PROCEEDINGS OF SPIE

Organic, Hybrid, and Perovskite Photovoltaics XX

Zakya H. Kafafi Paul A. Lane Kwanghee Lee Editors

12–15 August 2019 San Diego, California, United States

Sponsored by SPIE

Cosponsored by RISE (Research Institute for Solar and Sustainable Energies) in GIST (Korea, Republic of)

Published by SPIE

Volume 11094

Proceedings of SPIE 0277-786X, V. 11094

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

Organic, Hybrid, and Perovskite Photovoltaics XX, edited by Zakya H. Kafafi, Paul A. Lane, Kwanghee Lee, Proc. of SPIE Vol. 11094, 1109401 · © 2019 SPIE · CCC code: 0277-786X/19/\$21 · doi: 10.1117/12.2551452

Proc. of SPIE Vol. 11094 1109401-1

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 Organic, Hybrid, and Perovskite Photovoltaics XX, edited by Zakya H. Kafafi, Paul A. Lane, Kwanghee Lee, Proceedings of SPIE Vol. 11094 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X ISSN: 1996-756X (electronic)

ISBN: 9781510628816 ISBN: 9781510628823 (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.org Copyright © 2019, 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 \$21.00 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/19/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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 seven-digit CID article numbering system structured as follows:

• The first five 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 Authors
- vii Conference Committee

NOVEL PROPERTIES OF PEROVSKITES

11094 0J Analysis of dynamical mechanisms of CsFAPblBr perovskite solar cells [11094-17]

ADVANCED STRUCTURES AND CONCEPTS FOR ORGANIC SOLAR CELLS

Bottom-up design of organic photovoltaics for upscaling [11094-19]

POSTER SESSION

- 11094 1Q Measurements of dark triplet exciton diffusion in a phosphor-sensitized organic photovoltaic cell [11094-59]
- 11094 20 Investigating the effect of lamination on FAMACs: toward a new phase space of perovskite solar cell fabrication [11094-69]
- Block copolymer optoelectronic property versus bridge and morphology [11094-76]
- 11094 2L Preparation of highly efficient carbon-based perovskite solar cells (C-based PSCs) by screenprinting [11094-91]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five 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.

Alfaifi, Amani H., 20 Alhosiny, Najm, 20 Arredondo, Belén, OJ Balzar, Davor, 20 Berry, Joe, 20 Blank, David A., 1Q Chinen-Mendez, Alyssa B., OL Curtin, Ian J., 1Q del Pozo, Gonzalo, OJ Dunfield, Sean P., 20 Eisenhart, Reed J., OL Galagan, Yulia, OJ Hasib, Muhammad, 27 Hasse, Ariel E., 20 Healy, Andrew T., 1Q Hernández-Balaguera, Enrique, OJ Holmes, Russell J., 1Q Lai, Jinfeng, OL Larson, Bryon W., 20 Martinez, Vanessa, 2L Martin-Martin, Diego, 0J Najafi, Mehrdad, OJ Pan, Hualong, OL Reese, Matthew O., 20 Romero, Beatriz, OJ Shaheen, Sean E., 20 Shi, Kaicheng, 1Q Sun, Sam-Shajing, 27 van Hest, Maikel, 20 Worfolk, Brian J., OL Zhang, Tao, 1Q

Conference Committee

Symposium Chairs

Zakya H. Kafafi, Lehigh University (United States) Ifor D.W. Samuel, University of St. Andrews (United Kingdom)

Conference Chairs

Zakya H. Kafafi, Lehigh University (United States)
Paul A. Lane, NSF (Professional Development) (United States)
Kwanghee Lee, Gwangju Institute of Science and Technology (Korea, Republic of)

Conference CoChair

Ana Flávia Nogueira, Universidade Estadual de Campinas (Brazil)

Conference Program Committee

Harald W. Ade, North Carolina State University (United States)
Hendrik J. Bolink, Universidad de Valencia (Spain)
Paul L. Burn, The University of Queensland (Australia)
Fei Huang, South China University of Technology (China)
Gang Li, The Hong Kong Polytechnic University (Hong Kong, China)
Monica Lira-Cantú, Institut Català de Nanociència i Nanotecnologia (ICN2) (Spain)
Yueh-Lin (Lynn) Loo, Princeton University (United States)
Thuc-Quyen Nguyen, University of California, Santa Barbara (United States)
Hideo Ohkita, Kyoto University (Japan)
Barry P. Rand, Princeton University (United States)
Ifor D. W. Samuel, University of St. Andrews (United Kingdom)
Huanping Zhou, Peking University (China)

Session Chairs

- 20 Years of Organic and Hybrid Solar Cells
 Zakya H. Kafafi, Lehigh University (United States)
- Interfaces in Organic and Hybrid Solar Cells: Joint Session with Conferences 11084 and 11094
 Ifor D.W. Samuel, University of St. Andrews (United Kingdom)
 Christian Nielsen, Queen Mary University of London (United Kingdom)
 Daniel Congreve, The Rowland Institute at Harvard (United States)

- Advanced Perovskite Solar Cells
 Kwanghee Lee, Gwangju Institute of Science and Technology (Korea, Republic of)
- 4 Novel Properties of Perovskites **Ana Flávia Nogueira**, Universidade Estadual de Campinas (Brazil)
- 5 Advanced Structures and Concepts for Organic Solar Cells Harald W. Ade, North Carolina State University (United States)
- 6 Connecting Photophysics of Organic Semiconductors with Solar Cells Gang Li, The Hong Kong Polytechnic University (Hong Kong, China)
- Morphology of Organic and Hybrid Solar Cells
 Sean E. Shaheen, University of Colorado Boulder (United States)
- 8 Materials and Structures for Perovskite Solar Cells **Paul A. Lane**, NSF (Professional Development) (United States)