MATTHEW R. SHANER

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EDUCATION

2016 - Present | Postdoctoral Fellow, Carnegie Institute & NearZero (*Dr. Ken Caldeira and Dr. Michael Mastrandrea*) | *Stanford University*

2015 | Ph.D., Chemical Engineering (*Prof. Nathan S. Lewis and Harry A. Atwater*) | *California Institute of Technology*

2012 | M.S., Chemical Engineering | *California Institute of Technology*

2010 | B.S., Chemical Engineering (Highest Honors) | *University of California at Santa Barbara*

PROFESSIONAL EXPERIENCE

2010 – 2015 | Ph.D. | Joint Center for Artificial Photosynthesis (JCAP) | California Institute of Technology

Advisors: *Prof. Nathan S. Lewis and Harry A. Atwater*

- Design, fabrication and characterization of tandem junction silicon-based photoelectrochemical devices for solar water splitting
- Presented research at many internal JCAP meetings/events: JCAP Science Advisory Board (2014, 2013), JCAP DOE Review (2014, 2013), JCAP Strategic Advisory Board (2014), JCAP All Hands meeting (2014, 2013), conferences (2014, 2013, 2012), Caltech campus seminar (2015, 2012)
- **Skills**: Semiconductor fabrication, (photo)electrochemistry, chemical vapor deposition, physical vapor deposition, X-ray diffraction, scanning electron microscopy

2014 | Techno-economic Analyst | DOW Centre for Sustainable Engineering Innovation | University of Queensland, Brisbane, Australia

Advisor: *Prof. Eric McFarland*

- Performed discounted cash flow (DCF) analyses on solar hydrogen and photochemical processes and assessed their competitiveness in current and future markets
- **Skills**: Discounted cash flow analysis, bill of materials analysis

2011-2013 | Teaching Assistant | California Institute of Technology

- Undergraduate chemical engineering thermodynamics
- Graduate Principles and Applications of Semiconductor Photoelectrochemistry
- Designed and taught photoelectrochemical measurements course for 2013 JCAP Solar-fuels winter school

2011 – 2014 | Undergraduate Resident Associate | California Institute of Technology

- Actively co-managed 70 student residence including student government, mental and physical health, relationship and other inter- and intra-personal student issues
- Worked continuously with student services administration to improve student life through well-being and targeted educational events

2009 | Chemical Engineering Intern | Green Works Division | Clorox Research and Development

- Developed and applied working fabric softening theory to formulate and prove feasibility of a "green" fabric softener

2008 | Materials Engineer Intern | DuPont Displays

- Optimized, automated and tested existing ion exchange process

2007 – 2010 | Undergraduate Research Assistant | University of California at Santa Barbara

Advisors: *Prof. Eric McFarland and Galen Stucky*

- Investigated SiO_2 synthesis and deposition for sintering resistance of metallic nanoparticulate gas phase catalysts

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AWARDS AND HONORS

- Resnick Institute for Sustainability Graduate Student Fellowship, *California Institute of Technology,* **2013 - 2015**
- Constantin G. Economou Memorial Prize, *California Institute of Technology*, *Chemical Engineering*, **2012**
- Boeing Corporation Scholarship, *University of California at Santa*

Barbara, **2009, 2010**

- Undergraduate Excellence in Inorganic Chemistry, American Chemical Society, *University of California at Santa Barbara*, **2009**
- Chevron Corporation Scholarship, *University of California at Santa Barbara*, **2008**
- Jean Dreyfus Research Award, *University of California at Santa Barbara*, **2008**
- Tau Beta Pi Engineering Honors Society, *University of California at Santa Barbara*
- American Institute of Chemical Engineers, *University of California at Santa Barbara*

PROFESSIONAL PUBLICATIONS

14. **Experimental Demonstrations of Spontaneous, Solar-Driven Photoelectrochemical Water Splitting**
    Joel W. Ager, **Matthew R. Shaner**, Karl A. Walczak, Ian D. Sharp, Shane Ardo
    In Press Energy and Environmental Science, 2015

13. **Photochemical Process Source Economics**
    Matthew R. Shaner, Thomas McConnaughy, Eric W. McFarland
    In Preparation, 2015

12. **Design and Validation of a Si Microwire Array Non-Noble-Metal Catalyzed Photoelectrode for Decoupling the Negative Correlation Between Fill-Factor and Short Circuit Current Density**
    Matthew R. Shaner, James R. McKone, Harry B. Gray, Nathan S. Lewis
    In Preparation, 2015

11. **A Comparative Techno-economic Analysis of Renewable Hydrogen Production Using Solar Energy**
    Matthew R. Shaner, Harry A. Atwater, Nathan S. Lewis, Eric W. McFarland
    In Preparation, 2015

10. **Stable Solar-Driven Water Oxidation to O_2(g) by Ni-oxide Coated Silicon Photoanodes**
    Ke Sun, Matthew T. McDowell, Adam C. Nielander, Shu Hu, **Matthew R. Shaner**, Fan Yang, Bruce S. Brunschwig, Nathan S. Lewis
    Journal of Physical Chemistry Letters, **2015** (DOI: 10.1021/jz5026195)

9. **Modeling, Simulation and Fabrication of a Fully Integrated, Acid-Stable, Scalable Solar-Driven Water Splitting System**
    Karl A. Walczak, Yikai Chen, Christopher Karp, Jeffery W. Beeman, **Matthew R. Shaner**, Joshua Spurgeon, Ian D. Sharp, Xenia Amashukeli,

William West, Jian Jin, Nathan S. Lewis, Chengxiang Xiang
ChemSusChem, **2015** (DOI: 10.1002/cssc.201402896)

8. **Stabilization of Si Microwire Arrays for Solar-Driven H_2O Oxidation to O_2(g) in 1.0 M KOH(aq) using Conformal Coatings of Amorphous TiO2**
   Matthew R. Shaner, Shu Hu, Ke Sun, Nathan S. Lewis
   Energy and Environmental Science, **2015**, 8, 203-207 (DOI: 10.1039/C4EE03012E)

7. **A Taxonomy for Solar Fuels Generators**
   Adam C. Nielander*, **Matthew R. Shaner***, Kimberly M. Papadantonakis, Sonja A. Francis, Nathan S. Lewis
   Energy and Environmental Science, **2015**, 8, 16-25 (DOI: 10.1039/C4EE02251C)
   *Denotes equal authorship

6. **Amorphous TiO_2 Coatings Stabilize Si, GaAs and GaP Photoanodes for Efficient Water Oxidation**
   Shu Hu, **Matthew R. Shaner**, Joseph Berdslee, Michael Lichterman, Bruce S. Brunschwig, Nathan S. Lewis
   Science, **2014**, 344, 1005-1009 (DOI: 10.1126/science.1251428)

5. **Photoelectrochemistry of Core–Shell Tandem Junction n-p^+-Si/n-WO_3 Microwire Array Photoelectrodes**
   Matthew R. Shaner, Katherine R. Fountaine, Shane Ardo, Robert H. Coridan, Harry A. Atwater, Nathan S. Lewis
   Energy and Environmental Science, **2014**, 7, 779-790 (DOI: 10.1039/C3EE43048K)

4. **Enhanced Stability and Activity for Water Oxidation in Alkaline Media with Bismuth Vanadate Photoelectrodes Modified with a Cobalt Oxide Catalytic Layer Produced by Atomic Layer Deposition**
   Michael F. Lichterman, **Matthew R. Shaner**, Shelia G. Handler, Bruce S. Brunschwig, Harry B. Gray, Nathan S. Lewis, Joshua M. Spurgeon
   The Journal of Physical Chemistry Letters, **2013**, 4, 4188-4191 (DOI: 10.1021/jz4022415)

3. **Current-voltage characteristics of coupled photodiode-electrocatalyst devices**
   Matthew R. Shaner, Katherine R. Fountaine, Joachim H. Lewerenz
   Applied Physics Letters, **2013**, 103, 143095 (DOI: 10.1063/1.4822179)

2. **Electrical and Photoelectrochemical Properties of WO_3/Si Tandem Photoelectrodes**
   Robert Coridan, **Matthew R. Shaner**, Craig Wiggenhorn, Bruce Brunschwig, Nathan S. Lewis
   The Journal of Physical Chemistry C, **2013**, 6949-6957 (DOI: 10.1021/jp311947x)

1. *(available upon request)*
   Shane Ardo, **Matthew R. Shaner**, Robert Coridan, Nicholas Strandwitz, James McKone, Harry A. Atwater, Nathan S. Lewis
   California Institute of Technology, **2012**, *CIT-6160-P*

PROFESSIONAL PRESENTATIONS

Talks

8. **Development of Fully Integrated Microwire-Based Devices**
   Matthew R. Shaner, Harry A. Atwater, Nathan S. Lewis
   Joint Center for Artificial Photosynthesis, Annual All-Hands Meeting, Asilomar, Monterey, CA, **February 19 – February 21, 2014**

7. **Tandem Junction Si Microwire Based Devices for Water Splitting**
   Matthew R. Shaner, Katherine R. Fountaine, Shane Ardo, Robert H. Coridan, Harry A. Atwater, Nathan S. Lewis
   The Electrochemical Society, 224th ECS Meeting, San Francisco, CA, **October 27, 2013 - November 1, 2013**

6. **A Tandem Junction Microwire Si/WO3 Device For Solar Water Splitting**
   Matthew R. Shaner, Harry A. Atwater, Nathan S. Lewis
   Constantin G. Economou Memorial Lecture, California Institute of Technology, Chemical Engineering, Pasadena, CA, **November 29, 2012**

5. **Silicon Microwires Coupled to Earth Abundant Catalysts as Photocathodes for the Hydrogen Evolution Reaction**
   Emily L. Warren, James R. McKone, **Matthew R. Shaner**, Harry A. Atwater, Harry B. Gray, Nathan S. Lewis
   The Electrochemical Society, Pacific Rim Meeting (PRiME), Honolulu, HI, **October 7, 2012-October 12, 2012**

4. **A Tandem Junction Microwire Si/WO3 Device For Solar Water Splitting**
   Matthew R. Shaner, Shane Ardo, Robert Coridan, Katherine Fountaine, Harry A. Atwater, Nathan S. Lewis
   International Conference on Photochemical Conversion and Storage of Solar Energy (IPS-19), California Institute of Technology, Pasadena, CA, **July29 – August 3, 2012**

3. **Heterojunction Wire Array Structures, Photovoltaics and Solar Fuels** *(PI Invited)*
   Harry A. Atwater, Dan Turner-Evans, Chris T. Chen, Hal S. Emmer, Katherine Foutaine, **Matthew R. Shaner**, Anna Beck
   Materials Research Society, Annual Spring National Meeting, San Francisco, CA, **April 9, 2012-April 13, 2012**

2. **Optimizing Catalyst Placement for Enhanced Light Absorption in Silicon Microwire Water Splitting Devices**
   Matthew R. Shaner, James McKone, Emily Warren, Harry A. Atwater, Nathan S. Lewis
   Materials Research Society, Annual Spring National Meeting, San Francisco, CA, **April 9, 2012-April 13, 2012**

1. **Design, Fabrication and Characterization of Monolithic, Tandem-Junction Microwire Devices**
   Matthew R. Shaner, Katherine Fountaine, Harry A. Atwater, Nathan S. Lewis
   Joint Center for Artificial Photosynthesis, Annual All-Hands Meeting, California Institute of Technology, Pasadena, CA, **May 1, 2012-May 3, 2012**

Posters

1. **Optimizing Catalyst Placement for Enhanced Light Absorption in Silicon Microwire Water Splitting Devices**
   Matthew R. Shaner, James McKone, Emily Warren, Harry A. Atwater, Nathan S. Lewis
   Joint Center for Artificial Photosynthesis, Annual All-Hands Meeting, California Institute of Technology, Pasadena, CA, **May 1, 2012-May 3, 2012**

Videos

1. **Getting More Out of the Sun's Rays: Artificial Photosynthesis**
   Matthew R. Shaner, Nathan S. Lewis
   Bitesize Science, The American Chemical Society, **2012**
   https://www.youtube.com/watch?v=qQYBoGk180I