Zachary J Schiffer

Assistant Professor, Harvard John A. Paulson School of Eng. and App. Science

CONTACT

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PROFESSIONAL APPOINTMENTS

2024 – **Assistant Professor**
Harvard University, Cambridge, MA
Applied Physics Area; John A. Paulson School of Engineering and Applied Science

2021 – 2023 **Resnick Sustainability Postdoctoral Scholar**
California Institute of Technology, Pasadena, CA
Advisor: Prof. Harry Atwater

EDUCATION

2016 – 2021 **Ph.D. in Chemical Engineering**
Massachusetts Institute of Technology, Cambridge, MA
GPA: 5.00

Thesis: Kinetic and Thermodynamic Aspects of Voltage as a Driving Force for Ammonia Activation
Advisor: Prof. Karthish Manthiram

2012 – 2016 **B.S.E. in Chemical & Biological Engineering**
Graduated with Highest Honors, Princeton University, Princeton, NJ
GPA: 3.96 (Major GPA: 4.0)

Thesis: Piezoelectrochemical Energy Harvesting from the Coupling of Mechanics and Electrochemistry in Li-Ion Batteries
Advisor: Prof. Craig Arnold

RESEARCH EXPERIENCE

2021 – 2023 **Environmental Chemistry & Catalysis** | Caltech Applied Physics and Mat. Sci.
Postdoctoral Scholar with Prof. Harry Atwater

- Designing and synthesizing catalysts for photo(electro)catalytic nitrogen reduction to ammonia.
- Building and optimizing systems for electrochemical sequestration of carbon from seawater.
- Exploring chemical mechanisms and system design for sustainable electrocatalysis as a part of the Liquid Sunlight Alliance (LiSA).

2017 – 2021 **Sustainable Chemical Synthesis** | MIT Chemical Engineering

Ph.D. Student with Prof. Karthish Manthiram

- Developed electrochemical routes for nitrogen cycle reactions under ambient conditions.
- Explored electrification and decarbonization possibilities for industrial chemical processes.
- Combined fundamental thermodynamics, kinetic analysis techniques, and materials syntheses to study electrochemical reactions.

2014 – 2016 **Energy Storage and Conversion** | Princeton University

Researcher with Prof. Craig Arnold

- Investigated the coupling between mechanical expansion and voltage in Li-ion batteries.
- Correlated mechanical measurements with battery material characterization and predictions of capacity fade and aging.
- Demonstrated voltage-pressure coupling in a desalination battery.

Summer 2014 **Systems Research and Analysis** | Sandia National Laboratory

Research Intern

- Implemented dispersion model for bioagent release within new emergency, planning, and preparedness toolkit.
- Analyzed output scenarios while validating model against known standard.

Summer 2013 **Research Tool Development** | Dow Innovation Center at UIUC Research Park

Software Engineering Intern

- Collaborated with R&D and information research to design and program web applications for Dow Chemical scientists, streamlining and converting older applications into web programs.

Summer 2012 **International Summer Science Institute** | Weizmann Institute

Researcher with Prof. Gary Hodes

- Created and analyzed homemade solar cells while collaborating with international students.

2009 – 2011 **Theoretical Chemistry** | Penn State Chemistry Department

Researcher with Prof. Barbara Garrison

- Performed molecular dynamics simulations of atomic bombardment on organic solids and proposed mechanism for Ar beams to aid clusters in depth profiling.

AWARDS

2024 **William F. Milton Fund Award**

2024 **Scialog Fellow in Sustainable Minerals, Metals, and Materials**

2024 **Forbes 30 Under 30, Science**

2022 **Resnick Sustainability Institute Postdoctoral Scholar**

2022	**ECS Energy Technology Division Graduate Student Award**
2020	**Chevron Fellow of MIT Society of Energy Fellows** Selection of ~24 fellows each year to become part of global MIT network
2019	**AIChE Catalysis and Reaction Engineering Travel Award**
2019	**2019 Kokes Award for the 26th North American Catalysis Society Meeting**
2016 – 2021	**NSF Graduate Research Fellowship**
2016 – 2017	**MIT Presidential Fellowship**
2016	**The Calvin Dodd MacCracken Award** Awarded for the top senior thesis in Princeton School of Eng. & Appl. Science
2016	**Outstanding Materials Student Award** Awarded to the top senior in Princeton Institute of Materials certificate program
2015	**Lidow and Friedland Independent Work Award** | Princeton SEAS
2015	**Michelle Goudie '93 Fellowship in Environmental Studies |** Princeton CBE
2015	**Barry Goldwater Scholarship Honorable Mention**
2013 & 2014	**Shapiro Prize for Academic Excellence** Given to top three percent of freshman and sophomore students at Princeton
2014 – 2016	**Honor Societies:** Sigma Xi (2016), Phi Beta Kappa (2015), Tau Beta Pi (2014)

PUBLICATIONS

1. **Schiffer, Z.J.;** Lucas, E.; Watkins, N.B.; Ardo, S.; Xiang, C.X.; Atwater, H.A.; Electrochemical Hydrogen Looping Cell for Acid and Base Generation in Direct Ocean Capture of Carbon Dioxide. *Device* **2024**, *2*, 100506.
2. Watkins, N.B.; Lai, Y.; **Schiffer, Z.J**; Canestraight, V.; Atwater, H.A.; Agapie, T.; Peters, J.; Gregoire, J.; Electrode Surface Heating with Organic Films Improves CO2 Reduction Kinetics on Copper. *ACS Energy Letters* **2024**, *9*, 1440-1445.
3. **Schiffer, Z.J.;** Reports From The Frontier-Heterogeneous Electrocatalysis for Sustainable Electrochemical Synthesis. *Electrochemical Society Interface* **2023**, *32*, 37.
4. Watkins, N.B.;† **Schiffer, Z.J;**† Lai, Y.; Musgrave, C.B.; Atwater, H.A.; Goddard, W.A.; Peters, J; Agapie, T.; Gregoire, J; Hydrodynamics Change Tafel Slopes in Electrochemical CO_2 Reduction on Copper. *ACS Energy Letters* **2023**, *8* (5), 2185-2192.
5. **Schiffer, Z.J.;** Chung, M..; Steinberg, K.; Manthiram, K.; Selective Electrochemical Reductive Amination of Benzaldehyde at Heterogeneous Metal Surfaces. *Chem Catalysis* **2023**, *3* (2), 100500.
6. **Schiffer, Z.J.;** † Biswas, S.; † Manthiram, K.; Ammonium Formate as a Safe, Energy-Dense Electrochemical Fuel Ionic Liquid. *ACS Energy Letters* **2022**, *7*, 3260-3267.
7. **Schiffer, Z.J.;** Limaye, A.M.; Manthiram, K.; Thermodynamic Discrimination between Energy Sources for Chemical Reactions. *Joule* **2021**, *5* (1), 135-148.
8. Park, J.; Jin, J.; Sahasrabudhe, A.; Chiang, P.; Maalouf, J.H.; Koehler, F.; Rosenfeld, D.; Rao, S.; Tanaka, T.; Khudiyev, T.; **Schiffer, Z. J.**; Fink, Y.; Yizhar, O.; Manthiram, K.; Anikeeva. P.; In situ electrochemical generation of nitric oxide for neuronal modulation. *Nature Nanotech.* **2020** *15*, 690-697.
9. **Schiffer, Z.J.**; Lazouski, N.; Corbin, N.; Manthiram, K.; Nature of the first electron transfer in electrochemical ammonia activation in a non-aqueous medium. *J. Phys. Chem. C* **2019** *123* (15), 9713-9720.

10. Yang, D.; Zhu, M.; **Schiffer, Z. J.**; Williams, K; Song, X.; Liu, X.; Manthiram, K. Direct electrochemical carboxylation of benzylic C-N bonds with carbon dioxide, *ACS Catalysis* **2019** *9*, 4699-4705.

11. Lazouski, N.; **Schiffer, Z. J.**; Williams, K.; Manthiram, K. Understanding Continuous Lithium-Mediated Electrochemical Nitrogen Reduction. *Joule* **2019**, *3* (4), 1127-1139.

12. **Schiffer, Z. J.**; Manthiram, K. Electrification and Decarbonization of the Chemical Industry. *Joule* **2017**, *1* (1), 10-14.

13. **Schiffer, Z. J.**; Arnold, C. B. Characterization and Model of Piezoelectrochemical Energy Harvesting Using Lithium ion Batteries. *Experimental Mechanics* **2017**, 1-7.

14. **Schiffer, Z. J.**; Cannarella, J.; Arnold, C. B. Strain Derivatives for Practical Charge Rate Characterization of Lithium Ion Electrodes. *The Journal of the Electrochemical Society* **2016**, *163* (3), A427–A433.

15. Garrison, B. J.; **Schiffer, Z. J.**; Kennedy, P. E.; Postawa, Z.; Modeling Dynamic Cluster Sims Experiments. *Surface and Interface Analysis* **2013,** *45*, 14-17.

16. **Schiffer, Z. J.**; Kennedy, P. E.; Postawa, Z.; Garrison, B. J.; Molecular Dynamics Simulations Elucidate the Synergy of C_{60} and Low-Energy Ar Cobombardment for Molecular Depth Profiling. *The Journal of Physical Chemistry Letters* **2011**, *2*, 2635-2638.

PATENTS & PATENT APPLICATIONS

1. US. Patent No. 18484332, “Electrochemical Hydrogen Looping for Acid and Base Generation,” Oct. 10, 2022. *Inventors*: H.A. Atwater (Pasadena, CA), **Z.J. Schiffer** (Pasadena, CA), C. Xiang (Pasadena, CA).

2. Patent, No. US20220298650A1, “Ionic Liquid Based Materials and Catalysts for Hydrogen Release,” Sept. 16, 2020. *Inventors*: V. Viswanathan (Pittsburgh, PA), D. Krishnamurthy (Pittsburgh, PA), K. Manthiram (Cambridge, MA), **Z.J. Schiffer** (Cambridge, MA)

FUNDED PROPOSALS

1. **Title**: Renewable Electricity as a Tool to Recycle Plastic. **Funding Source**: Harvard University William F. Milton Fund (2024). **Amount**: 150,000. **Contributions**: Conception and writing.

2. **Title**: Sustainable Ammonia Synthesis for Zero-Carbon Fertilizers and Fuels. **Funding Source**: CalTech Resnick Sustainability Institute (2022). **Contributions***:* Writing of section on photocatalytic nitrogen reduction.

3. **Title**: Ionic liquids as safe, energy-dense electrochemical fuels. **Funding Source***:* Air Force Office of Scientific Research (2021). **Contributions**: Conceptualization and writing with K. Manthiram.

INVITED TALKS AND SEMINARS

1. **Schiffer, Z.J.**; Watkins, N.B.; Lai, Y.; Musgrave, C.; Atwater, H.; Goddard, W.; Agapie, T.; Peters, J.; Gregoire, J.; *Electrolyte hydrodynamics change Tafel slopes in electrochemical CO2 reduction on copper*. 20 minute talk on March 18, 2024 at the 2024 Spring ACS Meeting in New Orleans, LA.

2. **Schiffer, Z.J.**; *Why and When to Use Voltage: Electrochemical Systems for Decarbonization of the Chemical Industry*. One hour seminar for the MIT ECS Student Chapter on February 28, 2024 at MIT in Cambridge, MA.

3. **Schiffer, Z.J.**; *Why and When to Use Voltage: Electrochemical Systems for Decarbonization of the Chemical Industry*. One hour workshop talk on October 25, 2023 at the Brown University Sustainable Energy Workshop in Providence, RI.

4. **Schiffer, Z.J.**; *Voltage as a Driving Force for Small Molecule Separations and Activations*. One hour research seminar for faculty interview on February 27, 2023 at the Harvard John A. Paulson School of Engineering and Applied Science in Cambridge, MA.

5. **Schiffer, Z.J.;** *Voltage as a driving force for small molecule separations and activations*. One hour research seminar for faculty interview on January 23, 2023 at the University of Toronto Department of Chemical Engineering & Applied Chemistry in Toronto, ON.

6. **Schiffer, Z.J.**; Xiang, CX; Atwater, H.A.; *Electrochemical hydrogen looping for carbon dioxide capture from ocean water*. 30 minute seminar on October 3, 2022 at Caltech Resnick Sustainability Institute seminar series Fall 2022 in Pasadena, CA.

7. **Schiffer, Z.J**.; Manthiram, K.; *Voltage as a Driving Force for Ammonia Activation*. 40 minute award talk on June 1, 2022 at the 2022 ECS meeting in Vancouver, BC.

CONTRIBUTED PRESENTATIONS

1. **Schiffer, Z.J.;** Panel on “Innovative Climate Technologies” along with Frank Keutsch, Lene Hau, Gage Hills, and Daniel Tish at Harvard Climate Action Week, June 11 2024 in Cambridge MA.

2. **Schiffer, Z.J;** *Why and when to use voltage: Electrochemical systems for decarbonization of the chemical industry*. One hour seminar on June 17, 2024 for the Harvard REU students in Cambridge, MA

3. Watkins, N.B.; Lai, Y.; **Schiffer, Z.J.**; Canestraight, C.; Atwater, H.; Goddard, W.; Agapie, T.; Peters, J.; Gregoire, J.; *Electrode surface heating with organic films improves CO2 electroreduction kinetics on copper*. 20 minute talk on March 18, 2024 at the 2024 Spring ACS Meeting in New Orleans, LA.

4. **Schiffer, Z.J.**; Lucas, E.; Watkins, N.; Ardo, S.; Xiang, C.; Atwater, H.; *Electrochemical hydrogen looping for acid and base generation in direct ocean capture of carbon dioxide*. 30 minute talk on March 18, 2024 at the 2024 Spring ACS Meeting in New Orleans, LA.

5. **Schiffer, Z.J.;** Atwater, H.A.; Mass transport as an essential tool for designing electrochemical reactors. 10 minute talk at the 2024 Electrochemistry GRC in Ventura, CA.

6. **Schiffer, Z.J.;** Lucas, E.; Xiang, CX; Atwater, H.A.; *Electrochemical H_2 looping for CO_2 capture from ocean water*. 15 minute talk at the 2023 Carbon Capture, Utilization, and Storage GRS and poster at GRC in Les Diablerets, VD, Switzerland.

7. **Schiffer, Z.J.**; Biswas, S.; Manthiram, K.; *Ionic Liquids as Safe, Energy-dense Electrochemical Fuels*. 30 minute talk at the virtual AFOSR Ionic Liquid Workshop in Jan. 2023.

8. **Schiffer, Z.J.**; Manthiram, K.; *Kinetic and Thermodynamic Aspects of Voltage As a Driving Force for Ammonia Activation*. 15 minute talk at the 2022 AIChE meeting in Phoenix, AZ.

9. **Schiffer, Z.J.**; Biswas, S.; Manthiram, K.; *Ammonium Formate As a Safe, Energy-Dense Electrochemical Fuel Ionic Liquid*. 30 minute talk at the 2022 AIChE meeting in Phoenix, AZ.

10. **Schiffer, Z.J.**; Chung, M.; Manthiram, K.; *Selective Electrochemical Reductive Amination of Benzaldehyde Using a Silver Catalyst*. 18 minute talk at the 2021 AIChE meeting in Boston, MA.

11. **Schiffer, Z.J.**; Limaye, A. M.; Manthiram, K.; *Thermodynamic Discrimination between Energy Sources for Chemical Reactions*. 20 minute talk at the 2021 AIChE meeting in Boston, MA.

12. **Schiffer, Z.J.**; Biswas, S.; Manthiram, K *Ammonium Formate as a Safe, Energy-Dense Electrochemical Fuel Ionic Liquid*. 25 minutes virtual talk at the 2021 AIChE meeting in Boston, MA.

13. **Schiffer, Z.J.**; Manthiram, K.; *Electrocatalytic Reductive Amination for Synthesis of Primary Amines*. 15 minute talk at the 2020 AIChE Virtual Fall meeting.

14. **Schiffer, Z.J.**; Limaye, A. M.; Manthiram, K.; *Thermodynamic Discrimination between Energy Sources for Chemical Reactions*. 15 minute talk at the 2020 AIChE Virtual Fall meeting.

15. **Schiffer, Z.J.**; Lazouski, N.; Corbin, N.; Manthiram, K.; *Nature of the First Electron Transfer in Electrochemical Ammonia Activation in a Nonaqeuous Medium*. 18 minute talk at the 2019 AIChE meeting in Orlando, Fl.

16. **Schiffer, Z. J.**; Lazouski, N.; Corbin, N.; Manthiram, K.; *Electrochemical Ammonia Oxidation in a Non-Aqueous Electrolyte* (Summer 2019). 20 minute talk at 26th meeting of the N. American Catalysis Soc. in Chicago, IL.

17. **Schiffer, Z. J.**; Cannarella, J.; Arnold, C. B.; *Characterizing Lithium-Ion Electrodes at Practical Charge Rates with Strain* (Spring 2016). 15 minute talk at the Materials Research Society Spring 2016 in Phoenix, AZ.

TEACHING & MENTORING

Spring 2024 **Course Instructor** | Harvard John A. Paulson SEAS

Course: Introduction to Fluid Mechanics & Transport Processes | ES 123

Updated and redesigned core course for undergraduate mechanical, biomedical, and environmental engineers with a focus on integral fluid dynamics, differential fluid mechanics, mass transfer, and reaction engineering.

2023 – 2024 **Solar Energy Activity Lab (SEAL) Mentor** | Caltech

Research mentor to a group of local high school students interested in STEM. Guided them in a multi-month project focused on understanding solar energy applications through MudWatt experiments, solar desalination, and more.

Summer 2022 **Hybrid Summer Research Connection Mentor** | Caltech

Research mentor to a group of LA county high school students interested in STEM. Led them in a six-week project focused on understanding applications of electrochemistry.

Spring 2017 **Teaching Assistant** | MIT Department of Chemical Engineering

Course: Electrochemical Energy Systems | 10.626 | Prof. Karthish Manthiram

Helped develop homework and exam problems, wrote supplementary material, and delivered lecture on how electrochemical instruments work.

Spring 2017 **NetPals Mentor** | MIT | Worked with local 7th graders on STEM projects

2016 **MIRTHE REU Mentor** | Arnold lab at Princeton University

2013 – 2016 **Princeton Peer Tutor** | Math, science, and engineering classes

REVIEWING EXPERIENCE

Peer reviewer for academic journals

Joule; ACS Nano Letters; ACS Energy Letters; Chem Catalysis

Grant proposal reviewer
ARPA-E, Resnick Institute (Caltech), ACS Petroleum Research Fund, DOE BES YIP

ACTIVITIES

2024 – present **Sustainability programs at Harvard SEAS**
Member of climate & sustainability faculty working group (Spring 2024), panel member at Harvard Climate Action Week (2024), and developing course based on sustainable electrochemistry for Fall 2025.

2021 – present **Scientific Consultant for Startup Companies**
Provide paid consulting advice to startup companies on a range of topics, generally focused on electrochemistry and the chemical & energy industries.

Fall 2019 **Cyclic Voltammetry International School in Paris**
A five-day training course on fundamentals of electrochemistry that combines class time and hands-on laboratory work. The class takes place at the Université Paris Diderot and is limited to 10 participants.

2018 – 2019 **VP of Information at Sidney Pacific Graduate Student Residence** | MIT
Organized and ran the Sidney Pacific Student Residence with the other members of the executive council. In particular, directly in charge of all coordinating electronic resources and information distribution.

2018 **MIT Energy Hackathon Co-Director**
Helped organize and run energy-focused hackathon with participants from universities around the US. Built on previous experience leading hackathon advertising team in 2017.

Spring 2018 **AAAS CASE Workshop on Science and Technology Policy**
Four-day program on Catalyzing Advocacy in Science and Engineering (CASE) in Washington D.C. Students learn about science policy and interact with policy makers through seminars and workshops.

2016 – 2018 **Web Officer of Sidney Pacific Graduate Student Residence at MIT**
Developed a new website for the graduate residence community.

2015 – 2016 **Technology Chair of Princeton Student AIChE Chapter**