McLain Evan Leonard — Curriculum Vitae

Contact Information

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MIT
77 Massachusetts Avenue
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Cambridge, MA 02139 USA

Education & Credentials

Massachusetts Institute of Technology (Dual Ph.D./M.S.CEP Program)

Ph.D., Chemical Engineering — Expected Graduation: 2020

- Thesis Title: *Engineering porous electrodes for CO_2 upgrading*
- Advisor: Professor Fikile R. Brushett
- Current GPA: 4.6/5.0
- Minor: Electrochemistry

M.S.CEP, David H. Koch School of Chemical Engineering Practice — June 2017

- Station 1: MedImmune
- Station 2: Woodside Energy

Montana State University

B.S., Chemical Engineering — May 2015

- GPA: 3.99/4.00
- Minor: Economics
- Honors Baccalaureate with Distinction
- Magna Cum Laude
- Electrochemical Society Student Chapter President

Engineering Experience

Doctoral Candidate — January 2016 to Present
Brushett Research Group, Massachusetts Institute of Technology

Engineering Gas Diffusion Electrodes for CO_2 Reduction Reactors

- Constructed a gas-fed, flowing liquid electrolyte reactor platform with a modular design
- Functionalized gas diffusion electrodes with metal electrocatalysts via spray-deposition methods
- Developed and evaluated a protocol to track both electrode gas-liquid interfacial stability and reduction product compositions in long-duration electrolysis studies
- Designed and utilized a capillary pressure screening platform to measure macroscopic flow properties of porous materials
- Identified gas-liquid interfacial control as a dominant predictor of CO_2 reduction performance in gas-fed reactors
- Investigated the fundamental wettability of porous material models with aqueous and organic liquid electrolyte mixtures towards applying flooding-resistant modifications to gas diffusion electrodes

Technoeconomic Analysis to Identify Market-viable CO_2 Reduction Products

- Used thermodynamics-based approach to determine minimum power inputs for carbon products
- Performed sensitivity analyses with commodity materials and electricity prices to find feasible reactor voltage ranges
- Identified carbon monoxide and formic acid as potential market viable products

Laboratory Manual Editor

- Initiated and coordinated the 2020 revision of the Brushett Group Lab Manual
- Delegated revision responsibilities among group members
- Authored new standard operating procedures (SOPs) for the Energy Conversion Subgroup
- Typeset the Laboratory Manual with Adobe InDesign®

Laboratory Data Manager

- Organized and managed the group's data with a Dropbox file system
- Improved data collection from laboratory sensors with Python-based data recording routines

Graduate Consultant January 2017 to May 2017

Woodside Energy, Inc.

Pluto Feed Composition Modeling - Project Lead

- Developed a model to predict subsea natural gas well compositions for a network of offshore sites using onshore measurements from the Pluto LNG plant
- Validated operator heuristics composition lag times with model predictions for offshore-to-onshore composition changes

Assessing Train Efficiency During Offshore Constrained Production at KGP

- Evaluated LNG train efficiencies at the Karratha Gas Plant (KGP) to inform future plant operation and turndown strategies in resource-constrained scenarios
- Recommended using individual compressor efficiencies as descriptors for overall train efficiency

MedImmune, LLC

Developing Automation to Enable a Self-Regulating Continuous Purification Process

- Developed an automated control system for continuous purification of biologic drug products using a simple, low-cost Arduino platform
- Enabled future functionality upgrades by a second group of MIT Graduate Consultants in 2018

Evaluating an in vitro Tool to Predict Bioavailability of Protein Therapeutics Upon Subcutaneous Injection

- Evaluated the feasibility of deploying a commercial in vitro screening platform for comparing the release rates of various subcutaneously-injected drug formulations
- Identified a low-cost, in-house alternative to the commercial solution

Undergraduate Research Assistant January 2012 to May 2015

High-Temperature Materials Laboratory, Montana State University

Developing MAX-phase coatings for hot corrosion mitigation

- Advisor: Professor Roberta Amendola
- Fabricated thin-film MAX-phase coatings using magnetron sputtering physical vapor deposition
- Pursued Cr-Al-C thin-films for mitigating Type II hot corrosion in jet turbine combustion zones

High-temperature corrosion of electroless nickel-plated ferritic stainless steel for SOFC components

- Advisor: Professor Paul E. Gannon
- Investigated high-temperature corrosion of metallic interconnect components for solid oxide fuel cells (SOFC) under a dual hydrogen-oxygen environment in the absence of electrical current
- Concluded from SEM, EDS, and XRD of sample cross-sections that electroless nickel coatings did not protect the 441SS alloy from corrosion over 100 hour experiments at 800°C

Process Engineering Intern May 2014 to August 2014

IM Flash, LLC

- Implemented a process quality enhancement project in the Physical Vapor Deposition group
- Used Fab production data to improve the group's engineering processes
- Designed production defect reduction experiments to improve NAND wafer yield

Intern Engineer May 2013 to August 2013

The Boeing Company

- Worked with the Boeing Research Technology 787 Wing & Propulsion Support group
- Optimized the application methods of critical aircraft sealants and surface finishes
- Designed protocols to evaluate methods by duration, feasibility, and material usage

Teaching & Mentoring Experience

Station Director - SGCE, Pasadena, TX, USA February 2019 to March 2019
David H. Koch School of Chemical Engineering Practice

- Facilitated collaboration between the host company (SGCE) and MIT
- Advised and mentored MSCEP students during consulting projects
- Evaluated students' performances and assigned course grades

Teaching Assistant - Analysis of Transport Phenomena August 2017 - December 2017
Massachusetts Institute of Technology (2018 EdX Course)

- Developed supplementary lectures and problems with solutions to enhance the course
- Held weekly 2 hour recitation section to expand beyond material covered during lecture
- Held weekly office hours to help students working through homework specific problems
- Assisted with editing and grading of exams

Research Advisor and Mentor January 2017 to Present
Massachusetts Institute of Technology

- Train and supervise undergraduate students in laboratory research activities
- Nicholas Aiello (MITEI-UROP), *Wettability of Gas Diffusion Electrodes* Summer 2019
- David Silverstein (UROP), *MEAs for CO_2 electrolyzers* Fall 2018
- Geneva Casalegno (UROP), *TEMPO-mediated alcohol oxidation* Spring 2018

Leadership

Representative June 2017 - Present
Graduate Student Advisory Board, MIT Department of Chemical Engineering

President May 2014 - May 2015
Electrochemical Society, Montana State University

Treasurer May 2013 - May 2014
Electrochemical Society, Montana State University

Secretary May 2012 - May 2013
American Institute of Chemical Engineers, Montana State University

ChemE Car Competition Chair - Pacific Northwest Student Regional Conference April 2013
American Institute of Chemical Engineers, Montana State University

Research Awards

- ECS Summer Fellowship 2020
- IEEE Division Student Travel Award, 235th ECS Meeting, Dallas, TX, USA May 2019
- National Science Foundation Graduate Research Fellowship - Finalist 2015
- Goldwater Scholarship 2014

Academic Awards

- Jefferson W. Tester Award, David H. Koch School of Engineering Practice October 2017
- ExxonMobil-MIT Energy Initiative Energy Fellowship September 2015
- Most Outstanding Chemical Engineering Graduate, Montana State University May 2015
- Balanced Leader Scholarship, Sigma Phi Epsilon, Montana State University January 2012

Languages

English — Native Proficiency
Spanish — Limited Working Proficiency

Skills & Courses

Engineering & Economics
Kinetics, Thermodynamics, Transport Phenomena, Numerical Methods, Systems Engineering, Electrochemistry, Electrical Engineering, Microeconomics, Macroeconomics, Development Economics, International Economics

Computational
MATLAB, Solidworks, Python

Systems
Electrolyzers, HPLC, GC, Arduino

Materials Characterization
SEM, EDS, UV/vis, XRD, XPS

Machining & Fabrication
Catalyst spray-deposition, Membrane-electrode-assembly hot pressing, CNC milling, Laser cutting, Waterjet cutting

Professional Memberships

The Electrochemical Society

Academic Memberships

- Society of Energy Fellows
- Goldwater Scholars

Publications

1. M. E. Leonard; M. J. Orella; N. Aiello; Y. Román-Leshkov; A. Forner-Cuenca; F. R. Brushett, "Flooded by Success: On the role of wettability in CO_2 electrolyzers that generate liquid products", *Journal of The Electrochemical Society*, (In Review).
2. M. J. Orella; M. E. Leonard; Y. Román-Leshkov; F. R. Brushett, "Automated Analysis of Contact Angle Goniometry Data Using DropPy", *Software X*, (In Review).
3. M. J. Orella; S. M. Brown; M. E. Leonard; Y. Román-Leshkov; F. R. Brushett, "A General Techno-Economic Model for Evaluating Emerging Electrolytic Processes", *Energy Technology*, 2019, 1–12.
4. M. E. Leonard; L. E. Clarke; A. Forner-Cuenca; S. M. Brown; F. R. Brushett, "Investigating Electrode Flooding in a Flowing Electrolyte, Gas-Fed Carbon Dioxide Electrolyzer", *ChemSusChem*, 2020, 13(2), 400–411.
5. S. Sen; S. M. Brown; M. Leonard; F. R. Brushett, "Electroreduction of carbon dioxide to formate at high current densities using tin and tin oxide gas diffusion electrodes", *Journal of Applied Electrochemistry*, 2019, 49(9), 917-928.
6. S. Sen; M. Leonard; R. Radhakrishnan; S. Snyder; B. Skinn; D. Wang; T. Hall; E. J. Taylor; F. R. Brushett, "Pulse Plating of Copper onto Gas Diffusion Layers for the Electroreduction of Carbon Dioxide", *MRS Advances*, 2018, 3(23), 1277–1284.
7. S. Sen; B. Skinn; R. Radhakrishnan; M. Leonard; F. R. Brushett, "Investigation of Pulse-Reverse Electrodeposited Copper Electrocatalysts for Carbon Dioxide Reduction to Ethylene", *ECS Transactions*, 2017, 77(11), 933–946.
8. L. Aw; R. Amendola; P. E. Gannon; M. Leonard, "Type II Hot Corrosion Behaviors of Cr, Al, C Binary and Ternary Thin Film Coatings on Ni-201", *ECS Transactions*, 2015, 64(26), 149–159.
9. M. E. Leonard; R. Amendola; P. E. Gannon; W.-J. Shong; C.-K. Liu, "High-Temperature (800 °C) Dual Atmosphere Corrosion of Electroless Nickel-Plated Ferritic Stainless Steel", *International Journal of Hydrogen Energy*, 2014, 39(28), 15746–15753.

Presentations

1. M. E. Leonard; N. Aiello; L. E. Clarke; M. J. Orella; F. R. Brushett, "Wettability of Gas Diffusion Electrode Materials for CO_2 Reduction", *Oral Presentation*, 236th Meeting of the Electrochemical Society, Atlanta, GA, USA, 2019.
2. M. E. Leonard; L. E. Clarke; A. Forner-Cuenca; S. M. Brown; F. R. Brushett, "Towards Understanding GDE Flooding in a Flowing Electrolyte CO_2 Reactor", *Oral Presentation*, 235th Meeting of the Electrochemical Society, Dallas, TX, USA, 2019.
3. M. E. Leonard "Engineering Porous Electrode for CO_2 Upgrading", *Oral Presentation*, Doctoral Student Seminar, MIT Department of Chemical Engineering, Cambridge, MA, USA, 2018.
4. B. Skinn; S. Sen; M. Leonard; R. Radhakrishnan; D. Wang; A. Forner-Cuenca; T. D. Hall; S. Snyder; F. R. Brushett; E. J. Taylor, "Pulsed Electrodeposition of Gas-Diffusion Electrocatalysts for CO_2 Reduction", *Oral Presentation*, 234th Meeting of The Electrochemical Society, Cancun, Mexico, 2018.
5. R. Radhakrishnan; B. Skinn; S. Sen; M. Leonard; T. D. Hall; S. Snyder; F. R. Brushett; E. J. Taylor, "Pulsed Electrodeposition of Gas Diffusion Electrocatalysts for CO_2 Reduction to Value-Added Products", *Oral Presentation*, 233rd Meeting of The Electrochemical Society, Seattle, WA, USA, 2018.
6. M. Leonard "Synthesis of Cr_2AlC MAX-Phase Protective Coating on Ni-201 Substrate via Magnetron Sputtering", *Poster Presentation*, Montana Space Grant Consortium Research Symposium, Montana State University, Bozeman, MT, USA, 2014.

7. M. Leonard "Performance of Electroless Nickel Plating on 441 Stainless Steel for SOFC Interconnect Applications", *Poster Presentation*, National Conference on Undergraduate Research, University of Wisconsin - La Crosse, La Crosse, WI, USA 2013.