
Renewable Fuels from Sunlight and Electricity

Editors:

N. Wu

West Virginia University
Morgantown, West Virginia,
USA

H. Dinh

National Renewable Energy
Laboratory
Golden, Colorado, USA

J.-J. Lee

Konkuk University
Seoul, South Korea

R. Subramanian

University of Nevada – Reno
Reno, Nevada, USA

Z. Zou

Nanjing University
Nanjing, Jiangsu, People's
Republic of China

W. Chiu

University of Connecticut
Storrs, Connecticut, USA

K. Domen

The University of Tokyo
Tokyo, Japan

A. Manivannan

U.S. Department of Energy
Morgantown, West Virginia,
USA

H. Wang

National Renewable Energy
Laboratory
Golden, Colorado, USA

D. Chu

U.S. Army Research
Laboratory
Adelphi, Maryland

P. J. Kulesza

University of Warsaw
Warsaw, Poland

S. R. Narayan

University of Southern
California
Los Angeles, California, USA

X.-D. Zhou

University of South Carolina
Columbia, South Carolina,
USA

Sponsoring Divisions:



Energy Technology



High Temperature Materials



Physical and Analytical Electrochemistry



New Technology Subcommittee



Published by

The Electrochemical Society

65 South Main Street, Building D
Pennington, NJ 08534-2839, USA

tel 609 737 1902

fax 609 737 2743

www.electrochem.org

ecsttransactions™

Vol. 50, No. 49

Copyright 2013 by The Electrochemical Society.
All rights reserved.

This book has been registered with Copyright Clearance Center.
For further information, please contact the Copyright Clearance Center,
Salem, Massachusetts.

Published by:

The Electrochemical Society
65 South Main Street
Pennington, New Jersey 08534-2839, USA

Telephone 609.737.1902
Fax 609.737.2743
e-mail: ecs@electrochem.org
Web: www.electrochem.org

ISSN 1938-6737 (online)
ISSN 1938-5862 (print)
ISSN 2151-2051 (cd-rom)

ISBN 978-1-62332-085-0 (Softcover)
ISBN 978-1-60768-437-4 (PDF)

Printed in the United States of America.

Table of Contents

Preface *iii*

Chapter 1 **Photoelectrochemical Cells and Photocatalysts**

Optimum Conditions for Efficient Hydrogen Generation by Water Electrolysis in an Electrochemical Cell Powered either by Power Supply or Solar Cells 3

M. Frites, S. U. M. Khan

Combined Catalysis and Optical Screening for High Throughput Discovery of Solar Fuels Catalysts 9

J. M. Gregoire, C. Xiang, S. Mitrovic, X. Liu, M. Marcin, E. W. Cornell, J. Fan, J. Jin

Chapter 2 **Keynote Speech on Solar Fuels**

(Invited) Critical Assessment of Research and Development Needs in Solar to Hydrogen Production Technologies 23

E. L. Miller, S. Dillich, E. Sutherland, S. Studer

Chapter 3 **Photoelectrochemical Cells and Biological Devices**

Fueling Vehicles with Sun and Water 35

K. E. Ayers, E. B. Anderson, K. Dreier, K. W. Harrison

Photobiological H₂ Production: Theoretical Maximum Light Conversion Efficiency and Strategies to Achieve It 47

M. L. Ghirardi

Chapter 4
Poster Session: Renewable Energy and Fuels

Polycrystalline Cu(In, Ga)Se ₂ Thin Films and PV Devices Sputtered From a Binary Target without Additional Selenization <i>B. T. Jheng, P. T. Liu, Y. P. Chang, M. C. Wu</i>	53
Synthesis and Electrochemical Properties of Platinum-Based Films Used as Cathode Materials in the Dye-Sensitized Solar Cells <i>P. T. Hien, L. M. L. Phung, N. T. P. Thoa, N. T. Hoang</i>	59
The Activity of Ash-free Coal in Direct Carbon Fuel Cells <i>H. Ju, J. Eom, J. K. Lee, H. Choi, S. H. Lee, R. H. Song, J. Lee</i>	71
High Precision Evaluation of Gas Composition and Current Efficiency for High Temperature H ₂ O and CO ₂ Electrolysis <i>Y. Tanaka, K. Sato, K. Nozaki, T. Kato, A. Yamamoto</i>	81
Study of Alkaline Water Electrolysis (II) <i>A. Manabe, T. Hashimoto, M. Kashiwase, M. Kurosaki, T. Hayashida, K. Hirao, I. Shimomura, I. Nagashima</i>	87
Cu Monolayer on Au/C and Pt/C for the Electrochemical Reduction of CO ₂ to Hydrocarbons <i>I. L. Escalante-Garcia, J. S. Wainright, R. F. Savinell</i>	95
Transport Phenomena in Bi-Cells for Portable Fuel Cell Power Source <i>K. N. Grew, D. Chu</i>	103
The Co _{2p} Oxidation State In Co-PI Catalyst <i>M. Richter, D. Schmeißer</i>	113

Chapter 5
Electrochemical Synthesis of Fuels

Carbon Dioxide Decomposition and Oxygen Generation Via SOEC <i>H. Guo, B. Kang, A. Manivannan</i>	129
--	-----

Chapter 6
Electrocatalytic and Catalytic Synthesis of Fuels

Degradation of Solid Oxide Cells during Co-Electrolysis of H₂O and CO₂: Carbon
Deposition under High Current Densities 139
Y. Tao, S. D. Ebbesen, M. Mogensen

High Efficiency CuCl Electrolyzer for Cu-Cl Thermochemical Cycle 153
R. Schatz, S. Kim, S. Khurana, M. Fedkin, S. N. Lvov

Chapter 7
Fuel Cells and Electrochemistry

Kinetics of Oxidation of H₂ and Reduction of H₂O in Ni-YSZ based Solid Oxide Cells 167
S. D. Ebbesen, M. Mogensen

Crossover in a Homogeneous-Catalyst Reactor 183
J. Newman

Author Index 195