Monty R. Cosby, Ph. D

SSRL Materials Science Division, SLAC National Accelerator Laboratory
2575 Sand Hill Road Mail Stop 69, Menlo Park, CA 94025
Phone: (503) 523-8027
Email: mcosby@slac.stanford.edu, montyrcosby@gmail.com

Research Vision: To characterize and develop materials for electrochemical applications in the pursuit of improved energy technologies. Research pertains to developing novel high-throughput methods, creating on-the-fly analysis tools, and utilizing mathematical modeling to optimize materials processes.

Education

Ph. D.	Stony Brook University (*Aug 2017 - Jan 2022*) Focus: Inorganic Chemistry, Materials Chemistry, Crystallography	Department of Chemistry
B.S.	University of Oregon (*Oct 2013 - Jun 2017*) Major: Chemistry, Minor: Economics	Department of Chemistry

Held Positions

Postdoc	SLAC/Stanford University (*2022- present*) Advisor, Dr. Kevin Stone	SSRL Materials Sciences Div.

Research

2022- *present* *Materials Sciences* Advisor: Dr. Kevin Stone SSRL/Stanford University

Work is primarily on *operando* XRD, PDF, XAS, and GIWAXS analysis of structural changes within perovskite photovoltaic materials. High-throughput on-the-fly analysis of structural evolutions combined with machine learned databases is being developed to automate beamline experiments. Secondary projects include engineering and maintaining general tools for users to take advantage of in conducting their research. Completed several career and teaching development workshops through Stanford University towards holding a job within academia.

2017- 2022 *Materials Chemistry* Advisor: Pr. Peter Khalifah Stony Brook University/BNL

Thesis title: Quantitative analysis of chemical and electrochemical processes relevant to energy storage using rapid and sensitive synchrotron diffraction methods. Thesis under embargo until 2025 and is available upon request.

Material structure evolutions were determined by sequential Rietveld refinements often exceeding a thousand scans on one compound per day. To actively monitor reaction progress, an automated refinement Python code was created to integrate, refine, and analyze synchrotron data on-the-fly. Work was split into three separate projects: (1) investigating ion exchange kinetics and thermodynamics for optimizing solid electrolyte creation, (2) mathematically modeling thick cathode gradients with computational software: MAPLE, and (3) lateral mapping battery electrode inhomogeneities by synchrotron diffraction.

2015- 2017 *Electrocatalysis* Advisor: Pr. Shannon Boettcher University of Oregon

Studied first-row transition metal electrocatalysts (Ni, Mn, Co) for water splitting. Blueprinted and fabricated an anion-exchange water electrolysis system for real world testing of oxygen evolution reaction electrocatalysts. Synthesized and characterized nanomaterials for use in water electrolysis system.

Awards and Fellowships

2022 SSRL Users Meeting Poster Prize Finalist

2022 Chemistry Award for Outstanding Doctoral Student – Stony Brook University
Departmental award rewarded to two graduating Ph D students who performed exemplary work while completing their degree.

2020- 2021 NSF NRT Fellow (Quantitative Analysis of Dynamic Structures)
Competitive award given to PhD students that have demonstrated exemplary research in data-intensive synchrotron methods. Program includes trainings on various synchrotron techniques and career development.

Skills

- Have led countless beamline experiments at the Advanced Photon Source, National Synchrotron Light Source II, Stanford Synchrotron Radiation Lightsource and Spallation Neutron Source.
- Expert in neutron and X-ray diffraction collection (grazing and transmission) and high throughput thorough Rietveld analysis (TOPAS) of collected patterns.
- Stanford postdoc workshops attended thus far: Preparing for Faculty Careers, Getting Funding and How to Write a Grant, Stanford Teaching Workshop for Postdocs, and The Art of Negotiation
- Solid state synthesis.
- High throughput computational data analysis.
- Coding in Python, MAPLE, and beamline specific languages: Spec (APS/SSRL) and BlueSky.
- Mentored 2 undergraduate researchers who have written and presented senior research theses.
- Electrochemical techniques using MACCOR, BioLogic, and Gamry instruments.

Other Activities

2020- 2021 Seminar Coordinator: GENESIS EFRC: Early Career Team

2018- 2021 Laboratory Safety Officer, Khalifah Group, Stony Brook University

2020- 2021 Chem. Dept. Empowering Safe Practices Team, Stony Brook University

2017- 2018 Teaching Assistant, General Chemistry, Stony Brook University

2018 Modern Methods in Rietveld Refinement for Structural Analysis School

Publications

7. **Cosby, M. R.**; Bartel, C. J.; Corrao, A. A.; Yakovenko, A. A.; Gallington, L. C.; Mattei, G. S.; Chapman, K. W.; Persson, K.A; Ceder, G.; Khalifah, P.G., Thermodynamic and kinetic barriers limiting ion exchange reactions in lithium halide salts resolved through *in situ* synchrotron studies. *Chem. Mater*. **2023**, *35* (3), 917-926 [doi]

6. **Cosby, M.R.**; Carignan, G. M.; Li, Z.; Efaw, C.M.; Yin, L; Dufek, E.J.; Li, B.; Khalifah, P.G., Synchrotron high energy lateral mapping studies of inhomogeneities in pouch cell batteries. *JES.* **2022**, *169*, 020571. [doi] [press release]

5. Li, Z.; Yin, L.; Mattei, G. S; **Cosby, M. R**.; Lee, B. S.; Wu, Z.; Bak, S. M.; Chapman, K.; Yang, X. Q.; Liu, P.; Khalifah, P.G., Synchrotron *operando* depth profiling studies of state-of-charge gradients in thick $Li(Ni_{0.8}Mn_{0.1}Co_{0.1})O_2$ cathode films. *Chem. Mater.* **2020**, *32* (15), 6358-6364. [doi]

4. **Cosby, M. R**.; Mattei, G. S.; Wang, Y.; Li, Z.; Bechtold, N.; Chapman, K. W.; Khalifah, P. G., Salt effects on Li ion exchange kinetics of $Na_2Mg_2P_3O_9N$ – Systematic *in situ* synchrotron diffraction studies *J. Phys. Chem. C* **2020**, *124* (12), 6522-6527. [doi]

3. Liu, H.; Li, Z.; Grenier, A.; Kamm, G. E.; Yin, L.; Mattei, G. S.; **Cosby, M. R**.; Khalifah, P. G.; Chupas, P. J.; Chapman, K. W., Best practices for *operando* depth-resolving battery experiments. *J. App. Crystallogr.* **2020**, *53* (1), 133-139. [doi]

2. Xu, D.; Stevens, M. B.; **Cosby, M. R**.; Oener, S. Z.; Smith, A. M.; Enman, L. J.; Ayers, K. E.; Capuano, C. B.; Renner, J. N.; Danilovic, N., Earth-abundant oxygen electrocatalysts for alkaline anion-exchange-membrane water electrolysis: Effects of catalyst conductivity and comparison with performance in three-electrode cells. *ACS Cat.* **2018**, *9* (1), 7-15. [doi]

1. Stevens, M. B.; Enman, L. J.; Batchellor, A. S.; **Cosby, M. R.**; Vise, A. E.; Trang, C. D.; Boettcher, S. W., Measurement techniques for the study of thin film heterogeneous water oxidation electrocatalysts. *Chem. Mater.* **2017**, *29* (1), 120-140. [doi]

Presentations

16. IUCr 26th Congress, August 2023, " Using on-the-fly Rietveld analysis to follow in situ synchrotron X-ray powder diffraction experiments in real time"
15. MRS Spring Meeting, April 2023, "Hidden Structural Characteristics of Metal Halide Perovskites"
14. MRS Spring Meeting, April 2023, "On The Fly Rietveld Analysis of Synchrotron Powder X-Ray Diffraction"
13. SSRL Users Meeting, September 2022, "Realtime monitoring $FAPbI_3$ perovskite degradation by on-the-fly Rietveld analysis of synchrotron diffraction data"
12. Stony Brook Chemistry Research Day, October 2021, "Resolving the origin of thermodynamic and kinetic limitations in solid state ion exchange"
11. 240th Electrochemical Society Meeting, October 2021, "Mapping the deposition of Li metal in pouch cells by synchrotron diffraction" [doi]
10. 71st Annual Meeting of the American Crystallographic Association, August 2021, "Salt effects on Li-ion exchange kinetics and activation energies – systematic *in situ* synchrotron diffraction studies" [doi]
9. Stony Brook Chemistry Research Day, March 2021, "How does salt choice effect the thermodynamics of ion exchange?"
8. Battery 500 Consortium, in-person quarterly review meeting, November 2019, "Modeling potential gradients in thick NMC cathodes"
7. North American Solid State Chemistry Conference, August 2019, "*In situ* studies of ion exchange reactions of $Na_2Mg_2P_3O_9N$: kinetic and thermodynamic insights"
6. Stony Brook Chemistry Research Day, October 2019, "*In situ* studies of ion exchange reactions of $Na_2Mg_2P_3O_9N$: Kinetic and thermodynamic insights"

5. Battery 500 Consortium, in-person quarterly review meeting, April 2019, “Modeling State-of-Charge Gradients in Operating Thick Battery Cathodes”
4. Battery 500 Consortium, in-person quarterly review meeting, December 2018, “Modeling of Experimental Depth Profiling Data”
3. Stony Brook Chemistry Research Day, October 2018, “Modeling state-of-charge gradients in operating thick battery cathodes”
2. ACS Undergraduate Research Symposium PSU, September 2016, “Characterization of Nanoparticulate Oxygen Evolution Catalysts for use in an Anion Exchange Water Electrolysis System”
1. University of Oregon Energy and Sustainable Materials symposium, June 2016, “The impact of electrolyte, morphology, and structure on catalysts for the oxygen evolution reaction”