 **Effect of grating period on the excitation of multiple surface-plasmon-polariton waves guided by the interface of a metal grating and a photonic crystal [8620-2]**
A. S. Hall, M. Faryad, G. D. Barber, A. Lakhtakia, T. E. Mallouk, The Pennsylvania State Univ. (United States)
- 8620 04 **Improving photovoltaic devices using silver nanocubes [8620-3]**
F. Hejazi, S. Y. Ding, Y. Sun, A. Bottomley, A. Ianoul, W. N. Ye, Carleton Univ. (Canada)
- 8620 05 **Efficiency enhancement of amorphous-silicon tandem solar cell due to multiple surface-plasmon-polariton waves [8620-4]**
M. Faryad, A. Lakhtakia, The Pennsylvania State Univ. (United States)
- 8620 06 **On energy transfer in metallic nanomodified photocells via surface plasmons in metallic nanoparticles: inclusion of nanoparticle size-effect [8620-5]**
W. A. Jacak, Wroclaw Univ. of Technology (Poland)

ADVANCED CHARACTERIZATION TECHNIQUES

- 8620 08 **Intraband carrier dynamics in InAs/GaAs quantum dots studied by two-color excitation spectroscopy [8620-7]**
Y. Harada, T. Maeda, T. Kita, Kobe Univ. (Japan)
- 8620 09 **Evaluation of micrometer scale lateral fluctuations of transport properties in CIGS solar cells [8620-8]**
A. Delamarre, D. Ory, M. Paire, D. Lincot, J.-F. Guillemoles, L. Lombez, Institut de Recherche et Développement sur l'Energie Photovoltaïque, CNRS, Chimie Paristech (France)

LIGHT MANAGEMENT FOR ULTRA THIN PV DEVICES

- 8620 0C **Broadband light-trapping in ultra-thin nano-structured solar cells (Green Photonics Award Paper)** [8620-11]
C. Colin, Lab. de Photonique et de Nanostructures, CNRS (France) and IRDEP, CNRS, Chimie Paristech (France); I. Massiot, A. Cattoni, N. Vandamme, C. Dupuis, N. Bardou, Lab. de Photonique et de Nanostructures, CNRS (France); I. Gerard, Institut de Recherche et Développement sur l'Energie Photovoltaïque, CNRS, Chimie Paristech (France); N. Naghavi, J.-F. Guillemoles, Institut Lavoisier de Versailles, Univ. de Versailles (France); J. Pelouard, S. Collin, Lab. de Photonique et de Nanostructures, CNRS (France)
- 8620 0D **Silicon solar cell light-trapping using defect mode photonic crystals** [8620-12]
K. A. Whitesell, D. M. Callahan, H. Atwater, California Institute of Technology (United States)

APPROACHES TO SPECTRAL SHAPING AND LIGHT MANAGEMENT

- 8620 0G **Nanostructured down-converter module for photovoltaic application** [8620-15]
T. Deschamps, Univ. de Lyon, Institut des Nanotechnologies de Lyon, CNRS-INSA-ECL-UCBL (France) and Ecole Centrale de Lyon (France); A. Guille, Institut Lumière Matière, Univ. Claude Bernard Lyon 1, CNRS (France); E. Drouard, R. Mazurczyk, Univ. de Lyon, Institut des Nanotechnologies de Lyon, CNRS-INSA-ECL-UCBL (France) and Ecole Centrale de Lyon (France); R. Orobetchouk, C. Jamois, A. Fave, Univ. de Lyon, Institut des Nanotechnologies de Lyon, CNRS-INSA-ECL-UCBL (France) and Institut National des Sciences Appliquées de Lyon (France); R. Peretti, Univ. de Lyon, Institut des Nanotechnologies de Lyon, CNRS-INSA-ECL-UCBL (France) and Ecole Centrale de Lyon (France); E. Fourmond, Univ. de Lyon, Institut des Nanotechnologies de Lyon, CNRS-INSA-ECL-UCBL (France) and Institut National des Sciences Appliquées de Lyon (France); A. Pereira, B. Moine, Institut Lumière Matière, Univ. Claude Bernard Lyon 1, CNRS (France); C. Seassal, Institut des Nanotechnologies de Lyon (France), Ecole Centrale de Lyon (France), and Institut National des Sciences Appliquées de Lyon (France)
- 8620 0H **Enhancing absorption in a thin film photovoltaic system with periodic nanostructures obtained by low-cost techniques** [8620-16]
A. Le Bris, Saint-Gobain Recherche (France); B. Brudieu, Saint-Gobain Recherche (France) and Lab. de Physique de La Matière Condensée, Ecole Polytechnique (France); T. Gacoin, Lab. de Physique de La Matière Condensée, Ecole Polytechnique (France); J. Teisseire, F. Sorin, Saint-Gobain Recherche (France)
- 8620 0I **Broadband light absorption enhancement in thin-film solar cells by combining front dielectric and back metallic gratings** [8620-17]
S. Guo, G. Su, D. Xiao, Z. Zhang, Peking Univ. Shenzhen Graduate School (China)

INTERMEDIATE BAND AND QUANTUM DOT ENHANCED DEVICES

- 8620 0J **Six not so easy pieces in intermediate band solar cell research (Invited Paper)** [8620-18]
A. Martí, Univ. Politécnica de Madrid (Spain); E. Antolín, Univ. Politécnica de Madrid (Spain) and The Univ. of Nottingham (United Kingdom); P. García-Linares, I. Ramiro, I. Artacho, E. López, E. Hernández, Univ. Politécnica de Madrid (Spain); M. J. Mendes, Univ. Politécnica de Madrid (Spain) and CNR - IMM - UOS Catania (Italy); A. Mellor, I. Tobías, D. Fuentes Marrón, C. Tablero, A. B. Cristóbal, Univ. Politécnica de Madrid (Spain); C. G. Bailey, U.S. Naval Research Lab. (United States); M. Gonzalez, U.S. Naval Research Lab. (United States) and Sotera Defense Solutions (United States); M. Yakes, U.S. Naval Research Lab. (United States); M. P. Lumb, U.S. Naval Research Lab. (United States) and The George Washington Univ. (United States); R. Walters, U.S. Naval Research Lab. (United States); A. Luque, Univ. Politécnica de Madrid (Spain)
- 8620 0K **Modification of band alignment at interface of $\text{Al}_y\text{Ga}_{1-y}\text{Sb}/\text{Al}_x\text{Ga}_{1-x}\text{As}$ type-II quantum dots by concentrated sunlight in intermediate-band solar cells with separated absorption and depletion regions** [8620-20]
A. Kechiantz, The George Washington Univ. (United States) and On leave: Institute of Radiophysics and Electronics (Armenia); A. Afanasev, The George Washington Univ. (United States); J.-L. Lazzari, Ctr. Interdisciplinaire de Nanoscience de Marseille, CNRS, Aix-Marseille Univ. (France)
- 8620 0L **Investigation of the design parameters of quantum dot enhanced III-V solar cells** [8620-21]
K. Driscoll, M. Bennett, S. Polly, D. V. Forbes, S. M. Hubbard, Rochester Institute of Technology (United States)
- 8620 0M **Improving photonic-electronic characteristics in quantum-dot solar cells via lattice strain mechanisms** [8620-22]
W. P. Kirk, Univ. of Texas at Arlington (United States); J. Gandhi, Univ. of Houston (United States); C.-U. Kim, Univ. of Texas at Arlington (United States)

ANTIREFLECTIVE COATINGS AND TEXTURING

- 8620 0N **Towards high-efficiency triple-junction solar cells with bio-inspired nanostructures (Invited Paper)** [8620-23]
P. Yu, H.-V. Han, T.-T. Yang, National Chiao Tung Univ. (Taiwan); M.-M. Hung, National Chiao Tung Univ. (Taiwan) and Arima Photovoltaic & Optical Corp. (Taiwan); C.-Y. Hong, Y.-L. Tsai, K.-H. Hung, T.-G. Chen, National Chiao Tung Univ. (Taiwan); Y.-R. Wu, Arima Photovoltaic & Optical Corp. (Taiwan); G.-C. Chi, National Chiao Tung Univ. (Taiwan)
- 8620 0P **Simulation and development of sub-wavelength textured ARCs for CPV applications** [8620-25]
W. Wang, Univ. of Houston (United States); P. Narchi, Univ. of Houston (United States) and Ecole Polytechnique (France); A. Freundlich, Univ. of Houston (United States)

EMERGING DEVICE CONCEPTS

- 8620 0S **Silicon rich carbide as a conductive substrate for Si QD solar cells** [8620-28]
D. Lan, D. Di, G. Conibeer, X. Jia, L. Wu, The Univ. of New South Wales (Australia)

- 8620 0T **Non PN junction solar cells using carrier selective contacts (Invited Paper)** [8620-29]
S. Bowden, K. Ghosh, C. Honsberg, Arizona State Univ. (United States)

RADIATION EFFECTS IN PV DEVICES

- 8620 0U **Solar cell experiments for space: past, present and future (Invited Paper)** [8620-30]
R. Hoheisel, The George Washington Univ. (United States); S. R. Messenger, U.S. Naval Research Lab. (United States); M. P. Lumb, The George Washington Univ. (United States); M. Gonzalez, Sotera Defense Solutions (United States); C. G. Bailey, D. A. Scheiman, S. Maximenko, P. P. Jenkins, R. J. Walters, U.S. Naval Research Lab. (United States)
- 8620 0V **Modeling of defect tolerance of IMM multijunction photovoltaics for space application** [8620-31]
A. Mehrotra, A. Freundlich, Univ. of Houston (United States)
- 8620 0W **Investigation of carrier removal from QD TJSCs** [8620-32]
C. Kerestes, D. V. Forbes, Rochester Institute of Technology (United States); C. D. Cress, U.S. Naval Research Lab. (United States); B. C. Richards, EMCORE Corp. (United States); W. T. Lotshaw, S. D. LaLumondiere, The Aerospace Corp. (United States); E. Fernandez, Rochester Institute of Technology (United States); Y. Lin, P. Sharps, EMCORE Corp. (United States); S. M. Hubbard, Rochester Institute of Technology (United States)
- 8620 0X **Simulation of radiation effects in solar cells: DLTS vs. SRIM for trap data** [8620-33]
M. Turowski, T. Bald, A. Raman, A. Fedoseyev, CFD Research Corp. (United States); J. H. Warner, U.S. Naval Research Lab. (United States)
- 8620 0Y **Characterization of radiation tolerance in doping superlattice solar cells** [8620-34]
M. A. Slocum, D. V. Forbes, M. H. Bohra, S. M. Hubbard, Rochester Institute of Technology (United States)

ADVANCES IN LIGHT CONCENTRATION

- 8620 0Z **Physics of Cu(In,Ga)Se₂ microcells under ultrahigh illumination intensities (Invited Paper)** [8620-36]
M. Paire, L. Lombez, F. Donsanti, M. Jubault, Institut de Recherche et Développement sur l'Energie Photovoltaïque, CNRS, Chimie Paristech (France); S. Collin, J.-L. Pelouard, Lab. de Photonique et de Nanostructures, CNRS (France); D. Lincot, J.-F. Guillemoles, Institut de Recherche et Développement sur l'Energie Photovoltaïque, CNRS, Chimie Paristech (France)
- 8620 10 **Efficiency of a micro-bubble reflector based, self-adaptive waveguide solar concentrator** [8620-37]
V. Zagolla, E. Tremblay, C. Moser, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8620 11 **Self-tracking planar concentrator using a solar actuated phase-change mechanism** [8620-38]
E. J. Tremblay, V. Zagolla, D. Loterie, C. Moser, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

- 8620 12 **Adjustable planar lightguide solar concentrators with liquid-prism structure** [8620-39]
M.-C. Tsai, A. J.-W. Whang, T.-X. Lee, Y.-Y. Chen, National Taiwan Univ. of Science and Technology (Taiwan)

EMERGING PV AND TCO MATERIALS

- 8620 15 **Modeling Cu₂ZnSnS₄ (CZTS) solar cells with kesterite and stannite phase variation** [8620-42]
E. A. Lund, M. A. Scarpulla, The Univ. of Utah (United States)
- 8620 16 **GaN microdomes for broadband omnidirectional antireflection for concentrator photovoltaics** [8620-43]
L. Han, M. R. McGoogan, T. A. Piedimonte, I. V. Kidd, R. H. French, H. Zhao, Case Western Reserve Univ. (United States)

THIN FILM MATERIALS AND DEVICES

- 8620 19 **Lambertian back reflector in Cu(InGa)Se₂ solar cell: optical modeling and characterization** [8620-46]
N. Dahan, Institut de Recherche et Développement sur l'Energie Photovoltaïque, CNRS, Chimie Paristech (France) and Lab. Charles Fabry, CNRS, Univ. Paris-Sud (France); Z. Jehl, J.-F. Guillemoles, D. Lincot, N. Naghavi, Institut de Recherche et Développement sur l'Energie Photovoltaïque, CNRS, Chimie Paristech (France); J.-J. Greffet, Lab. Charles Fabry, CNRS, Univ. Paris-Sud (France)
- 8620 1A **Effect of nonhomogeneous intrinsic layer in a thin-film amorphous-silicon solar cell** [8620-47]
M. R. M. Atalla, The Pennsylvania State Univ. (United States)

QUANTUM WELL ENHANCED DEVICES

- 8620 1C **Thick-well quantum-structured solar cells: design criteria for nano-enhanced absorbers** [8620-49]
R. E. Welser, Magnolia Solar, Inc. (United States) and Magnolia Optical Technologies, Inc. (United States)
- 8620 1D **Modeling of dilute nitride cascaded quantum well solar cells for high efficiency photovoltaics** [8620-50]
G. Vijaya, A. Alemu, A. Freundlich, Univ. of Houston (United States)
- 8620 1F **Carrier collection efficiency in multiple quantum well solar cells** [8620-52]
H. Fujii, K. Toprasertpong, The Univ. of Tokyo (Japan); K. Watanabe, Research Ctr. for Advanced Science and Technology (Japan); M. Sugiyama, The Univ. of Tokyo (Japan); Y. Nakano, The Univ. of Tokyo (Japan) and Research Ctr. for Advanced Science and Technology (Japan)

ADVANCED PHOTOVOLTAIC DEVICE SIMULATION: JOINT SESSION WITH CONFERENCES 8619 AND 8620

- 8620 1G **Drift-diffusion modeling of InP-based triple junction solar cells (Invited Paper)** [8620-53]
M. P. Lumb, U.S. Naval Research Lab. (United States) and The George Washington Univ. (United States); M. González, U.S. Naval Research Lab. (United States) and Sotera Defense Solutions (United States); C. G. Bailey, I. Vurgaftman, J. R. Meyer, J. Abell, M. Yakes, U.S. Naval Research Lab. (United States); R. Hoheisel, U.S. Naval Research Lab. (United States) and The George Washington Univ. (United States); J. G. Tischler, U.S. Naval Research Lab. (United States); P. N. Stavrinou, M. Fuhrer, N. J. Ekins-Daukes, Imperial College London (United Kingdom); R. J. Walters, U.S. Naval Research Lab. (United States)
- 8620 1H **FEM-based optical modeling of silicon thin-film tandem solar cells with randomly textured interfaces in 3D** [8620-54]
M. Hammerschmidt, Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany); D. Lockau, Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany) and Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany); S. Burger, F. Schmidt, Konrad-Zuse-Zentrum für Informationstechnik Berlin (Germany) and JCMwave GmbH (Germany); C. Schwanke, S. Kirner, S. Calnan, PVcomB (Germany); B. Stannowski, B. Rech, PVcomB (Germany) and Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (Germany)

III-V TANDEM MATERIALS AND DEVICES

- 8620 1I **High current generation in dilute nitride solar cells grown by molecular beam epitaxy** [8620-55]
A. Aho, A. Tukiainen, V. Polojärvi, J. Salmi, M. Guina, Tampere Univ. of Technology (Finland)
- 8620 1J **Dilute phosphide nitride materials as photocathodes for electrochemical solar energy conversion** [8620-56]
V. Parameshwaran, X. Xu, Y. Kang, J. Harris, H.-S. P. Wong, B. Clemens, Stanford Univ. (United States)
- 8620 1K **Ohmic contacts to n-type GaSb grown on GaAs by the interfacial misfit dislocation technique** [8620-57]
N. Rahimi, A. A. Aragon, O. S. Romero, The Univ. of New Mexico (United States); D. M. Kim, Virginia Polytechnic Institute and State Univ. (United States); N. B. J. Traynor, SUNY Geneseo (United States); T. J. Rotter, G. Balakrishnan, S. D. Mukherjee, L. F. Lester, The Univ. of New Mexico (United States)
- 8620 1L **Carrier dynamics in bulk 1eV InGaAsNSb materials and epitaxial lift off GaAs-InAlGaP layers grown by MOVPE for multi-junction solar cells** [8620-58]
Y. Sin, S. LaLumondiere, W. Lotshaw, S. C. Moss, The Aerospace Corp. (United States); T. W. Kim, K. Forghani, L. J. Mawst, T. F. Kuech, The Univ. of Wisconsin-Madison (United States); R. Tafavarti, A. Wibowo, N. Pan, MicroLink Devices, Inc. (United States)

- 8620 1M **Efficiency enhancement of InGaN/GaN multiple quantum well solar cells using CdS quantum dots and distributed Bragg reflectors** [8620-59]
Y.-L. Tsai, C.-C. Lin, H.-V. Han, H.-C. Chen, K.-J. Chen, National Chiao Tung Univ. (Taiwan); W.-C. Lai, J.-K. Sheu, National Cheng Kung Univ. (Taiwan); F.-I. Lai, Yuan Ze Univ. (Taiwan); P. Yu, H.-C. Kuo, National Chiao Tung Univ. (Taiwan)

POSTER SESSION

- 8620 1Q **Tuning up the performance of GaAs-based solar cells by inelastic scattering on quantum dots and doping of Al_yGa_{1-y}Sb type-II dots and Al_xGa_{1-x}As spacers between dots** [8620-64]
A. Kechiantz, The George Washington Univ. (United States) and Institute of Radiophysics and Electronics (Armenia); A. Afanasev, The George Washington Univ. (United States)
- 8620 1R **Modification of MBE for growth of dilute nitride quantum well photovoltaics** [8620-65]
G. Vijaya, A. Mehrotra, M. Gunasekera, A. Freundlich, Univ. of Houston (United States)
- 8620 1S **An innovative static compound parabolic concentrator with prism structure used in Natural Lighting Illumination System (NLIS)** [8620-67]
A. J.-W. Whang, G.-W. Chen, C.-S. Ren, National Taiwan Univ. of Science and Technology (Taiwan)
- 8620 1T **The hybrid coupling element for light-correcting in Natural Light Illumination Systems (NLIS)** [8620-68]
A. J.-W. Whang, C. Y. Hui, T.-X. Lee, Y.-Y. Chen, National Taiwan Univ. of Science and Technology (Taiwan)
- 8620 1U **Modular design optical light pipe with high efficiency** [8620-69]
A. J.-W. Whang, Y.-H. Yeh, Y.-Y. Chen, National Taiwan Univ. of Science and Technology (Taiwan)
- 8620 1V **Improve GaAs solar cells efficiency by using high-transmittance textured PDMS film** [8620-70]
H. V. Han, H. C. Chen, C. C. Lin, Y. L. Tsai, H. C. Kuo, P. Yu, National Chiao Tung Univ. (Taiwan)
- 8620 1W **Investigation in feasibility of molybdenum as a back contact layer for silicon based quantum dot solar cells** [8620-71]
Z. Lin, I. Perez-Wurfl, L. Wu, X. Jia, T. Zhang, B. Puthen-Veettil, H. Zhang, The Univ. of New South Wales (Australia); D. Di, Univ. of Cambridge (United Kingdom); G. Conibeer , The Univ. of New South Wales (Australia)
- 8620 1X **Miniaturized concentrator arrays as compact angle transformers for light collection and distribution** [8620-72]
R. Bitterli, T. Scharf, F. J. Haug, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8620 1Y **Improvement in etching rate for epilayer lift-off with surfactant** [8620-73]
F.-L. Wu, R.-H. Horng, J.-H. Lu, C.-L. Chen, Y.-C. Kao, National Chung Hsing Univ. (Taiwan)

- 8620 1Z **Zinc oxide nanowire arrays for photovoltaic and light-emitting devices** [8620-74]
B. Janfeshan, B. Sadeghimakki, N. M. S. Jahed, S. Sivoththaman, Univ. of Waterloo
(Canada)
- 8620 20 **Effect of grain boundary on nanoscale electronic properties of hydrogenated nanocrystalline silicon studied by Kelvin probe force microscopy** [8620-75]
R. B. Priti, S. Mahat, V. Bommisetty, South Dakota State Univ. (United States)
- 8620 21 **Numerical investigation on the structural characteristics of GaN/InGaN solar cells** [8620-76]
Y.-K. Kuo, J.-Y. Chang, S.-H. Yen, National Changhua Univ. of Education (Taiwan)
- 8620 22 **Thin film solar cells based on cavity enhanced grating structure** [8620-77]
G. Su, F. Gou, C. Liu, S. Guo, Z. Zhang, Peking Univ. Shenzhen Graduate School (China)
- 8620 23 **Use freeform reflector method in lighting coupler** [8620-78]
A. J.-W. Whang, Y. H. Hsu, S. H. Chang, National Taiwan Univ. of Science and Technology
(Taiwan)

Author Index

Conference Committee

Symposium Chair

David L. Andrews, University of East Anglia Norwich (United Kingdom)

Symposium Cochairs

Alexei L. Glebov, OptiGrate Corporation (United States)
Klaus P. Streubel, OSRAM GmbH (Germany)

Program Track Chair

James G. Grote, Air Force Research Laboratory (United States)

Conference Chairs

Alexandre Freundlich, University of Houston (United States)
Jean-Francois Guillemoles, Institut de Recherche et Développement sur l'Energie Photovoltaïque (France)

Conference Program Committee

Harry Atwater Jr., California Institute of Technology (United States)
Sheila G. Bailey, NASA Glenn Research Center (United States)
Gavin Conibeer, The University of New South Wales (Australia)
Nicholas J. Ekins-Daukes, Imperial College London (United Kingdom)
Christiana B. Honsberg, Arizona State University (United States)
Seth M. Hubbard, Rochester Institute of Technology (United States)
Daniel Lincot, Ecole Nationale Supérieure de Chimie de Paris (France)
Antonio Martí, Universidad Politécnica de Madrid (Spain)
Marek Osinski, The University of New Mexico (United States)
Mike Scarpulla, The University of Utah (United States)
Masakazu Sugiyama, The University of Tokyo (Japan)
Robert J. Walters, U.S. Naval Research Laboratory (United States)
David M. Wilt, Air Force Research Laboratory (United States)
Peichen Yu, National Chiao Tung University (Taiwan)

Session Chairs

- 1 Plasmonics Approaches to PV
Jean-Francois Guillemoles, Institut de Recherche et Développement sur l'Energie Photovoltaïque (France)

- 2 Advanced Characterization Techniques
Alexandre Freundlich, University of Houston (United States)
- 3 Light Management for Ultra Thin PV Devices
Gavin Conibeer, The University of New South Wales (Australia)
- 4 Approaches to Spectral Shaping and Light Management
Christiana B. Honsberg, Arizona State University (United States)
- 5 Intermediate Band and Quantum Dot Enhanced Devices
Raymond Hoheisel, U.S. Naval Research Laboratory (United States)
Matthew P. Lumb, U.S. Naval Research Laboratory (United States)
- 6 Antireflective Coatings and Texturing
Michael A. Scarpulla, The University of Utah (United States)
- 7 Emerging Device Concepts
Antonio Martí Vega, Universidad Politécnica de Madrid (Spain)
- 8 Radiation Effects in PV Devices
Alexandre I. Fedoseyev, CFD Research Corporation (United States)
- 9 Advances in Light Concentration
Marek Osinski, The University of New Mexico (United States)
- 10 Emerging PV and TCO Materials
Daniel Lincot, Institut de Recherche et Développement sur l'Energie Photovoltaïque (France)
- 11 Thin Film Materials and Devices
Peichen Yu, National Chiao Tung University (Taiwan)
- 12 Quantum Well Enhanced Devices
Nicholas J. Ekins-Daukes, Imperial College London (United Kingdom)
- 13 Advanced Photovoltaic Device Simulation: Joint Session with Conferences 8619 and 8620
Alexandre I. Fedoseyev, CFD Research Corporation (United States)
- 14 III-V Tandem Materials and Devices
Roger E. Welser, Magnolia Solar, Inc. (United States)
- 15 Hybrid PV Devices
Myriam Paire, Institut de Recherche et Développement sur l'Energie Photovoltaïque (France)

Introduction

After a year full of uncertainties and hard times in industry and in all domains, photovoltaics are very much alive. This is manifested not only by the continuing expansion of the technology (100 GW installed were reached pretty much as the symposium took place), the unprecedented cost reduction of the technology, but also by the thriving scientific and technological developments.

The second edition of the symposium "Physics, Simulation, and Photonic Engineering of Photovoltaic Devices" brought together experts in physics, optics, and photovoltaics and was a place where such developments could be witnessed.

With more than 60 oral presentations and 15 posters, the symposium has been growing since its first edition in 2012. We beheld excellent presentations in topics related to applications of nanophotonics to photovoltaics, material issues with polycrystalline materials, modeling and new device concepts. This is further evidenced in this volume.

As a further example of the vitality of the field, the Green Photonics Award of Photonics West went to C. Colin et al. (LPN, France) for their achievements in advanced light trapping for ultrathin CIGS solar cells.

The sad news is that of the untimely passing of Manuel Romero, initially invited in this symposium to present advances in characterization of thin film solar cells, a few months before the conference. He would have met a thriving scientific symposium, rich in talented young scientists.

**Alexandre Freundlich
Jean-François Guillemoles**