Advay N. Shirwalkar

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Education

Ph.D. in Chemical & Petroleum Engineering — Aug. 2022 – Dec. 2026 *(est.)*
University of Pittsburgh — *Pittsburgh, PA*

Bachelor of Chemical Engineering — Aug. 2018 – May 2022
Institute of Chemical Technology — *Mumbai, India*

Technical Skills

Analytical & Characterization Techniques: Cyclic/Linear voltammetry (CV/LSV), Energy Dispersive X-ray Spectroscopy (EDX), Electro-impedance Spectroscopy (EIS), Gas Chromatography–Mass Spectrometry (GC-MS), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Infrared Spectroscopy (FTIR), Nuclear Magnetic Resonance Spectroscopy (NMR), Optical Surface Profilometry, Raman Spectroscopy, Scanning Electron Microscopy (SEM), Thermogravimetric Analysis (TGA), Transmission Electron Microscopy (TEM), UV-Vis Spectroscopy, X-ray Diffraction (XRD), X-ray Fluorescence (XRF), X-ray Photoelectron Spectroscopy (XPS)
Synthesis & Fabrication Tools: Colloid/Slurry Processing, Electrodeposition, Glovebox Operations, High-Pressure Autoclave Reactors, Hydrothermal Reactors, Potentiostat, Physical Vapor Deposition (PVD), Spray Coaters, Sputtering, 3D Printing (FDM, SLA), Tube Furnaces, Wet chemistry
Software & Programming: Python, MATLAB, LaTeX, AutoCAD, Fusion 360, ChemCAD/DWSIM, COMSOL Multiphysics, OriginPro/Prism, ImageJ, VESTA, Adobe Illustrator

Research and Professional Experience

Graduate Student Researcher — Nov. 2022 – Present
Department of Chemical & Petroleum Engineering | University of Pittsburgh — *Pittsburgh, PA*
Dissertation: *Engineering advances in Nickel–based cathodes for alkaline hydrogen chemistry*
Doctoral advisor: Dr. James McKone & Dr. Götz Veser

- Engineered of nickel-based alloy electrocatalysts (e.g., Ni–Mo composites, bi- and tri-metallic nanoparticulates) through novel synthesis strategies, achieving high efficiency and durability in alkaline hydrogen chemistry at both lab and practical scales.
- Scaled nanoparticulate catalyst production from milligrams to tens of gram-scale quantities.
- Designed and constructed a modular three-electrode MEA system with full automation for electrocatalyst benchmarking and durability analysis.
- Developed a novel electro-analytical methodology to filter and elucidate the reaction kinetics in a modular three-electrode MEA configuration, coupled with ex-situ characterization toolbox.

Undergraduate Student Researcher — Jan. 2020 – Mar. 2022
Department of Chemistry | Institute of Chemical Technology — *Mumbai, India*
Advisor: Dr. Bhalchandra Bhanage

- Developed and appliesad the protic ionic liquid catalyst for solvent-free CO_2 cyclocondensation reactions, yielding >99% conversion of diamine substrates, with products structure and purity verified via GC–MS, ^{1}H and ^{13}C NMR.
- Investigated CeO_2 nanoparticle-mediated CO_2 fixation using methanol substrate, achieving ∼75% product yield.

Process Engineering Intern — May 2021 – Jul. 2021
Department of production & Effluent treatment | Gharda Chemicals Limited — *Dombivli, India*

- Kinetics study and safety analysis for de-bottlenecking the synthesis of cypermethrin in a batch configuration.
- Designed a control logic and process flow model for the Multiple Effect Evaporator (MEE) and Effluent Treatment Plant (ETP), optimizing sequencing and minimizing hazardous waste discharge by a factor of 5.

Publications

- **Shirwalkar, A.**, Kaur, M., Zhong, S., Pupucevski, M., Hu, K., Yan, Y., Lattimer, J., & McKone, J. (2025). Comparing Intrinsic Catalytic Activity and Practical Performance of Ni- and Pt-Based Alkaline Anion Exchange Membrane Water Electrolyzer Cathodes. *ACS Energy Letters*. 10(4), 1779
- Patil, R., Roenigk, S., **Shirwalkar, A.**, Meng, Q., & McKone, J. (2024). Unsupported Pt nanoparticles: Synthesis, Deactivation, and Hydrogen Electrocatalysis in Unpurified Electrolytes. *Journal of Electrochemical Society*. 171, 036509.
- **Shirwalkar, A.**, Sarawate, D., & McKone, J. (2026). Elucidating Internal Mass Transfer in Thin Catalyst Films: Experimental and COMSOL Simulation Approaches. (*manuscript in preparation*)
- **Shirwalkar, A.**, Nandkumaran, N., Leighton, C., & McKone, J. (2026). Investigating the shelf-life stability of Nickel–Molybdenum composites (Ni–Mo/C) through chemical and magnetic signatures. (*manuscript in preparation*)
- **Shirwalkar, A.**, Pupucevski, M., Lattimer, J., & McKone, J. R. (2026). Configuring Half-Cell Flow Systems for Ni–Mo/C Catalysts in Alkaline Hydrogen Evolution: Impact of Impurities and Seawater Feedstocks on Catalytic Performance. *(TBD)*
- **Shirwalkar, A.**, Bender, J. & McKone, J. R. (2026). Trimetallic Ni–Mo–X nanoparticulate composites (X = Cu/Ag) for operationally stable alkaline electrolyzer cathodes. *(TBD)*

Conference Presentations

- **Shirwalkar, A.** & McKone, J. (2026). "Accessing Operational Durability of Ni–Mo Composite Catalysts During Alkaline Hydrogen Evolution." *249th ECS-Electrochemical Society Meeting, Seattle.*
- **Shirwalkar, A.**, Sarawate, D., & McKone, J. (2026). "Elucidating Transport Limitations in Porous Catalyst Films for Alkaline Hydrogen Evolution" *249th ECS-Electrochemical Society Meeting, Seattle.*
- **Shirwalkar, A.**, Sarawate, D., & McKone, J. (2026). "Understanding Transport Phenomena in Porous Alkaline Hydrogen Evolution Electrodes." *249th ECS-Electrochemical Society Meeting, Seattle.*
- **Shirwalkar, A.** & McKone, J. (2025). "Understanding the Impact of Shelf Storage on Ni–Mo Catalysts for Alkaline Hydrogen Evolution." *AIChE Annual Meeting, Boston.*
- **Shirwalkar, A.** & McKone, J. (2025). "Elucidating the Operational Degradation of Ni–Mo Composites Towards Alkaline Hydrogen Evolution." *AIChE Annual Meeting, Boston.*
- **Shirwalkar, A.**, Kaur, M., & McKone, J. (2024). "On the Oxidative Reactivity of Nickel–Molybdenum Composite and Its Effect Towards Hydrogen Evolution." *AIChE Annual Meeting, San Diego.*
- **Shirwalkar, A.**, Kaur, M., Patil, R., Zhong, S., Lattimer, J., & McKone, J. (2024). "Understanding the Degradation Mechanism for Ni–Mo Composite and Effect of Ionomer on the Activity Towards HER." *245th ECS-Electrochemical Society Meeting, San Francisco.*
- **Shirwalkar, A.** & McKone, J. (2025). "Probing Performance and Durability of Ni–Mo/C Cathodes through half-cell Membrane Electrode Assembly." *Pittsburgh–Cleveland Catalysis Society 2025 Annual Symposium, State College.*
- **Shirwalkar, A.**, Kaur, M., Patil, R., Zhong, S., Lattimer, J., & McKone, J. (2024). "Investigating Ni–Mo Catalyst Degradation and Ionomer Interactions in Hydrogen Evolution." *Pittsburgh–Cleveland Catalysis Society 2024 Annual Symposium, Pittsburgh.*
- **Shirwalkar, A.**, Kaur, M., Patil, R., & McKone, J. (2023). "Ni–Mo Composites ascends to the realm of Platinum, uniting in hydrogen evolution and oxidation reactions." *Pittsburgh–Cleveland Catalysis Society 2023 Annual Symposium, State College.*
- **Shirwalkar, A.** & McKone, J. (2025). "Elucidating the Shelf Life and Operation Degradation of Ni–Mo Composite Towards Alkaline Hydrogen Evolution." *Department of Chemical & Petroleum Engineering Spring Research Day, Pittsburgh.*
- **Shirwalkar, A.**, Kaur, M., Patil, R., & McKone, J. (2024). "Elucidating Ni–Mo catalyst degradation and catalyst ionomer interaction toward hydrogen evolution." *Department of Chemical & Petroleum Engineering Spring Research Day, Pittsburgh.*
- Bender, J., **Shirwalkar, A.**, & McKone, J. (2025). "Creating tools to reproducibly and consistently test alkaline

water electrolysis catalysts." *Department of Chemical & Petroleum Engineering Spring Research Day, Pittsburgh.*

- Dossa, M., **Shirwalkar, A.**, & McKone, J. (2024). "Reproducing Ni–Mo/C Composite Synthesis and Showcasing its Potential for Hydrogen Production." *Research Experiences for Undergraduates (REU) program symposium, Pittsburgh.*

Honors and Awards

Catalysis & Reaction Engineering (CRE) Division Best Poster Award | *AIChE Annual Meeting, Boston* Nov. 2025
Best Scientific Animation | Best Scientific Animation | *University of Pittsburgh* Apr. 2025
Best Research Poster Presentation | *University of Pittsburgh* Apr. 2025
Best Scientific Journal Art | *University of Pittsburgh* Apr. 2024
Government of India undergraduate scholarship | *ICT, India* 2018 – 2022
Government of India post-matriculate scholarship | *Smt. CHM College, India* Mar. 2018
Student of the Year | *RGS English High School, India* Mar. 2016
Karate Black Belt and National Gold Medalist | *MH, India* Mar. 2012

Teaching and Mentorship Roles

Teaching Assistant, *Department of Chemical & Petroleum Engineering* | *University of Pittsburgh*
System Engineering & Controls (CHE0500) Fall 2025
Chemical Engineering Thermodynamics (CHE0200) Spr. 2024, 2025

Undergraduate Research Mentor, *Department of Chemical & Petroleum Engineering* | *University of Pittsburgh*
Actively mentoring 2 undergraduate students and collectively mentored 4 undergraduates.

Activities

Design EXPO Judge, *Swanson School of Engineering* Dec. 2025
Graduate Qualifying Exam Judge, *Departmental Service* 2024 – 2025
Undergraduate Research Poster Judge, *Departmental Research Day* 2024 – 2025
McKone Lab Scheduling Liaison, *University of Pittsburgh* 2023 – 2025
Outreach Activity Volunteer, *University of Pittsburgh* Jun. 2024
Head of Photography, *TEDx ICT Mumbai* May 2021
Overall Event Organizer, *Manthan ICT Mumbai* Jun. 2021