

PROCEEDINGS OF SPIE

Organic Photonics V

Barry P. Rand
Chihaya Adachi
Volker van Elsbergen
Editors

16–18 April 2012
Brussels, Belgium

Sponsored by
SPIE

Cosponsored by
B-PHOT—Brussels Photonics Team (Belgium) • Brussels-Capital Region (Belgium)
FWO—Fonds Wetenschappelijk Onderzoek (Belgium) • Kurt J. Lesker Company
ICO—International Commission for Optics • MBRAUN • Solvay Group (Belgium)
Ville de Bruxelles (Belgium)

Cooperating Organisations
CBO-BCO (Belgium) • EOS—European Optical Society (Germany) • IET—The Institution of
Engineering and Technology (United Kingdom) • IOP—Institute of Physics (United Kingdom)
Photonics4Life (Germany) • Photonics@be (Belgium) • Photonics 21 (Germany)
PromOptica (Belgium)

Published by
SPIE

Volume 8435

Proceedings of SPIE, 0277-786X, v. 8435

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 Photonics V*, edited by Barry P. Rand, Chihaya Adachi, Volker van Elsbergen, Proceedings of SPIE Vol. 8435 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X

ISBN 9780819491275

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 © 2012, 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/12/\$18.00.

Printed in the United States of America.

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



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 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

ix	Conference Committee
xi	Introduction

SESSION 1 TECHNOLOGY DEVELOPMENT IN ORGANIC PHOTONICS

- 8435 05 **Influence of barrier absorption properties on laser patterning thin organic films** [8435-04]
S. Naithani, Ghent Univ. (Belgium) and IMEC (Germany); R. Mandamparambil, F. van Assche, Holst Ctr. (Netherlands); D. Schaubroeck, Ghent Univ. (Belgium) and IMEC (Belgium); H. Fledderus, A. Prenen, Holst Ctr. (Netherlands); G. Van Steenberge, J. Vanfleteren, Ghent Univ. (Belgium) and IMEC (Germany)

SESSION 2 MATERIAL DEVELOPMENT FOR ORGANIC ELECTRONICS AND PHOTONICS

- 8435 08 **Singlet harvesting with brightly emitting Cu(I) and metal-free organic compounds** [8435-07]
H. Yersin, R. Czerwieniec, A. Hupfer, Univ. Regensburg (Germany)
- 8435 09 **Measuring efficiency losses in quantum dot polymer solar cells** [8435-94]
E. Palomares, Institute of Chemical Research of Catalonia (Spain) and Catalan Institution for Research and Advanced Studies (Spain); J. Albero, Institute of Chemical Research of Catalonia (Spain)
- 8435 0B **Meniscus coated high open-circuit voltage bi-layer solar cells** [8435-10]
O. Malinkiewicz, M. Lenes, H. Brine, H. J. Bolink, Univ. de Valencia (Spain)
- 8435 0D **Nonlinear optical properties of conjugated polymers** [8435-12]
G. Koeckelberghs, Katholieke Univ. Leuven (Belgium); I. Asselberghs, Katholieke Univ. Leuven (Belgium) and IMEC (Belgium); K. Clays, Katholieke Univ. Leuven (Belgium) and Washington State Univ. (United States); T. Verbiest, Katholieke Univ. Leuven (Belgium)

SESSION 3 INTERFACES, OXIDES, AND DOPING

- 8435 0E **Improving the photocurrent in low bandgap polymer: fullerene solar cells with molecular doping (Invited Paper)** [8435-13]
A. De Sio, A. V. Tunc, J. Parisi, Carl von Ossietzky Univ. Oldenburg (Germany); E. Da Como, Ludwig-Maximilians-Univ. München (Germany); E. von Hauff, Albert-Ludwigs Univ. of Freiburg (Germany) and Fraunhofer Institute for Solar Energy Systems (Germany)

SESSION 4 EXPLORING FUNDAMENTAL PROCESSES

- 8435 0L **Exploring the exciton dissociation process at a donor-acceptor heterojunction in both time and space via an induced Stark shift** [8435-20]
N. C. Giebink, The Pennsylvania State Univ. (United States) and Argonne National Lab. (United States); B. P. Rand, D. Cheyns, J. Genoe, IMEC (Belgium)

SESSION 5 OPV DEVICE DEVELOPMENT

- 8435 0R **Morphology control and nanoscale patterning of small molecule organic thin films** [8435-26]
J. G. Van Dijken, N. L.-Y. Wu, Univ. of Alberta (Canada); M. D. Fleischauer, National Institute for Nanotechnology (Canada); J. M. Buriak, National Institute for Nanotechnology (Canada) and Univ. of Alberta (Canada); M. J. Brett, Univ. of Alberta (Canada) and National Institute for Nanotechnology (Canada)
- 8435 0S **Modelling of organic triple-junction solar cells** [8435-27]
B. Minnaert, P. Veelaert, Univ. College Ghent (Belgium)
- 8435 0V **Crystallization kinetics and morphology relations on thermally annealed bulk heterojunction solar cell blends studied by rapid heat cool calorimetry (RHC)** [8435-30]
F. Demir, N. Van den Brande, Vrije Univ. Brussel (Belgium); S. Bertho, Hasselt Univ. (Belgium); E. Voroshazi, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); J. Manca, D. Vanderzande, Univ. Hasselt (Belgium); P. Heremans, IMEC (Belgium) and Katholieke Univ. Leuven (Belgium); B. Van Mele, G. Van Assche, Vrije Univ. Brussel (Belgium)

SESSION 6 THIN FILM OPTICS AND ELECTRODES FOR OLEDs AND OPV

- 8435 11 **On the effects of a solid environment on sensitized up-conversion** [8435-36]
A. Monguzzi, Univ. Milano Bicocca (Italy)

SESSION 7 PHYSICS AND OPTICS OF OLEDs

- 8435 13 **Non-isotropic emitter orientation and its implications for efficiency analysis of organic light-emitting diodes (Best Student Paper Award)** [8435-38]
T. D. Schmidt, Univ. of Augsburg (Germany); M. Flämmich, Fraunhofer Institute for Applied Optics and Precision Engineering (Germany); B. J. Scholz, Univ. of Augsburg (Germany); D. Michaelis, Fraunhofer Institute for Applied Optics and Precision Engineering (Germany); C. Mayr, Univ. of Augsburg (Germany); N. Danz, Fraunhofer Institute for Applied Optics and Precision Engineering (Germany); W. Brütting, Univ. of Augsburg (Germany)
- 8435 15 **Experimental and theoretical study of the optical and electrical properties optimization of an OLED in a microcavity** [8435-40]
A. Coens, M. Chakaroun, A. P. Fischer, M. W. Lee, A. Boudrioua, Lab. de Physique des Lasers, CNRS, Univ. Paris 13 (France); J. Solard, Univ. Paris 13 (France); B. Geffroy, CEA Saclay, IRAMIS (France)
- 8435 16 **OLED light extraction improvement with surface nano-micro texturation based on speckle lithography** [8435-41]
J. Loicq, K. Fleury-Frenette, Univ. of Liège (Belgium); P. Viville, R. Lazzaroni, Materia Nova ASBL (Belgium); H. Kanaan, CEA-LETI/LTCV (France); P. Guaino, CRM group (Belgium)

SESSION 8 OLEDs AND OLETs

- 8435 1B **Charge carrier dynamics in hybrid organic-inorganic light emitting devices** [8435-43]
E. Martínez-Ferrero, CETEMMSA Technological Ctr. (Spain); A. Forneli, Institute of Chemical Research of Catalonia (Spain) and Instituto de Tecnología Química (Spain); E. Palomares, Institute of Chemical Research of Catalonia (Spain) and Institució Catalana de Recerca i Estudis Avançats (Spain)
- 8435 1C **Organic light-emitting transistors optimized by self-assembled monolayers** [8435-47]
F. Liu, Univ. of Southern Denmark (Denmark) and Univ. of Twente (Netherlands); J. Kjelstrup-Hansen, X. Liu, H.-G. Rubahn, Univ. of Southern Denmark (Denmark)

SESSION 9 ORGANIC-BASED LASER STUDIES

- 8435 1F **High-power CW tunable solid state dye lasers: from the visible to UV** [8435-50]
R. Bornemann, Univ. Siegen (Germany); E. Thiel, Univ. Siegen (Germany) and ERT-OPTIK (Germany); P. Haring Bolívar, Univ. Siegen (Germany)
- 8435 1G **Whispering gallery modes microcavities with J-aggregates and plasmonic hot spots** [8435-51]
Y. P. Rakovich, CSIC-UPV/EHU (Spain) and IKERBASQUE (Spain); D. Melnikau, CIC nanoGUNE Consolider (Spain); D. Savateeva, CSIC-UPV/EHU (Spain); A. Chuvilin, R. Hillenbrand, CIC nanoGUNE Consolider (Spain) and IKERBASQUE (Spain)
- 8435 1H **Evaluation of amplified spontaneous emission from photopumped thiophene/phenylene co-oligomers in polycrystalline states** [8435-52]
H. Mochizuki, Y. Kawaguchi, F. Sasaki, National Institute of Advanced Industrial Science and Technology (Japan); S. Hotta, Kyoto Institute of Technology (Japan)
- 8435 1I **Study of two-dimensional photonic crystals cavity using organic gain materials** [8435-53]
F. Gourdon, N. Fabre, M. Chakaroun, Lab. de Physique des Lasers, CNRS, Univ. Paris 13 (France); J. Solard, IUT Villetaneuse, Univ. Paris 13 (France); E. Cambil, A. M. Yacomotti, S. Bouchoule, Lab. de Photonique et de Nanostructures, CNRS (France); A. Fischer, A. Boudrioua, Lab. de Physique des Lasers, CNRS, Univ. Paris 13 (France); B. Geffroy, Lab. de Physique des Interfaces et Couches Minces, CNRS, Ecole Polytechnique (France)

POSTER SESSION

- 8435 1J **Tuning of superfine electron-nuclear interaction in structure of the ground states and the characteristics of the full systems electronic excited states for formation of effective photophysics and spectral-energy of properties in the series of multinuclear compounds** [8435-54]
A. E. Obukhov, Moscow Power Institute, National Research Univ. (Russian Federation)
- 8435 1K **Theoretical analysis of the absorption spectra of organic dyes differing by the conjugation sequence: illusion of negative solvatochromism** [8435-55]
S. Manzhos, H. Segawa, K. Yamashita, Univ. of Tokyo (Japan)
- 8435 1L **Behaviour of electron and hole currents in a 3-layer heterostructure OLET** [8435-56]
K. Jokinen, A. Bykov, R. Siiz, R. Myllyla, Univ. of Oulu (Finland)

- 8435 1O **Integrated light sources based on self-formed polymer waveguide doped with active medium** [8435-60]
S. Sugimoto, T. Kawaguchi, K. Yamashita, Kyoto Institute of Technology (Japan)
- 8435 1P **Investigation of covalent functionalized single-wall carbon nanotubes using surface-enhanced Raman scattering** [8435-61]
N. Al-Alattar, R. Al-Majmaie, Univ. College Dublin (Ireland); I. Kopf, S. Giordani, Trinity College Dublin (Ireland); J. H. Rice, Univ. College Dublin (Ireland)
- 8435 1Q **Synthesis, optical, and thermal properties of glassy trityl group containing luminescent derivatives of 2-tert-butyl-6-methyl-4H-pyran-4-one** [8435-63]
E. Zarins, K. Siltane, E. Misina, V. Kokars, K. Lazdovica, Riga Technical Univ. (Latvia); A. Vembris, Univ. of Latvia (Latvia); V. Kampars, Riga Technical Univ. (Latvia); I. Muzikante, M. Rutkis, Univ. of Latvia (Latvia)
- 8435 1S **Synthesis and properties of 2-dicyanomethylenethiazole merocyanines** [8435-65]
D. J. Clarke, A. J. Kay, Industrial Research Ltd. (New Zealand); A. P. Middleton, Industrial Research Ltd. (New Zealand) and Victoria Univ. of Wellington (New Zealand); G. J. Smith, Victoria Univ. of Wellington (New Zealand)
- 8435 1T **Luminescent properties of polymer nanocomposites activated with praseodymium-doped nanocrystals** [8435-66]
A. Jusza, Warsaw Univ. of Technology (Poland); L. Lipińska, M. Baran, Institute of Electronic Materials Technology (Poland); P. Mergo, Maria Curie-Skłodowska Univ. (Poland); A. Millan, F. Dieleman, R. Piramidowicz, Warsaw Univ. of Technology (Poland)
- 8435 1U **Charge transport studies of polymeric photovoltaic thin films with an electron blocking and trapping layer** [8435-67]
H. K. H. Lee, K. K. H. Chan, S. K. So, Hong Kong Baptist Univ. (Hong Kong, China)
- 8435 1Z **Extraction of circuital parameters of organic solar cells using the exact solution based on Lambert W-function** [8435-72]
G. Del Pozo, B. Romero, B. Arredondo, Univ. Rey Juan Carlos (Spain)
- 8435 2I **Manufacturing polymer light emitting diode with high luminance efficiency by solution process** [8435-74]
M. Kim, S. Jo, H. C. Yang, D. M. Yoon, J.-T. Kwon, S.-H. Lee, J. H. Choi, B.-J. Lee, J.-K. Shin, Korea Electronics Technology Institute (Korea, Republic of)
- 8435 24 **AC-driven light emission from in situ grown organic nanofibers** [8435-77]
X. Liu, J. Kjølstrup-Hansen, R. M. de Oliveira Hansen, M. Madsen, H.-G. Rubahn, Univ. of Southern Denmark (Denmark)
- 8435 26 **Perylene bisimide derivatives as innovative sensitizers for photorefractive composites** [8435-80]
T. Schemme, K. Ditte, E. Travkin, Westfälische Wilhelms-Univ. Münster (Germany); W. Jiang, Z. Wang, Institute of Chemistry (China); C. Denz, Westfälische Wilhelms-Univ. Münster (Germany)

- 8435 27 **Light-emitting thin films of glassy forming organic compounds containing 2-tert-butyl-6-methyl-4H-pyran-4-ylidene** [8435-81]
A. Vembris, K. Pudzs, I. Muzikante, Univ. of Latvia (Latvia)
- 8435 29 **NIL fabrication of a polymer-based photonic sensor device in P3SENS project** [8435-83]
D. Giannone, F. Dortu, D. Bernier, Multitel Research Ctr. (Belgium); N. P. Johnson, G. J. Sharp, L. Hou, A. Z. Khokhar, Univ. of Glasgow (United Kingdom); P. Fürjes, S. Kurunczi, P. Petrik, R. Horvath, Institute for Technical Physics and Materials Science (Hungary); T. Aalto, K. Kolari, S. Ylinen, T. Haatainen, VTT Technical Research Ctr. of Finland (Finland); H. Egger, Bayer Technology Services GmbH (Germany)
- 8435 2A **Synthesis and characterization of RE³⁺:Al₂O₃ nanopowders for application in the polymer-based composite light sources** [8435-84]
P. Polis, A. Jusza, K. Anders, A. Jastrzębska, A. Olszyna, J. Jureczko, W. Fabianowski, A. Kunicki, R. Piramidowicz, Warsaw Univ. of Technology (Poland)
- 8435 2B **Solvent effects on spectral emission of PVK and PVK-Ir(ppy)₃ based OLEDs** [8435-85]
A. Bruno, A. De Girolamo Del Mauro, G. Nenna, M. G. Maglione, ENEA (Italy); S. A. Haque, Imperial College London (United Kingdom); C. Minarini, ENEA (Italy)
- 8435 2C **Enhancing the color gamut of white displays using novel deep-blue organic fluorescent dyes to form color-changed thin films with improved efficiency** [8435-86]
W. Liu, W.-Y. Huang, National Sun Yat-Sen Univ. (Taiwan)
- 8435 2D **The role of molecular packing on the UV-visible optical properties of [Re₂Cl₂(CO)₆4,5-(Me₃Si)₂pyridazine]** [8435-87]
P. Spearman, S. Tavazzi, Univ. degli Studi di Milano-Bicocca (Italy); L. Silvestri, Univ. degli Studi di Milano-Bicocca (Italy) and The Univ. of New South Wales (Australia); A. Burini, A. Borghesi, Univ. degli Studi di Milano-Bicocca (Italy); P. Mercandelli, M. Panigati, G. D'Alfonso, A. Sironi, Univ. degli Studi di Milano (Italy); L. De Cola, Westfälische Wilhelms-Univ. Münster (Germany)
- 8435 2E **Looking at bulk-heterojunction organic photovoltaics from two viewpoints: morphology development and charge transfer** [8435-88]
N. Van den Brande, F. Demir, P. Geerlings, B. Van Mele, G. Van Lier, G. Van Assche, Vrije Univ. Brussel (Belgium)
- 8435 2F **Titanium dioxide nanostructure synthesized by sol-gel for organic solar cells using natural dyes extracted from black and red sticky rice** [8435-89]
A. H. Ramelan, H. Harjana, L. S. Sakti, Sebelas Maret Univ. (Indonesia)
- 8435 2G **Equilibrium component composition and structure of nanometer cyanine dye layers and their photoinduced modification** [8435-93]
A. A. Starovoytov, E. N. Kaliteevskaya, V. P. Krutyakova, T. K. Razumova, N. A. Toropov, National Research Univ. of Information Technologies, Mechanics and Optics (Russian Federation)

Conference Committee

Symposium Chairs

Francis Berghmans, Vrije Universiteit Brussel (Belgium)
Ronan Burgess, European Commission (Belgium)
Jürgen Popp, Institut für Photonische Technologien e.V. (Germany)
Peter Hartmann, SCHOTT AG (Germany)

Honorary Symposium Chair

Hugo Thienpont, Vrije Universiteit Brussel (Belgium)

Conference Chairs

Barry P. Rand, IMEC (Belgium)
Chihaya Adachi, Kyushu University (Japan)
Volker van Elsbergen, Philips Research (Germany)

Programme Committee

Heinrich Becker, Merck OLED Materials GmbH (Germany)
David Beljonne, Université de Mons (Belgium)
Paul W. M. Blom, University of Groningen (Netherlands)
Donal D. C. Bradley, Imperial College London (United Kingdom)
Franco Cacialli, University College London (United Kingdom)
Enrico Da Como, Ludwig-Maximilians-Universität München (Germany)
Richard H. Friend, University of Cambridge (United Kingdom)
Alan J. Heeger, University of California, Santa Barbara (United States)
Paul L. Heremans, IMEC (Belgium)
René A. J. Janssen, Technische Universiteit Eindhoven (Netherlands)
Junji Kido, Yamagata University (Japan)
Jang-Joo Kim, Seoul National University (Korea, Republic of)
Guglielmo Lanzani, Politecnico di Milano (Italy)
Karl Leo, Technische Universität Dresden (Germany)
Niyazi Serdar Sariciftci, Johannes Kepler Universität Linz (Austria)
Paul van der Schaaf, BASF Schweiz AG (Switzerland)
Chung-Chih Wu, National Taiwan University (Taiwan)

Session Chairs

- 1 Technology Development in Organic Photonics
Volker van Elsbergen, Philips Research (Germany)
- 2 Material Development for Organic Electronics and Photonics
Chihaya Adachi, Kyushu University (Japan)
- 3 Interfaces, Oxides, and Doping
Barry P. Rand, IMEC (Belgium)
- 4 Exploring Fundamental Processes
Wolfgang Brütting, Universität Augsburg (Germany)
- 5 OPV Device Development
Barry P. Rand, IMEC (Belgium)
- 6 Thin Film Optics and Electrodes for OLEDs and OPV
Barry P. Rand, IMEC (Belgium)
- 7 Physics and Optics of OLEDs
Paul W. M. Blom, University of Groningen (Netherlands)
- 8 OLEDs and OLETs
Volker van Elsbergen, Philips Research (Germany)
- 9 Organic-based Laser Studies
Chihaya Adachi, Kyushu University (Japan)

Introduction

Organic electronic and optoelectronic materials and devices have received significant interest in recent years, and are now emerging as an important application for displays, solid-state lighting, and solar energy generation, with potential in many other future application domains. This conference, entitled "Organic Photonics," served as a forum that brought together the academic and industrial communities to maintain momentum in this growing field.

The Organic Photonics field is interdisciplinary in nature, and the papers in these proceedings as well as the presentations reflect this, with contributions from chemists, materials scientists, physicists, and engineers. Contained in this proceedings volume are studies of fundamental materials synthesis and characterization, device physics and optimization, and deposition and patterning technologies. And these studies cover application domains in light emitting devices, photovoltaic cells, light emitting transistors, nonlinear optics, and organic-based lasers.

We thank all contributors to the conference, the SPIE team, and the programme committee, for making the conference a success. We also gratefully acknowledge the generous support from Solvay, MBraun, and Kurt J. Lesker that enabled us to attract world-class invited speakers and give away poster awards to deserving students.

Barry P. Rand
Chihaya Adachi
Volker van Elsbergen

