

# Paul Kempler

Research Assistant Professor

Associate Director of the Oregon Center for Electrochemistry

---

pkempler@uoregon.edu LISB 430  
541-346-7652 Eugene, OR 97403

## Education

---

**California Institute of Technology**, Pasadena, CA September, 2015 to September, 2020

Ph.D. in Chemical Engineering

Advisor: Prof. Nathan S. Lewis

**Vanderbilt University School of Engineering**, Nashville, TN August, 2011 to May, 2015

Bachelor of Engineering, Chemistry and Chemical Engineering, Cum Laude

Advisors: Prof. Paul E. Laibinis and Prof. G. Kane Jennings

## Awards and Honors

---

- University of Oregon Sustainability Fellowship (2023)
- University of Oregon Sustainability Award, Research and Scholarship (2023)
- “Practical Innovations in Alkaline Water Electrolyzers”, HGEN, Senior Personnel, **\$139,155 (2023)**
- “Direct Reduction of Metal Oxides to Metals for Electrowinning and Energy Storage”, DOE BES, Lead PI, **\$752,144 (2022)**
- “Center for Interfacial Ionics”, NSF CCI, Senior Personnel, **\$1,800,000 (2022)**
- “Technoeconomic Analysis for Decarbonization” Environment Initiative Seed Funding Program, Project Lead, **\$20,000 (2022)**
- “A chlor-iron process for decarbonized steel” University of Oregon Translational Research Grant, Lead PI, **\$50,102 (2022)**
- NSF Partnerships for Innovation, Co-PI, **\$250,000 (2021)**
- Gray-Hill Seminar Series (2019)
- Robert D. Tanner Undergraduate Research Award (2015)
- Vanderbilt Honors Program in Chemical Engineering (2015)
- Littlejohn Fellowship (2014)
- Department of Homeland Security STEM Fellowship (2013)

## Research Experience

---

**University of Oregon**, Eugene, OR September, 2020 to Present

**Oregon Center for Electrochemistry (OCE)**

**Materials Science Institute (MSI)**

**Center for Interfacial Ionics (NSF Center for Chemical Innovation: CI<sup>2</sup>)**

**Liquid Sunlight Alliance (LiSA)**

*Broadly interested in fundamentals and applications of electrochemistry as they relate to technologies for decarbonization.*

\* Invented a new design (*provisional patent No. 63/349,953*) for zero-emissions ironmaking for sustainable steelmaking. Pending proposals with DOE EERE.

\* Lead PI on UO proposal funded \$752,114 over three years (DOE BES) for research on the “Direct Reduction of Metal Oxides to Metals for Electrowinning and Energy Storage”, with an additional \$750,000 sub-award granted to Pacific Northwest National lab for collaboration.

\* Co-PI on an industry-sponsored project on advanced alkaline water electrolysis (HGEN) for green hydrogen

\* With the Liquid Sunlight Alliance, directing fundamental studies of corrosion processes from single-crystal substrates to improve the durability of electrocatalysts used in devices for CO<sub>2</sub> utilization.

**California Institute of Technology**, Pasadena, CA September, 2015 to September, 2020

**Division of Chemistry and Chemical Engineering**

**Joint Center for Artificial Photosynthesis (JCAP)**

Ph.D. Research advised by Prof. Nathan S. Lewis

- Developed transparent metal films of metal-phosphorus alloys which exhibit > 90% transmissivity at hydrogen evolving photocathodes.
- Prepared microstructured cathodes that sustain gas evolution at low overpotentials while oriented against gravity or towards sunlight in stagnant electrolytes. Wrote packages for image analysis (MATLAB) and ray-tracing (Python).

- Demonstrated that microfabricated Si photoelectrodes allow high mass loadings of electrocatalysts with minimal parasitic absorption of light when serving as photocathodes for electrochemical hydrogen evolution and carbon-dioxide reduction.

Industry and Academic Collaborations

- Fabricated polymer-embedded microwire arrays for Lawrence Livermore National Lab for use as capillary structures that enhance the yield of positrons and high energy X-rays (2017-2020)
- Delivered silicon microwire and microcone array photodetectors to Lockheed Martin (2018)

**Vanderbilt University**, Nashville, TN

September, 2013 to May, 2015

**Department of Chemical and Biomolecular Engineering**

Independent study advised by Prof. Paul E. Laibinis

- Designed reticles for measuring the imaging resolution of instruments in the Center for Mass Spectrometry.
- Simulated ablation patterns in MATLAB and prepared reticles via soft-lithography.

**Vanderbilt Undergraduate Summer Research Program**, Nashville, TN

May, 2014 to August, 2014

Littlejohn Fellowship advised by Prof. G. Kane Jennings

- Discovered a procedure for the surface-initiated polymerization of gas phase dicyclopentadiene on gold substrates.
- Characterized polymer films via profilometry and ellipsometry in the Vanderbilt Institute for Nanoscale Science and Engineering.

**Pacific Northwest National Laboratory**, Richland, WA

May, 2013 to August, 2013

Homeland Security STEM Fellowship advised by Dr. John R. Cort

- Developed methods of chemical source attribution via  $^{13}\text{C}$  fingerprinting using NMR spectroscopy.

**Vanderbilt University**, Nashville, TN

January, 2012 to April 2013

**Institute of Chemical Biology**

Undergraduate Research assistantship advised by Dr. Martin Egli.

- Studied circadian clock regulation in cyanobacteria; responsible for cell harvesting, protein purification, and crystal growth.

## **Teaching and Mentoring**

**University of Oregon**, Eugene, OR

Oregon Center for Electrochemistry

- Developed new course “Technoeconomic Analysis for Decarbonization” (first offered spring 2023), in collaboration with UO Lundquist College of Business, that introduced an interdisciplinary approach to the principles and business practices of decarbonization strategies. Funding provided by UO Environment Initiative.
- Designed and taught “Analytical Methods in Electrochemistry” course, a modern and hands-on approach to electrochemistry education. Developed new labs for students to gain practical experience in instrumental analysis through the construction of potentiostat circuits, writing of data analysis algorithms in Python, and submission of lab reports as Jupyter Notebooks.
- Designed and taught a new laboratory course “Electrochemical Device Laboratory”, where students apply engineering principles while learning electrochemical impedance spectroscopy, Design of Experiments, and modern characterization techniques (e.g. XPS, AFM). Case studies include electrolyzers, fuel-cells, lithium-ion batteries, corrosion engineering, and electrodeposition.
- Developed capstone research projects for “Applied Electrochemical Projects” course. Recruited industry partners sponsoring paid projects related to energy storage, electrolysis, and electroplating sectors. Past industry sponsors include De Nora Tech LLC, Twelve, EnZinc, Moses Lake Industries, Sila Nanotechnologies, HGEN, and Polaris Battery Labs LLC

**California Institute of Technology**, Pasadena, CA

Division of Chemistry and Chemical Engineering

- Supervised 4 summer undergraduate research projects, 2 undergraduate independent study projects, and 3 graduate student rotations. Conceived projects, mentored students, and assisted with lab work.
- Wrote and taught an undergraduate short course titled “Chemistry of Renewable Energy”, under supervision of Prof. Zhen-Gang Wang and assistance from the Center for Teaching Learning and Outreach (2019)
- Led recitations as a teaching assistant for Graduate Thermodynamics (2016), Graduate Electrochemistry (2017), and Undergraduate Thermodynamics (2018).

### Lead Mentor, Solar Energy Activity Laboratory (2016-2020)

- Guided research experience for high school students searching for new mixed metal oxide semiconductors capable of solar-driven water oxidation.
- Recruited and organized graduate student mentors.
- Maintained campus lab space, materials, furnaces, and LabView kits.
- Cumulatively mentored > 30 high school students, meeting weekly during the academic year.

### Professional Activities

---

- Member of the American Chemical Society and the Electrochemical Society
- Independent consultant in energy storage and electrochemical device design (projects have included vanadium redox flow batteries, alkaline water electrolysis, zinc batteries, glucose monitoring sensors, and lithium extraction)
- Project Selection Committee Member for the Pacific Northwest Hydrogen Hub (~\$1B proposal)
- Peer reviewer for *Joule*, *Journal of the American Chemistry Society*, *Nature Communications*, *Nature Catalysis*, *Chemical Society Reviews*, *Communications Chemistry*, *ACS Applied Materials and Interfaces*, *Journal of the Electrochemical Society*

### University of Oregon Service

---

- Associate Director for the Oregon Center for Electrochemistry (2020-2023)
- Member of the Thermal Study Task Force focused on decarbonization of campus heating
- Lead organizer for the annual Oregon Center for Electrochemistry Conference (2021, 2022)
- Graduate Admissions Committee representative (2022)

### Research Advisor for Postdocs:

1. Anastasiia Konovalova (UO)
2. Shujin Hou (UO)

### Research Advisor for Ph.D. Students:

3. Kira Thurman (UO, chemistry)
4. Nick D'Antona (UO, chemistry)
5. Manasa Rajeev (UO, chemistry)
6. Raj Shekhar (UO, chemistry)

### Research/Internship Advisor for M.S. Students:

1. Ashley Heldibridle (UO, Lyten)
2. Avi Grinberg (UO, Enovix)
3. Jared Iland (UO, Nuvera)
4. Kassandra Flores (UO, HRL)
5. Mauricio Paz (UO, Form Energy)
6. Sam Reul (UO, EnZinc)
7. Karana Dunn (UO, ESS Inc)
8. Gainer Phay (UO, ESS Inc)
9. Joao Morgado (UO, Natron)
10. Linn Kelley (UO, NREL)
11. Antowan Davtians (UO, Redwood Materials)
12. Mark Mancini (UO, HRL)
13. Serafina Fortiner (UO, Nel Hydrogen)
14. Alfred Nkhama (UO, De Nora)
15. Berkley Noble (UO, Magrathea Metals)
16. Louka Moutarlier (UO, EnZinc)
17. Martin Chown (UO, Sila Nanotechnologies)
18. Kenny Nguyen (UO, Apple)
19. Carinna Lapson (UO)
20. Sara Scodellaro (UO, Moses Lake Industries)
21. Casey Mezerkor (UO)

### Research Advisor for Undergraduate Students:

1. Caitlyn Cannan (UO, chemistry)
2. Jillian Reed (Caltech, chemical engineering)
3. Gianmarco Terrones (Caltech, chemical engineering)
4. Amar Bhardwaj (visiting student, Caltech, chemical engineering)
5. Miguel Gonzalez (Caltech, chemical engineering)

### Thesis Committee Member

1. Olivia Trankle (UO)
2. Minkyong Kwak (UO)
3. Matt Clark (UO, Sila Nanotechnologies)
4. Elana Cope (UO)
5. Celsey Price (UO)

## Publications

---

### University of Oregon

- 22 Kang, R., Zhao, Y., Hait, D., Gauthier, J.A., **Kempler, P.A.**, Thurman, K., Boettcher S.W., and Head-Gordon M.\* Understanding Ion-transfer Reactions in Silver Corrosion and Electrodeposition from First-principles Calculations and Experiments. (*Submitted*, DOI: 10.26434/chemrxiv-2023-2m7jh)
- 21 Noble, B.B., Moutarlier, L.J., & **Kempler, P.A.**\* (2023) Electrochemical Chlor-Iron Process for Iron Production from Iron Oxide and Seawater. (*Submitted*, DOI: 10.26434/chemrxiv-2023-d22xj)
- 20 Yu, W., Pan, Z., Buabthong, P., Kempler, P.A., Tournet, J., Karuturi, S., Photoelectrocatalysis. *Encyclopedia of Electrochemical Power Sources* (*in press*)
- 19 **Kempler, P.A.**\* & Nielander, A.C. (2023) On the need for Faradaic efficiency measurements for evaluating electrocatalysts. *Nature Communications*. (2023)
- 18 McKenzie, J., **Kempler, P.A.**, & Brozek, C.K. (2022) Solvent-controlled ion-coupled charge transport in microporous metal chalcogenides. *Chemical Science*. 13(4), 12747-12759
- 17 **Kempler, P. A.**,\* Slack J., & Baker, A. M. (2022). Electrochemical research priorities for affordable seasonal energy storage using electrolyzers and fuel cells. *Joule*. 6(12), 280-285.
- 16 **Kempler, P. A.**,\* Boettcher, S. W.,\* & Ardo, S. (2021). Reinvigorating electrochemistry education. *iScience*, 102481.
- 15 Boettcher, S. W.,\* Oener, S. Z., Lonergan, M. C., Surendranath, Y., Ardo, S., Brozek, C., & **Kempler, P. A.** (2020). Potentially confusing: Potentials in electrochemistry. *ACS Energy Letters*, 6(1), 261-266.

### California Institute of Technology

- 14 Ifkovits, Z.P., Reed, J.T., Kempler, P.A., Meier, M.M., Byrne, S.T., Lin, S., Ye, A. Carim, A.I., & Lewis, N.S.\* (2023) Spontaneous Mesosstructure Formation Produces Optically Transmissive Ni-P Films That are Catalytically Active for the Photoelectrochemical Hydrogen Evolution Reaction. *Sustainable Energy & Fuels*
- 13 Ifkovits, Z.P., Evans, J.M., **Kempler, P.A.**, Dowling, J.A., Pham, K.H., Morla, M.B., and Lewis, N.S., (2022) Powdered  $Mn_xSb_{1-y}O_x$  Catalysts for Chemical and Electrochemical Oxygen Evolution. *ACS Energy Letters*, 7(12), 4258-4264
- 12 Yan, E., Morla, M., Kwon, S., Musgrave, C., **Kempler, P.A.**,; Brunshwig, B.,; Goddard, W.A.,; Lewis, N.S., (2022). Theoretical analysis of thermodynamic and kinetic limitations for covalent functionalization of 1T'-MoS<sub>2</sub>: a model for methylation coverage on chemically exfoliated MoS<sub>2</sub>. *J. Phys. Chem. C*. (*In review*)
- 11 Jiang, S., Link, A., Canning, D., Fooks, J. A., **Kempler, P. A.**, Kerr, S., ... & Chen, H.\* (2021). Enhancing positron production using front surface target structures. *Applied Physics Letters*, 118(9), 094101.
- 10 Kennedy, K. M., **Kempler, P. A.**, Cabán-Acevedo, M., Papadantonakis, K. M., & Lewis, N. S.\* (2021). Primary Corrosion Processes for Polymer-Embedded Free-Standing or Substrate-Supported Silicon Microwire Arrays in Aqueous Alkaline Electrolytes. *Nano Letters*, 21(2), 1056-1061.
- 9 **Kempler, P. A.**, Ifkovits, Z. P., Yu, W., Carim, A. I., & Lewis, N. S.\* (2021). Optical and electrochemical effects of H<sub>2</sub> and O<sub>2</sub> bubbles at upward-facing Si photoelectrodes. *Energy & Environmental Science*, 14(1), 414-423.
- 8 **Kempler, P. A.**, Richter, M. H., Cheng, W. H., Brunshwig, B. S., & Lewis, N. S.\* (2020). Si Microwire-Array Photocathodes Decorated with Cu Allow CO<sub>2</sub> Reduction with Minimal Parasitic Absorption of Sunlight. *ACS Energy Letters*, 5(8), 2528-2534.
- 7 Buabthong, P., Ifkovits, Z. P., **Kempler, P. A.**, Chen, Y., Nunez, P. D., Brunshwig, B. S., ... & Lewis, N. S.\* (2020). Failure modes of protection layers produced by atomic layer deposition of amorphous TiO<sub>2</sub> on GaAs anodes. *Energy & Environmental Science*, 13(11), 4269-4279.
- 6 **Kempler, P. A.**, Coridan, R. H., & Lewis, N. S.\* (2020). Effects of bubbles on the electrochemical behavior of hydrogen-evolving Si microwire arrays oriented against gravity. *Energy & Environmental Science*, 13(6), 1808-1817.
- 5 Yalamanchili, S., Verlage, E., Cheng, W. H., Fountaine, K. T., Jahelka, P. R., **Kempler, P. A.**, ... & Atwater, H. A.\* (2019). High Broadband Light Transmission for Solar Fuels Production Using Dielectric Optical Waveguides in TiO<sub>2</sub> Nanocone Arrays. *Nano Letters*, 20(1), 502-508.
- 4 **Kempler, P. A.**, Fu, H. J., Ifkovits, Z. P., Papadantonakis, K. M., & Lewis, N. S.\* (2019). Spontaneous Formation of > 90% Optically Transmissive, Electrochemically Active CoP Films for Photoelectrochemical Hydrogen Evolution. *The Journal of Physical Chemistry Letters*, 11(1), 14-20.

3 **Kempler, P. A.**,<sup>†</sup> Yalamanchili, S.,<sup>†</sup> Papadantonakis, K. M., Atwater, H. A., & Lewis, N. S.\* (2019). Integration of electrocatalysts with silicon microcone arrays for minimization of optical and overpotential losses during sunlight-driven hydrogen evolution. *Sustainable Energy & Fuels*, 3(9), 2227-2236.

2 **Kempler, P. A.**, Gonzalez, M. A., Papadantonakis, K. M., & Lewis, N. S. (2018). Hydrogen evolution with minimal parasitic light absorption by dense Co-P catalyst films on structured p-Si photocathodes. *ACS Energy Letters*, 3(3), 612-617.

#### Vanderbilt University

1 Njoroge, I., **Kempler, P. A.**, Deng, X., Arnold, S. T., & Jennings, G. K. (2017). Surface-Initiated Ring-Opening Metathesis Polymerization of Dicyclopentadiene from the Vapor Phase. *Langmuir*, 33(49), 13903-13912.

#### Manuscripts prepared for submission 2023

Thurman K., Cannan C., Shekhar, R., Boettcher S.W., **Kempler, P.A.\*** (*in preparation*) Influence of Supporting Anion Structure on Ion Transport Kinetics in Copper Corrosion

D'Antona, N., Boettcher, S.W.,\* **Kempler, P.A.\*** (*in preparation*) Guidelines for using facilitated proton transfer at the liquid-liquid interface to study proton transfer kinetics

**Kempler, P.A.\***, Cordian, R.H., Edwards M.E., Luo, L., Mehrabi, H. (*invited, in preparation*) Gas Liquid Interfaces in Water Electrolyzers. *Chemical Reviews*.

#### Invited Talks

---

1. MCARE. Seattle, WA (2023). "Carbon neutral production of iron from iron oxide and salt water"
2. NETL. Albany, OR (2023). "Direct reduction of metal oxides to metals for sustainable manufacturing".
3. Pittcon. Philadelphia, PA (2023). "Direct reduction of metal oxides to metals for sustainable manufacturing".
4. Telluride Innovation Workshop on Decarbonization of Cement. Telluride, CO (2022). "Electrochemical production of commodity chemicals: techno-economic analyses of cement, storage, and steel".
5. 240<sup>th</sup> ECS Meeting. *Virtual* (2021) "Reinvigorating Electrochemistry Education".
6. Gray-Hill Seminar Series. Los Angeles, CA. (2019) "Making Fuels from Sunlight: Micro- and Nanostructured Materials for Solar Driven Hydrogen Evolution".

#### Grants Pending

---

1. **UO Lead PI**, Form Energy Prime, *Funding Source: ARPA-E* Electrolytic chlor-iron process: direct electrification of ironmaking with net-negative CO<sub>2</sub> emissions at cost parity with blast furnace pig iron, UO Budget **\$708,995**
2. **UO Lead PI**, NETL Prime, *Funding Source: DOE LDRD*, Domestic production and manufacturing of electrical steels with zero carbon emissions, UO Budget **\$240,000**
3. **UO Lead PI**, UO Prime, *Funding Source: DOE EERE*, Ore electrolysis in seawater for the production of alloys for steelmaking, UO Budget: **\$740,429**
4. **UO Lead PI**, Rivalia Chemicals Prime, *Funding Source: NSF SBIR/STTR*, Sustainable REE Production from Coal Combustion Byproduct, UO Budget: **\$23,924**
5. **Co-PI**, HGEN Prime, *Funding Source: DOE EERE*, Advanced Alkaline Electrolyzer to Enable Dynamic Renewables-Integrated Hydrogen Production, UO Budget **\$1,000,000**
6. **Co-PI**, UO Prime led by Prof. Gary Harlow, *Funding Source: NSF-DFG MISSION*, Operando high-energy x-ray diffraction and x-ray fluorescence to study the activation of mixed Ir and Ru oxide anodes for PEM electrolysis by hydrogenation, UO Budget **\$455,000**