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Contents

- v Conference Committee
- vii Introduction
- ix *Commercialization of large scale CPV: What lies ahead? (Plenary Paper) [7043-104]*
D. Holland, Solar Systems Pty. Ltd. (Australia)
- xv *Nanostructures for high-efficiency photovoltaics (Plenary Paper) [7047-102]*
H. A. Atwater, California Institute of Technology (United States)
- xix *Reliability of PV systems (Plenary Paper) [7048-101]*
J. H. Wohlgemuth, BP Solar International Inc. (United States)

SOLAR HYDROGEN CATALYSTS I: WATER/CHARGE AND ELECTROCHEMISTRY BASED PROCESSING

- 7044 05 **Synthesis and characterization of nanostructured semiconductors for photovoltaic and photoelectrochemical cell applications [7044-03]**
P. J. Sebastian, Univ. Nacional Autónoma de México (Mexico) and Univ. Politécnica de Chiapas (Mexico); R. Castañeda, Univ. de Guadalajara (Mexico); L. Ixtlilco, R. Mejia, Univ. Autónoma del Estado de Morelos (Mexico); J. Pantoja, A. Olea, Univ. Politécnica de Chiapas (Mexico)

SOLAR HYDROGEN CATALYSTS III: METAL ORGANIC PROCESSING

- 7044 0B **Water splitting property of $Gd_{1-x}Bi_xVO_4$ powder photocatalysts and their thin film photoelectrodes (Invited Paper) [7044-09]**
H. Kishida, Y. Imagawa, T. Yamaguchi, Tokyo Univ. of Science (Japan); S. Sato, Nissan Arc, Ltd. (Japan); H. Arakawa, Tokyo Univ. of Science (Japan)

SOLAR HYDROGEN CATALYSTS IV: CHEMICAL VAPOR DEPOSITION

- 7044 0D **Development of a corrosion-resistant amorphous silicon carbide photoelectrode for solar-to-hydrogen photovoltaic/photoelectrochemical devices [7044-11]**
I. Matulionis, MVSystems, Inc. (United States); F. Zhu, MVSystems, Inc. (United States) and Colorado School of Mines (United States); J. Hu, MVSystems, Inc. (United States); T. Deutsch, National Renewable Energy Lab. (United States); A. Kunrath, MVSystems, Inc. (United States); E. Miller, B. Marsen, Univ. of Hawaii at Manoa (United States); A. Madan, MVSystems, Inc. (United States) and Colorado School of Mines (United States)

MODELING SURFACES, CHARGE, DEFECT, AND TRANSPORT PHENOMENA

- 7044 OE **Water adsorption beyond monolayer coverage on ZnO surfaces and nanoclusters (Invited Paper)** [7044-12]
D. Raymand, T. Edvinsson, D. Spångberg, Uppsala Univ. (Sweden); A. van Duin, California Institute of Technology (United States); K. Hermansson, Uppsala Univ. (Sweden)

SOLAR HYDROGEN CATALYSTS V: PHYSICAL VAPOR DEPOSITION AND ION IMPLANTATION

- 7044 OH **New benchmark to improve the photoelectrochemical properties of hematite** [7044-16]
A. P. Singh, Dayalbagh Educational Institute (India); A. Tripathi, Inter Univ. Accelerator Ctr. (India); R. Shrivastav, S. Dass, V. R. Satsangi, Dayalbagh Educational Institute (India)

COMPLEX PHOTOCATALYSTS: Z-SCHEME AND NP SENSITATION APPROACHES

- 7044 OJ **Overall water splitting on (oxy)nitride photocatalysts (Invited Paper)** [7044-18]
K. Domen, The Univ. of Tokyo (Japan)

SOLAR HYDROGEN BY THERMAL AND CHEMICAL APPROACHES

- 7044 OO **A novel nanostructured semiconductor photocatalyst for solar hydrogen production (Invited Paper)** [7044-24]
K. G. Kanade, Mahatma Phule College (India); J.-O. Baeg, K. Kong, Korea Research Institute of Chemical Technology (Korea, Republic of); B. B. Kale, Ctr. for Materials for Electronics Technology (India); S. M. Lee, S.-J. Moon, Korea Research Institute of Chemical Technology (Korea, Republic of)
- 7044 OP **Promotion of hydrogen production by resonant excitation of vibrational levels using spectrally controlled thermal radiation** [7044-25]
Y. Maegami, T. Sasaki, F. Iguchi, H. Yugami, Tohoku Univ. (Japan)

Author Index

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Solar Energy Plenary Session

Ravi Durvasula, Lightfleet Corporation (United States)

- 1 Solar Hydrogen Catalysts I: Water/Charge and Electrochemistry Based Processing

Gunnar Westin, Uppsala Universitet (Sweden)

- 2 Solar Hydrogen Catalysts II: Metal Organic Processing
Lionel Vayssieres, National Institute for Materials Science (Japan)
- 3 Solar Hydrogen Catalysts III: Metal Organic Processing
Per-Anders Glans, Lawrence Berkeley National Laboratory (United States)
- 4 Solar Hydrogen Catalysts IV: Chemical Vapor Deposition
Craig A. Grimes, The Pennsylvania State University (United States)
- 5 Modeling Surfaces, Charge, Defect, and Transport Phenomena
Abraham Wolcott, University of California, Santa Cruz (United States)
- 6 Solar Hydrogen Catalysts V: Physical Vapor Deposition and Ion Implantation
Frank E. Osterloh, University of California, Davis (United States)
- 7 Complex Photocatalysts: Z-scheme and NP Sensitation Approaches
Hironori Arakawa, Tokyo University of Science (Japan)
- 8 Detailed Analysis of Surface Reactions and Electronic Structure
Xianglei S. Mao, Lawrence Berkeley National Laboratory (United States)
- 9 Solar Hydrogen by Thermal and Chemical Approaches
Jun Kubota, University of Tokyo (Japan)

Introduction

With increasing population and economic growth in large parts of the globe, there is a rapidly growing need for energy that cannot be met by increased use of fossil fuels due to their limited availability. At the same time, signs of global warming due to human CO₂ emissions make a paradigm shift toward carbon free energy sources urgent. It is expected that the increased energy demand cannot be met by one single solution, but rather by a large number of different sources combined with more efficient energy use.

One of the most promising fuel sources is hydrogen which can be produced in a number of different ways, but the most environmentally beneficial and sustainable way is through solar light which is available in abundance. This can of course be achieved by electrolysis of water using electricity produced separately by solar cells or solar thermal techniques, but perhaps the most elegant and cost-efficient way will be to use the solar energy to decompose sea water directly by an inorganic or biological catalyst. However, this is not an easy task to achieve efficiently and in spite of large and growing research efforts in this promising area, there is still much to learn before large scale application can be achieved.

Inorganic catalysts have been the main concern of the participants in the Solar Hydrogen and Nanotechnology conference series. Development of such direct hydrogen catalysts represents one of the most difficult tasks in materials science due to the complex, multifunctional nature of a solar hydrogen cell encompassing photo generation of hole-electron pairs and their transport to the surface to perform different reactions eventually yielding H₂ and oxidized species at the surface. Increased knowledge in this area has led to more and more complex structures with different parts of the nano-structures optimized for different functions such as generation of hole/electron pairs by visible light and surface added co-catalysts to facilitate the H₂ and O₂ generation. From the presentations, it is clear that many types of semiconductors and morphologies are under investigation, but at the same time chemical and photo-corrosion has to be considered in order to prepare a time stable system which limits the choices of materials. One can also see a steady increase in the understanding and efficiency of the cells which strongly indicate that this is a feasible way of generating renewable fuel.

However, this area is still in its infancy searching for different paths to investigate and for the coming years, many different alternative approaches to solar hydrogen generation will be pursued and compared on their different merits. Thus, development in this field is truly a multidisciplinary endeavor requiring knowledge from broad teams of experts from many areas of science which has been shown in the presentations including for example, chemical and physical state-of-the-art materials preparation techniques; detailed experimental and

theoretic surface reaction studies and band-structure analyses; and different approaches to hydrogen generation from other sources than water.

When designing materials that will be produced in very large scale and utilized in a decentralized manner, there is also a constraint in not using potentially environmentally detrimental materials. Another constraint pointed out by Professor Craig Grimes in his plenary talk, is to use materials that are not at risk becoming a limiting factor due to a low abundance.

This conference series on Solar Hydrogen and Nanotechnology is running in its third year providing a forum for discussion of science and technology for solar hydrogen bringing experts of different fields needed for development of the area together. The conference has since its start attracted a large part of the leading researchers in the field from all over the globe, as well as leading experts in related and needed areas for development of solar hydrogen generation catalysts, and I dare to say that it has become one of the most important arenas for discussion in this field.

Finally, I wish to thank all contributors, whether plenary, invited, or contributed speakers, or participants for the consistent high level of the talks and discussions. I am particularly pleased to see the very open and collaborative atmosphere between the participants during the conference, as well as the many new acquaintances and collaborations formed. I also wish to take the opportunity to thank the SPIE staff and the Solar Hydrogen and Nanotechnology program committee for the good support.

Gunnar Westin