PROCEEDINGS OF SPIE

Solar Hydrogen and Nanotechnology II

Jinghua Guo
Editor

27–30 August 2007
San Diego, California, USA

Sponsored by
SPIE

Cosponsored by
Varian, Inc. (USA)

Published by
SPIE

Volume 6650

Proceedings of SPIE, 0277-786X, v. 6650

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 *Solar Hydrogen and Nanotechnology II*, edited by Jinghua Guo, Proceedings of SPIE Vol. 6650 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X
ISBN 9780819467980

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

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 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

Conference Committee

Symposium Chair

Ravi Durvasula, Lightfleet Corporation (USA)

Conference Chair

Jinghua Guo, Lawrence Berkeley National Laboratory (USA)

Program Committee

Hironori Arakawa, Tokyo University of Science (Japan)
Jan Augustynski, Université de Genève (Switzerland)
Joe da Costa, The University of Queensland (Australia)
Maria L. Ghirardi, National Renewable Energy Laboratory (USA)
Michael Graetzel, École Polytechnique Fédérale de Lausanne (Switzerland)
Ting Guo, University of California, Davis (USA)
Claude Lévy-Clément, Institut de Chimie et Matériaux de Paris-Est, CNRS (France)
Yoshihiro Nakato, Osaka University (Japan), Kwansei Gakuin University (Japan), and CREST, Japan Science and Technology Agency (Japan)
Janusz Nowotny, University of New South Wales (Australia)
Ian C. Plumb, Commonwealth Scientific and Industrial Research Organisation (Australia)
Pathiyamattom J. Sebastian, Universidad Nacional Autónoma de México (Mexico)
John A. Turner, National Renewable Energy Laboratory (USA)
Lionel Vayssieres, National Institute for Materials Science (Japan)
T. Nejat Veziroglu, The International Centre for Hydrogen Energy Technologies (Turkey)
Gunnar Westin, Uppsala Universitet (Sweden)
Upul Wijayantha, Loughborough University (United Kingdom)
Jin Z. Zhang, University of California, Santa Cruz (USA)

Session Chairs

1 Synthesis of Advanced Nanostructures and Semiconductor I
Jinghua Guo, Lawrence Berkeley National Laboratory (USA)

2 Synthesis of Advanced Nanostructures and Semiconductor II
Lionel Vayssieres, National Institute for Materials Science (Japan)

Introduction

Solar energy can be converted to heat for warming space and water, to electricity and chemical fuels for energy use and storage [1-4]. However, the cost and conversion efficiency have hampered the potential use of solar energy. There are the emerging technologies using semiconductors for light harvesting assemblies, and processes for charge transfer to solar cells. Sunlight in the near infrared, visible, and near ultraviolet regions has considerable energy (about 0.9 to 3.2 electron volts per photon) and intensity. It could provide a significant contribution to our electrical and chemical resources if efficient and inexpensive systems utilizing readily available materials could be devised for the conversion process.

The electron-hole pair formation that occurs at the interface between a semiconductor and a solution upon absorption of light leads to oxidation or reduction of solution species. The fabrication of artificial photosynthetic systems for the conversion of H_2O and CO_2 to fuels (like H_2 and CH_3OH) has become a field of much current research interest and has encouraged new fundamental investigations of the interactions of light, electron flow, and chemical reactions.

Bandgap, band edge positions, as well as the overall band structure of semiconductors are of crucial importance in photoelectrochemical and photocatalytic applications. The energy position of the band edge level can be controlled by the electronegativity of the dopants, solution pH (for example, flatband potential variation of 60 mV per pH unit), as well as by quantum confinement effects. Accordingly, the band edges and bandgap can be tailored to achieve specific electronic, optical, or photocatalytic properties in nanostructure semiconductors.

The aim of this conference is to offer a forum of discussion for scientists, engineers, and members of industry involved in photoelectrochemical systems and nanotechnology for solar generation of hydrogen. The technical program will address the current status and prospects of solar hydrogen R&D activities, major achievements and latest performances, technological limitations and crucial remaining challenges, latest advances in fundamental understanding and development in semiconductor nanostructures, devices fabrication, modeling, simulation and characterization techniques as well as assessing and establishing the role and contribution of solar hydrogen in the hydrogen economy.

Interested and committed individuals from academia, national laboratories, industries and start-ups are kindly invited to contribute to future conferences by submitting their abstract on the following relevant topics:

- Fundamentals of photoelectrochemical water splitting
- Modeling and simulation of photocatalytic reactions
- Energetics and electronic structure of photocatalysts and semiconductor nanostructures

- Electron and hole transport in large bandgap semiconductors
- Surface and interface properties of photocatalysts/electrolyte junctions
- Optical, electrical, mechanical, chemical, and physical properties of photo-anodes
- Long term aqueous stability, corrosion, and photocorrosion of semiconductors
- Recent advances in nano-structural analysis of photocatalysts
- New approaches to bandgap profiling and engineering
- Development of advanced photocatalysts for efficient solar hydrogen production
- New morphology of classical metal oxide semiconductors
- Large bandgap semiconductors of low dimensionality
- Combinatorial chemistry approach to photocatalysts
- Spectroscopic and photoelectrochemical characterization
- New devices, methods, and apparatus for solar hydrogen generation
- Solar hydrogen generation from sea water
- Solar thermal water splitting
- Photo-biological generation of hydrogen
- National and international solar hydrogen energy systems, projects, and networks
- Societal, educational, environmental, and economic aspects of solar hydrogen.

This year, we had 2 plenary talks, 21 invited talks and 8 contributed talks. For the poster competition, Drazenka Svedruzic Chang, et al., received the Best Poster Paper Award for the poster entitled "Interaction of [FeFe] hydrogenases with single-walled carbon nanotubes." The current proceedings volume includes 25 papers.

Finally, I would to acknowledge the support of SPIE staff for assistance throughout the preparation of the conference and in editing the proceedings. I would like to acknowledge the committee members for their strong support. And also I would like to thank all speakers and attendees who made the conference successful.

Jinghua Guo

References

1. "Solar Energy Conversion", George W. Crabtree and Nathan S. Lewis, Physics Today, March 2007. doi:10.1063/1.2718755
2. "Limiting and realizable efficiencies of solar photolysis of water", James R. Bolton, Stewart J. Strickler, and John S. Connolly, Nature **316**, 495 (1985). doi:10.1038/316495a0
3. "Photoelectrochemistry", Allen J. Bard, Science **207**, 139 (1980). doi: 10.1126/science.207.4427.139
4. "Solar Fuels", James R. Bolton, Science **202**, 705 (1978). doi: 10.1126/science.202.4369.705