

# PROCEEDINGS OF SPIE

## ***Organic Photovoltaics VIII***

**Zakya H. Kafafi**  
**Paul A. Lane**  
*Editors*

**28–30 August 2007**  
**San Diego, California, USA**

*Sponsored by*  
SPIE

*Cosponsored by*  
Air Products and Chemicals, Inc. (USA)

*Published by*  
SPIE

**Volume 6656**

Proceedings of SPIE, 0277-786X, v. 6656

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

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 *Organic Photovoltaics VIII*, edited by Zakya H. Kafafi, Paul A. Lane, Proceedings of SPIE Vol. 6656 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X

ISBN 9780819468048

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 © 2007, 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](http://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/07/\$18.00.

Printed in the United States of America.

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

**SPIE**   
Digital Library

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.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 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

vii *Conference Committee*

---

## SESSION 1 OPTIMIZED STRUCTURES FOR ORGANIC PHOTOVOLTAICS

---

- 6656 02 **Air-stable efficient polymer solar cells incorporating solution-processed titanium oxide layer (Invited Paper)** [6656-01]  
K. Lee, J. Y. Kim, Univ. of California, Santa Barbara (USA) and Gwangju Institute of Science and Technology (South Korea); A. J. Heeger, Univ. of California, Santa Barbara (USA)

---

## SESSION 2 SOLAR CELLS AND MODULES

---

- 6656 06 **Dye-sensitized solar cells with high efficiency: from interface control to solidification (Invited Paper)** [6656-04]  
Y. Ogomi, S. Sakaguchi, S. Hayase, Kyushu Institute of Technology (Japan)
- 6656 08 **All screen printed dye solar cell (Invited Paper)** [6656-06]  
T. Meyer, D. Martineau, A. Azam, A. Meyer, Solaronix SA (Switzerland)
- 6656 09 **Development of new efficient Ru dyes having  $\beta$ -diketonate and terpyridine ligands for solar cells** [6656-07]  
T. Yamaguchi, N. Shibayama, M. Nakade, Y. Abe, H. Arakawa, Tokyo Univ. of Science (Japan)
- 6656 0A **CMOS color image sensor with overlaid organic photoelectric conversion layers having narrow absorption band: depression of dark current** [6656-36]  
M. Ihama, M. Hayashi, Y. Maehara, T. Mitsui, S. Takada, Fujifilm Corp. (Japan)

---

## SESSION 3 CHARGE INJECTION AND TRANSPORT IN ORGANIC DEVICES: JOINT SESSION WITH CONFERENCE 6655

---

- 6656 0B **Charge separation and transport in ZnO nanostructures/polymer:TiO<sub>2</sub> hybrid solar cell** [6656-38]  
Y.-Y. Lin, T. H. Chu, C.-W. Chen, W.-F. Su, National Taiwan Univ. (Taiwan); C.-C. Lin, C.-H. Ku, J.-J. Wu, National Cheng Kung Univ. (Taiwan); C.-H. Chen, National Taiwan Univ. (Taiwan)

---

## SESSION 4 INTERFACES IN ORGANIC DEVICES: JOINT SESSION WITH CONFERENCE 6655

---

- 6656 0D **Role of intrinsic band-gap states for the energy level alignment at weakly interacting organic-conductor interfaces: gap states versus band dispersion in pentacene thin films (Invited Paper)** [6656-17]  
N. Ueno, S. Kera, H. Fukagawa, Chiba Univ. (Japan)

---

**SESSION 5 ELECTRONIC PROPERTIES AND PROCESSES**

---

- 6656 OE **Toward singlet fission for excitonic solar cells (Invited Paper)** [6656-14]  
J. Michl, Univ. of Colorado at Boulder (USA); A. J. Nozik, National Renewable Energy Lab. (USA); X. Chen, Univ. of Colorado at Boulder (USA); J. C. Johnson, National Renewable Energy Lab. (USA); G. Rana, A. Akdag, A. F. Schwerin, Univ. of Colorado at Boulder (USA)
- 6656 OG **Tailored heterojunctions for efficient thin-film organic solar cells: a photoinduced absorption study** [6656-19]  
R. Schueppel, Technische Univ. Dresden (Germany); K. Schmidt, Georgia Institute of Technology (USA); C. Urich, K. Schulze, D. Wynands, Technische Univ. Dresden (Germany); J. L. Brédas, Georgia Institute of Technology (USA); B. Maennig, M. Pfeiffer, K. Leo, Technische Univ. Dresden (Germany); E. Brier, E. Reinold, H.-B. Bu, P. Baeuerle, Univ. Ulm (Germany)
- 6656 OH **Electrical and photoelectrical properties of nickel phthalocyanine photovoltaic cells** [6656-30]  
T. G. Abdel-Malik, Univ. of Minia (Egypt); A. H. Elsayed, Univ. of Alexandria (Egypt)

---

**SESSION 6 ENERGY TRANSFER AND EXCITON DIFFUSION**

---

- 6656 OI **Analysis of surface plasmon polariton mediated energy transfer in organic photovoltaic devices (Invited Paper)** [6656-18]  
T. D. Heidel, J. K. Mapel, K. Celebi, M. Singh, M. A. Baldo, Massachusetts Institute of Technology (USA)

---

**SESSION 7 BULK HETEROJUNCTION SOLAR CELLS**

---

- 6656 ON **Formation of new bulk-heterojunction structure in organic thin film solar cells (Invited Paper)** [6656-22]  
T. Osasa, S. Yamamoto, S. Sasaki, M. Matsumura, Osaka Univ. (Japan)
- 6656 OP **Interface control in organic heterojunction photovoltaic cells by phase separation processes** [6656-24]  
J. Heier, F. A. Castro, F. Nüesch, R. Hany, Empa, Swiss Federal Labs. for Materials Testing and Research (Switzerland)
- 6656 OR **Integrated organic photovoltaic modules** [6656-53]  
W. J. Potscavage, S. Yoo, B. Domercq, J. Kim, J. Holt, B. Kippelen, Georgia Institute of Technology (USA)

---

**SESSION 8 PROCESSABLE AND LOW BAND GAP MATERIALS FOR OPVS**

---

- 6656 OU **Organic photovoltaics based on solution-processed benzoporphyrin** [6656-44]  
Y. Sato, T. Niinomi, M. Hashiguchi, Y. Matsuo, Japan Science and Technology Agency (Japan); E. Nakamura, Japan Science and Technology Agency (Japan) and Univ. of Tokyo (Japan)

- 6656 0X **Advances in Plexcore active layer technology systems for organic photovoltaics: roof-top and accelerated lifetime analysis of high performance organic photovoltaic cells** [6656-12]  
D. W. Laird, S. Vaidya, S. Li, M. Mathai, B. Woodworth, E. Sheina, S. Williams, T. Hammond, Plextronics, Inc. (USA)
- 6656 0Y **Fabrication of low band-gap polymer solar cells using chemical vapor deposition polymerization** [6656-49]  
C.-Y. Lee, M. H.-C. Jin, Univ. of Texas, Arlington (USA)
- 6656 0Z **High open-circuit-voltage organic solar cell based on two solution-processible triphenylamine-containing compounds** [6656-35]  
C. He, Q. He, G. Wu, F. Bai, Y. Li, Institute of Chemistry (China)

---

**POSTER SESSION**

- 6656 11 **Dye sensitized solar cells with a plastic counter electrode of poly(3,4-ethylene dioxythiophene)-poly(styrenesulfonate)** [6656-13]  
A. Kancierzewska, Linköping Univ. (Sweden); E. Dobruchowska, Linköping Univ. (Sweden) and Technical Univ. of Lodz (Poland); A. Baranzahi, E. Carlegrim, Linköping Univ. (Sweden); A. Fahlman, Linköping Univ. (Sweden) and Ovidius Univ. of Constanța (Romania); M. Fahlman, Linköping Univ. (Sweden); M. A. Gîrțu, Ovidius Univ. of Constanța (Romania)
- 6656 13 **Electrical and photoelectrical properties of nickel phthalocyanine photovoltaic cells** [6656-29]  
T. G. Abdel-Malik, Univ. of Minia (Egypt); A. H. Elsayed, Univ. of Alexandria (Egypt)
- 6656 14 **New bio-inorganic photo-electronic devices based on photosynthetic proteins** [6656-31]  
N. Lebedev, U.S. Naval Research Lab. (USA); A. Spano, Univ. of Virginia (USA); S. Trammell, Naval Research Lab. (USA); I. Griva, George Mason Univ. (USA); S. Tsoi, J. M. Schnur, Naval Research Lab. (USA)
- 6656 16 **Titanium nanotube array based photovoltaic cells** [6656-34]  
C. T. Yip, K. Y. Cheung, A. B. Djurišić, W. K. Chan, Univ. of Hong Kong (Hong Kong China)
- 6656 17 **The effect of hydrophobic absorbent for reducing charge recombination to improve dye-sensitized solar cell performance** [6656-39]  
C. Sae-Kung, E. Hatha, P. Sichanugrist, National Science and Technology Development Agency (Thailand); N. Pungwiwut, S. Laosooksathit, King Mongkut's Institute of Technology, North Bangkok (Thailand)
- 6656 19 **Elucidating the aspect of phase separation in organic blends by means of thermal analysis** [6656-42]  
A. Swinnen, Hasselt Univ. (Belgium); J. Zhao, G. Van Assche, Vrije Univ. Brussel (Belgium); D. Vanderzande, M. D'Olieslaeger, J. V. Manca, Hasselt Univ. (Belgium) and IMEC vzw (Belgium); B. Van Mele, Vrije Univ. Brussel (Belgium)
- 6656 1B **Efficient photovoltaic devices based on blends of C<sub>60</sub> and radical salt doped hole transporters** [6656-45]  
S. Vaddiraju, M. Mathai, Univ. of Connecticut (USA); E. Kymakis, Technological Education Institute of Crete (Greece); F. Papadimitrakopoulos, Univ. of Connecticut (USA)

- 6656 1F **Hybrid ionic liquid and polymer electrolytes for nanocrystalline dye-sensitized TiO<sub>2</sub> solar cells** [6656-50]  
A. C. Fadel Dalsin, A. F. Nogueira, M.-A. De Paoli, State Univ. of Campinas (Brazil);  
S. Passerini, W. A. Henderson, ENEA (Italy); C. Longo, State Univ. of Campinas (Brazil)
- 6656 1G **Molecular morphological effects to optoelectronics** [6656-51]  
S. Maaref, C. Zhang, C. Bonner, S.-S. Sun, Norfolk State Univ. (USA)
- 6656 1J **Annealing effects on surface-plasmon-enhanced bulk heterojunction organic photovoltaics** [6656-55]  
A. J. Morfa, Univ. of Colorado, Boulder (USA) and National Renewable Energy Lab. (USA);  
T. H. Reilly, National Renewable Energy Lab. (USA); K. L. Rowlen, Univ. of Colorado, Boulder (USA) and InDevR, Inc. (USA); J. van de Lagemaat, National Renewable Energy Lab. (USA)
- 6656 1L **Enhanced optical absorption of organic materials via surface plasmon resonance in gold nanoparticles** [6656-57]  
C.-W. Sue, H.-T. Hsieh, G.-D. J. Su, National Taiwan Univ. (Taiwan)

*Author Index*

# Conference Committee

## *Symposium Chair*

**Zakya H. Kafafi**, Naval Research Laboratory (USA)

## *Conference Chair*

**Zakya H. Kafafi**, Naval Research Laboratory (USA)

## *Conference Cochair*

**Christoph J. Brabec**, Konarka Austria (Austria)

## *Program Committee*

**Homer Antoniadis**, Innovalight, Inc. (USA)

**Rene A. J. Janssen**, Technische Universiteit Eindhoven (Netherlands)

**Bernard Kippelen**, Georgia Institute of Technology (USA)

**Paul A. Lane**, Naval Research Laboratory (USA)

**Kwanghee Lee**, University of California at Santa Barbara (USA) and  
Gwangju Institute of Science and Technology (South Korea)

**Peter Peumans**, Stanford University (USA)

**Niyazi S. Sariciftci**, Johannes Kepler Universität Linz (Austria)

**Sean E. Shaheen**, National Renewable Energy Laboratory (USA)

**Yasuhiko Shirota**, Fukui University of Technology (Japan)

**Tetsuo Tsutsui**, Kyushu University (Japan)

## *Session Chairs*

- 1 Optimized Structures for Organic Photovoltaics  
**Zakya H. Kafafi**, Naval Research Laboratory (USA)
- 2 Solar Cells and Modules  
**Michael F. Durstock**, Air Force Research Laboratory (USA)
- 3 Charge Injection and Transport in Organic Devices: Joint Session with  
Conference 6655  
**Kwanghee Lee**, University of California at Santa Barbara (USA) and  
Gwangju Institute of Science and Technology (South Korea)
- 4 Interfaces in Organic Devices: Joint Session with Conference 6655  
**Mark A. Baldo**, Massachusetts Institute of Technology (USA)

- 5 Electronic Properties and Processes  
**Gilles Dennler**, Konarka Austria (Austria)
- 6 Energy Transfer and Exciton Diffusion  
**Zakya H. Kafafi**, Naval Research Laboratory (USA)
- 7 Bulk Heterojunction Solar Cells  
**Garry Rumbles**, National Renewable Energy Laboratory (USA)
- 8 Processable and Low Band Gap Materials for OPVs  
**Yasuhiko Shirota**, Fukui University of Technology (Japan)