MICHAEL P. MARSHAK

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PROFESSIONAL EXPERIENCE

Assistant Professor, Department of Chemistry 2015−Present
Fellow, Renewable and Sustainable Energy Institute (RASEI), **University of Colorado Boulder**

Co-Founder & CTO, Otoro Energy Inc. 2020−Present

Postdoctoral Fellow, Roy Gordon and Michael Aziz Laboratories, **Harvard University** 2013−2015

Graduate Researcher, Daniel Nocera Laboratory, **MIT** 2006−2012

Undergraduate Researcher, Peter Wolczanski Laboratory, **Cornell University** 2003−2006

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA
Ph.D. Inorganic Chemistry June 2012
Dissertation: O−O Bond Formation and the Transition Metal Chemistry of β-Diketiminate, Siloxide, and Triamide Ligands

Cornell University, Ithaca, NY
B.A. Chemistry June 2006
Honors Thesis: C−H Bond Activation with $(^{t}Bu_3SiO)_2W{=}N^{t}Bu$

HONORS AND ACHIEVEMENTS

- CU Boulder Provost's Faculty Achievement Award for Pre-Tenure Faculty 2020
- CU Boulder Lab Venture Challenge Award Winner 2020
- ACS Faculty Mentor of Undergraduate Inorg. Chem. Research Award 2019
- CU-Boulder UROP Outstanding Mentor Award, Honorable Mention 2019
- Scialog Fellow for Advanced Energy Storage (RCSA) 2017

INVITED RESEARCH PRESENTATIONS

- CSU Dept of Chemistry October 25, 2022
- UTEP Dept of Chemistry October 7, 2022
- Telluride Science Research Center Workshop (Co-organizer) September 26-30, 2022
- UT Dallas, LEAP Battery Manufacturing Workshop September 22, 2022
- CU-Sandia Research Day August 29, 2022
- Stanford StorageX Keynote August 26, 2022
- ARPA-e Innovation Summit (poster/booth presenter) May 23-25, 2022
- DOE Manufacturing for Energy Storage Workshop May 6, 2022
- Rocky Mountain Catalysis Society Conference April 22, 2022
- Stanford University Dept of Chemistry April 7, 2022
- UCSD Dept of Chemistry April 1, 2022
- American Chemical Society Meeting March 22, 2022
- BizWest CEO Roundtable on Clean Tech March 8, 2022

- Destination Startup — February 16-17, 2022
- MSU Dept of Chemistry — November 15, 2021
- JHU Dept of Chemistry — October 26, 2021
- ACS Mid-Atlantic Regional Meeting — June 10, 2021
- 2020 International Flow Battery Forum (virtual) — January 21, 2021
- International Coalition for Energy Storage and Innovation — March 2, 2020
- UCLA Dept of Chemistry — November 13, 2019
- Organometallics Gordon Research Conference — July 10, 2019
- Colorado Energy Research Collaboratory, ARPA-e Workshop — November 28, 2017
- University of Calgary, Dept of Chemistry — December 16, 2016
- University of Tulsa, Dept of Chemistry — September 26, 2016

Also contributed presentations and posters at meetings of ACS, ECS, GRC (Inorganic Chemistry, Inorganic Reaction Mechanisms, Organometallics, Electron Donor-Acceptor Interactions, Batteries)

PEER-REVIEWED RESEARCH PUBLICATIONS

Total at CU-Boulder: 22, h-index: 12, citations since 2018: 2363; Data from Google Scholar.

- "System footprint and safety as key metrics for grid-scale energy storage" Reber, D.; Jarvis, S. R.; Marshak, M. P. *Nature* (under review). *ChemRxiv*. DOI: 10.26434/chemrxiv-2022-5ddhs
- "Sulfonated Diels-Alder Poly(phenylene) Membrane for Efficient Ion-Selective Transport in Aqueous Metalorganic and Organic Redox Flow Batteries" Robb, B. H.; George, T. Y.; Davis, C. M.; Tang Z.; Fujimoto, C. H.; Aziz, M. J.*; Marshak, M. P.* *J. Electrochem. Soc.* **2023**, Article Accepted. IF = 4.3 Citations = 0.
- "Stability of highly soluble ferrocyanides at neutral pH for energy-dense flow batteries" Reber, D.; Thurston, J. R.; Beker, M.; **Marshak, M. P.*** *Cell Reports Phys. Sci.* **2023**. DOI: 10.1016/j.xcrp.2022.101215
- "Realized Potential as Neutral pH Flow Batteries Achieve High Power Densities" Robb, B. H.; Waters, S. E.; Saraidaridis, J. D.; **Marshak, M. P.*** *Cell Rep. Phys. Sci.* **2022**, article accepted. IF = 7.8. Citations = 0.
- "Maximizing Vanadium Deployment in Redox Flow Batteries Through Chelation" Waters, S. E.; Davis, C. M.; Thurston, J. R.; **Marshak, M. P.*** *J. Am. Chem. Soc.* **2022**, ASAP. DOI: 10.1021/jacs.2c07076. IF = 16.4. Citations = 1.
- "High Energy Density Chelated Chromium Flow Battery Electrolyte at Neutral pH" Robb, B. H.; Waters, S. E.; **Marshak, M. P.*** *Asian J. Chem.* **2022**, Article in press (accepted). DOI: 10.1002/asia.202200700. IF = 4.8. Citations = 2.
- "Transport of Ligand Coordinated Iron and Chromium through Cation-Exchange Membranes" Saraidaridis, J. D.*; Darling, R. M.; Yang, Z.; Fortin, M. E.; Shovlin, C.; Robb, B. H.; Waters, S. E.; **Marshak, M. P.** *J. Electrochem. Soc.* **2022**, *169*, 0605332. DOI: 10.1149/1945-7111/ac7782. IF = 4.3. Citations = 3.
- "Isolation and characterization of a highly reducing aqueous chromium (II) complex" Waters, S. E.; Robb, B. H.; Scappaticci, S. J.; Saraidaridis, J. D.; **Marshak, M. P.*** *Inorg. Chem.* **2022**, *61*, 8752–8759. DOI: 10.1021/acs.inorgchem.2c00699. IF = 5.1. Citations = 4.
- "Mediating anion-cation interactions to improve aqueous flow battery electrolytes" Reber, D.*; Thurston, J. R.; Becker, M.; Pache, G. F.; Wagoner, M. E.; Robb, B. H.; Waters, S.

E.; **Marshak, M. P.*** *Appl. Mater. Today* **2022**, *28*, 101512. DOI: 10.1016/j.apmt.2022.101512. IF = 10. Citations = 7. (Reber, D. is a postdoc in my group)

- "Bismuth Electrocatalyst Enabling Reversible Redox Kinetics of a Chelated Chromium Flow Battery Anolyte" Proctor, A. D.; Robb, B. H.; Saraidaridis, J. D.; **Marshak, M. P.*** *J. Electrochem. Soc*. **2022**, *169*, 060532. DOI: 10.1149/1945-7111/ac56d3. IF = 4.3. Citations = 6
- "Holistic design principles for flow batteries: Cation dependent membrane resistance and active species solubility" Waters, S. E.; Thurston, J. R.; Armstrong, R. W.; Robb, B. H.; **Marshak, M. P.***; Reber, D.* *J. Power Sources* **2022**, *520*, 230877. DOI: 10.1016/j.jpowsour.2021.230877. IF = 9.7. Citations = 8. (Reber, D. is a postdoc in my group)
- "Synthesis, reactivity, and crystallography of a sterically hindered acyl triflate" Crossman, A. S.; Shi, J. X.; Krajewski, S. M.; Maurer, L. M.; **Marshak, M.P.*** *Tetrahedron* **2021**. *94*, 132308. DOI: 10.1016/j.tet.2021.132308. IF = 2.5. Citations = 0
- "Open for bismuth: main group metal-to-ligand charge transfer" Maurer, L. M.; Pearce, O. M.; Maharaj, F. D. R; Brown, N. L.; Amador, C. A.; Damrauer, N. H.; **Marshak, M. P.*** *Inorg. Chem*. **2021**. *60*, 10137–10146. DOI: 10.1021/acs.inorgchem.0c03818. IF = 5.1. Citations = 10
- "Evaluating Aqueous Flow Battery Electrolytes: A Coordinated Approach" Robb, B. H.; Waters, S. E.; **Marshak, M. P.*** *Dalton Trans.*, **2020**, *49*, 16047–16053. DOI: 10.1039/D0DT02462G. IF = 4.4. Citations = 10.
- "Minimizing Oxygen Permeation in Metal-Chelate Flow Batteries" Robb, B. H.; Waters, S. E.; **Marshak, M. P.*** *ECS Trans*. **2020**, *97*, 237–245. DOI: 10.1149/09707.0237ecst. IF = 1. Citations = 9.
- "Effect of Chelation on Iron-Chromium Redox Flow Batteries" Waters, S. E.; Robb, B. H.; **Marshak, M. P.*** *ACS Energy Letters*, **2020**, *6*, 1758–1762. DOI: 10.1021/acsenergylett.0c00761. IF = 23. Citations = 49.
- "Group 4 Organometallics Supported by Sterically Hindered β-Diketonates" Hopkins, E. J.; Krajewski, S. M.; Crossman, A. S.; Maharaj, F. D. R.; Schwanz, L. T.; **Marshak, M. P.***, *Eur. J. Inorg. Chem*. **2020**, *20*, 1951–1959. DOI: 10.1002/ejic.202000135. IF = 2.6. Citations = 4.
- "Titanium-Anthraquinone Material as a New Design Approach for Electrodes in Aqueous Rechargeable Batteries" Maharaj, F. D. R.; **Marshak, M. P.*** *Energies* **2020**, *13*, 1722. DOI: 10.3390/en13071722. IF = 3. Citations = 2.
- "Copper(II) as a Platform for Probing the Steric Demand of Bulky β-Diketonates" Larson, A. T.; Crossman, A.S.; Krajewski, S. M.; **Marshak, M. P.*** *Inorg. Chem.* **2020**, *59*, 423–432. DOI: 10.1021/acs.inorgchem.9b02721. IF = 5.1. Citations = 5
- "Chelated chromium electrolyte enabling high-voltage aqueous flow batteries" Robb, B. H.; Farrell, J. M.; **Marshak, M. P.*** *Joule* **2019**, *3*, 2503–2512. DOI: 10.1016/j.joule.2019.07.002. IF = 41. Citations = 57.
- "Sterically encumbered β-diketonates and base metal catalysis" Krajewski, S. M.; Crossman, A. S.; Akturk, E. S.; Suhrbier, T.; Scappaticci, S. J.; Staab, M. W.; **Marshak, M. P.*** *Dalton Trans.* **2019**, *48*, 10714–10722. DOI: 10.1039/C9DT02293G. IF = 4.4. Citations = 10.
- "Synthesis of sterically hindered β-diketones via condensation of acid chlorides with enolates" Crossman, A. S.; Larson, A. T.; Shi, J. X.; Krajewski, S. M.; Akturk, E. S.; **Marshak, M. P.*** *J. Org. Chem*. **2019**, *84*, 7434–7442. DOI: 10.1021/acs.joc.9b00433. IF = 4.4. Citations = 12.

- "Bulky β-Diketones Enabling New Lewis Acidic Ligand Platforms" Akturk, E. S.; Scappaticci, S. J.; Seals, R. N.; **Marshak, M. P.*** *Inorg. Chem*. **2017**, *56*, 11466–11469. DOI: 10.1021/acs.inorgchem.7b02077. IF = 5.1. Citations = 17.

PUBLICATIONS PRIOR TO CU

- "Anthraquinone Derivatives in Aqueous Flow Batteries" Gerhardt, M. R.; Tong, L.; Gómez-Bombarelli, R.; Chen, Q.; **Marshak, M. P.**; Galvin, C. J.; Aspuru-Guzik, A.; Gordon, R. G.; Aziz, M. J.* *Adv. Energy Mater.* **2017**. *7*, 1601488. DOI: 10.1002/aenm.201601488. IF = 29. Citations = 216.
- "Alkaline quinone flow battery" Lin, K.; Chen, Q.; Gerhardt, M. R.; Tong, L.; Kim, S. B.; Eisenach, L.; Valle, A. W.; Hardee, D.; Gordon, R. G.*; Aziz, M. J.*; **Marshak, M. P.*** *Science* **2015**, *349*, 1529–1532. DOI: 10.1126/science.aab3033. IF = 48. Citations = 852. (MPM is a co-corresponding author, work performed at Harvard, but uses @colorado.edu email)
- "Computational design of molecules for an all-quinone redox flow battery" Er, S.; Suh, C.; **Marshak, M. P.**; Aspuru-Guzik, A.* *Chem. Sci.* **2015**, *6*, 885–893. DOI: 10.1039/C4SC03030C. IF = 10. Citations = 364.
- "Cycling of a Quinone-Bromide Flow Battery for Large-Scale Electrochemical Energy Storage" Huskinson, B.; **Marshak, M. P.**; Gerhardt, M. R.; Aziz, M. J.* *ECS Trans.* **2014**, *61*, 27–30. DOI: 10.1149/06137.0027ecst. IF=1. Citations = 51.
- "A metal-free organic-inorganic aqueous flow battery" Huskinson, B.; **Marshak, M. P.**; Suh, C.; Er, S.; Gerhardt, M. R.; Galvin, C. J.; Chen, X.; Aspuru-Guzik, A.; Gordon, R. G.; Aziz, M. J.* *Nature* **2014**, *505*, 195–198. DOI: 10.1038/nature12909. IF = 70. Citations = 1366. (BH and MPM contributed equally)
- "Lewis Bases Trigger Intramolecular CH–Bond Activation: $(^{t}Bu_3SiO)_2W{=}N^{t}Bu \rightleftharpoons (^{t}Bu_3SiO)(\kappa O,\kappa C\text{-}^{t}Bu_2SiOCMe_2CH_2)HW{=}N^{t}Bu$" **Marshak, M. P.**; Rosenfeld, D. C.; Morris, W. D.; Wolczanski, P. T.*; Lobkovsky, E. B.; Cundari, T. R. *Eur. J. Inorg. Chem.* **2013**, 4056–4067. DOI: 10.1002/ejic.201300234. IF = 2.6. Citations = 6.
- "Chromium(IV) Siloxide" **Marshak, M. P.**; Nocera, D. G.* *Inorg. Chem.* **2013**, *52*, 1173–1175. DOI: 10.1021/ic3023612. IF = 5.1. Citations = 21.
- "Cobalt in a Bis-β-diketiminate Environment" **Marshak, M. P.**; Chambers, M. B.; Nocera, D. G.* *Inorg. Chem.* **2012**, *51*, 11190–11197. DOI: 10.1021/ic301970w. IF = 5.1. Citations = 33.
- "Thermodynamics, Kinetics, and Mechanism of $(silox)_3M(olefin)$ to $(silox)_3M(alkylidene)$ Rearrangements (silox = tBu_3SiO; M = Nb, Ta)" Hirsekorn, K. F.; Veige, A. S.; **Marshak, M. P.**; Koldobskaya, Y.; Wolczanski, P. T.*; Cundari, T. R.; Lobkovsky, E. B. *J. Am. Chem. Soc.* **2005**, *127*, 4809–4830. DOI: 10.1021/ja046180k. IF = 16. Citations = 88.

OTHER WORKS

Book Chapters and Reviews

- "Organic and Metal-Organic Redox Flow Batteries" Thurston, J. E.; Waters, S. E.; Robb, B. H.; **Marshak, M. P.*** *Encyclopedia of Energy Storage*, **2022**, *2*, 423–435. DOI: 10.1016/B978-0-12-819723-3.00082-2. Citations = 6

- "*β*-Diketones: Coordination and Application"
  Crossman, A. S. & **Marshak, M. P.*** *Comprehensive Coordination Chemistry III.* **2021**, 331–365. DOI: 10.1016/B978-0-08-102688-5.00069-6

Perspectives

- "Iron Flies Higher" **Marshak, M. P.*** *Nature Energy* **2021**, *6*, 854–855.
  DOI: 10.1038/s41560-021-00882-x
- "My trek back to science" **Marshak, M. P.*** *Science*, **2015**, *349*, 1406.
  DOI: 10.1126/science.349.6254.1406

Patents at CU (2)

- "Enhanced solubility of metalorganic chelates in urea containing electrolytes"
  Marshak, M. P.; Reber, D. US Provisional Patent Application No.: 63/342,416.
  Filed May 16, 2022.
- "Electrochemical Storage Devices Comprising Chelated Metals" Waters S.; **Marshak, M.**; Robb, B. H. PCT/US2020/023953. Filed March 20, 2020. License option granted to Otoro Energy Inc.

Patents Prior to CU (4)

- "Small organic molecule based flow battery" US 9,966,622B2. Huskinson, B.; **Marshak, M.**; Aziz, M. J.; Gordon, R. G.; Betley, T. A.; Aspuru-Guzik, A.; Er, S.; Suh, C. Issued May 8, 2018.
- "Bulky ligands and metal compounds comprising" US9,676,693B2. **Marshak, M. P.** Issued June 13, 2017.
- "High pH Organic Flow Battery" WO2016144909A1. **Marshak, M.**; Chen, Q.; Gerhardt, M. R.; Aziz, M. J.; Gordon, R. G.; Lin, K. Filed March 2016.
- "Quinone and hydroquinone based flow battery" US10847829B2. Huskinson, B.; **Marshak, M.**; Aziz, M. J.; Gordon, R. G.; Aspuru-Guzik, A.; Er, S.; Suh, C.; Tong, L.; Lin, K. Issued November 24, 2020.