Exponent®
Engineering & Scientific Consulting

Kyle Diederichsen, Ph.D.

Senior Engineer | Polymers & Chemistry
Seattle
+1-206-676-6917 | kdiederichsen@exponent.com

Professional Profile

Dr. Diederichsen specializes in the application of fundamental chemical engineering principals to understand the performance and failure of complex materials systems. With his background in polymer synthesis and characterization, chemical species transport, separations processes, battery technology, electrochemistry, and data analysis, he supports clients in a wide range of industries including building materials, construction, automotive, oil and gas, and consumer electronics.

Dr. Diederichsen has led and participated in investigations stemming from major litigation involving the analysis of plastic plumbing failures, chemical contamination, and industrial chemical processing. He has also assisted clients in proactive materials design and selection, and intellectual property evaluation.

Dr. Diederichsen is experienced with a range of characterization techniques to probe chemical, physical and thermal properties of polymeric and ion-containing materials, including thermogravimetric analysis (TGA), dynamic scanning calorimetry (DSC), gel permeation chromatography (GPC), nuclear magnetic resonance (NMR), Fourier Transform Infrared Spectroscopy (FTIR), electrochemical impedance spectroscopy (EIS), and scanning electron microscopy (SEM). He has built custom test systems for polymer characterization, flow electrochemistry, and gas absorption that combine fundamental understanding with engineering principles to illustrate solutions to multi-scale challenges and leveraged experience in Python and data science to automate and speed analysis.

Prior to joining Exponent, Dr. Diederichsen was a Postdoctoral Fellow at MIT where he worked with electrochemical carbon capture in continuous systems incorporating hollow fiber membranes, combining experience in flow electrochemistry and membrane contactor technology. His projects included finite element modeling and nondimensional analysis of separations systems. For his doctoral work, Dr. Diederichsen attended the University of California, Berkeley, focusing on the design and characterization of high transference number polymer – based electrolytes for lithium batteries including both solid polysulfone materials and polyelectrolyte solutions. His research interests have also included the self-assembly of block copolymer thin films for lithography.

Academic Credentials & Professional Honors

Ph.D., Chemical Engineering, University of California, Berkeley, 2019

B.S., Chemical Engineering, University of Colorado, Boulder, 2014

Intelligence Community Postdoctoral Fellowship at MIT, 2020 – 2022

Certificate in Data Science, University of Washington, 2024

MIT Infinite Mile Award, 2022

Marilyn and Howard L. Anseth Outstanding Undergraduate Research Award, 2014

Licenses and Certifications

Professional Engineer Chemical, California, #7176

Prior Experience

Postdoctoral Fellow, Massachusetts Institute of Technology (MIT), 2019-2022

Summer Internship, Bend Research (Oregon), 2013

Undergraduate Research Fellowship, National Institute of Standards and Technology, 2012-2013

Professional Affiliations

American Chemical Society (ACS)

Society of Polymer Engineering (SPE)

Electrochemical Society (ECS)

Publications

Massen-Hane, M.M.; Diederichsen, K. M.; Hatton, T. A. Engineering redox-active electrochemically mediated carbon dioxide capture systems. Nature Chemical Engineering. 2024, 11, 35-44

Diederichsen, K. M.; DeWitt, S. J.; Hatton, T. A. Electrochemically Facilitated Transport of CO2 between Gas Diffusion Electrodes in Flat and Hollow Fiber Geometries. ACS ES&T Engineering. 2023, 3, 7, 1001–1012

Diederichsen, K. M.; Hatton, T. A. Nondimensional Analysis of a Hollow Fiber Membrane Contactor for Direct Air Capture. Ind. Eng. Chem. Res. 2022, 61, 11964–11976.

Diederichsen, K. M.*; Sharifian, R.*; Kang, J. S.; Liu, Y.; Kim, S.; Gallant, B. M.; Vermaas, D.; Hatton, T. A. Electrochemical Methods for Carbon Dioxide Separations. Nat. Rev. Methods Prim. 2022, 2, 68.

Simeon, F.; Stern, M. C.; Diederichsen, K. M.; Liu, Y.; Herzog, H. J.; Hatton, T. A. Electrochemical and Molecular Assessment of Quinones as CO2-Binding Redox Molecules for Carbon Capture. J. Phys. Chem. C 2022, 126, 1389-1399.

Diederichsen, K. M.*; Liu, Y.*; Ozbek, N.; Seo, Hyowon; Hatton, T. A. Towards Solvent-Free Continuous-Flow Electrochemically Mediated Carbon Capture with High Concentration Liquid Quinone Chemistry. Joule 2022, 6, 221-239. *Equal contribution.

Rahimi, M.; Diederichsen, K. M.; Ozbek, N.; Wang, M.; Choi, W.; Hatton, T. A. An Electrochemically Mediated Amine Regeneration Process with a Mixed Absorbent for Postcombustion CO2 Capture. Environ. Sci. Technol. 2020, 54, 8999–9007.

Liu, Y.; Ye, H.; Diederichsen, K. M.; Van Voorhis, T.; Hatton, T. A. Electrochemically Mediated Carbon Dioxide Separation with Quinone Chemistry in Salt-Concentrated Aqueous Media. Nat. Commun. 2020, 11, 2278.

Kim, H. W.; Bukas, V. J.; Park, H.; Park, S. J.; Diederichsen, K. M.; Lim, J.; Cho, Y. H.; Yoon, H. W.; Kim,

W.; Han, H.; et al. Mechanisms of Two-Electron and Four-Electron Electrochemical Oxygen Reduction Reactions at Nitrogen-Doped Reduced Graphene Oxide. ACS Catal. 2020, 10, 852–863.

Diederichsen, K. M.; Terrell, R. C.; McCloskey, B. D. Counterion Transport and Transference Number in Aqueous and Nonaqueous Short-Chain Polyelectrolyte Solutions. J. Phys. Chem. B 2019, 123, 10858–10867.

Diederichsen, K. M.; McCloskey, B. D. Electrolyte Additives to Enable Nonaqueous Polyelectrolyte Solutions for Lithium Ion Batteries. Mol. Syst. Des. Eng. 2020, 5 (1), 91–96.

Fong, K. D.; Self, J.; Diederichsen, K. M.; Wood, B. M.; McCloskey, B. D.; Persson, K. A. Ion Transport and the True Transference Number in Nonaqueous Polyelectrolyte Solutions for Lithium Ion Batteries. ACS Cent. Sci. 2019, 5, 1250–1260.

Hsu, C. H.; Ma, C.; Bui, N.; Song, Z.; Wilson, A. D.; Kostecki, R.; Diederichsen, K. M.; McCloskey, B. D.; Urban, J. J. Enhanced Forward Osmosis Desalination with a Hybrid Ionic Liquid/Hydrogel Thermo-responsive Draw Agent System. ACS Omega 2019, 4, 4296-4303.

Diederichsen, K. M.; Fong, K. D.; Terrell, R. C.; Persson, K. A.; McCloskey, B. D. Investigation of Solvent Type and Salt Addition in High Transference Number Nonaqueous Polyelectrolyte Solutions for Lithium-Ion Batteries. Macromolecules 2018, 51, 8761-8771.

Liyana-Arachchi, T. P.; Haskins, J. B.; Burke, C. M.; Diederichsen, K. M.; McCloskey, B. D.; Lawson, J. W. Polarizable Molecular Dynamics and Experiments of 1,2-Dimethoxyethane Electrolytes with Lithium and Sodium Salts: Structure and Transport Properties. J. Phys. Chem. B 2018, 122, 8548–8559.

Kim, H. W.; Yoon, J. H.; Diederichsen, K. M.; Shin, J. E.; Yoo, B. M.; McCloskey, B. D.; Park, H. B. Exceptionally Reinforced Polymer Nanocomposites via Incorporated Surface Porosity on Graphene Oxide Sheets. Macromol. Mater. Eng. 2017, 302, 1700039.

Diederichsen, K. M.; McShane, E. J.; McCloskey, B. D. Promising Routes to a High Li + Transference Number Electrolyte for Lithium Ion Batteries. ACS Energy Lett. 2017, 2, 2563–2575.

Diederichsen, K. M.; Buss, H. G.; McCloskey, B. D. The Compensation Effect in the Vogel–Tammann–Fulcher (VTF) Equation for Polymer-Based Electrolytes. Macromolecules 2017, 50, 3831–3840.

Diederichsen, K. M.; Brow, R. R.; Stoykovich, M. P. Percolating Transport and the Conductive Scaling Relationship in Lamellar Block Copolymers under Confinement. ACS Nano 2015, 9, 2465–2476.

Miller, D. L.; Keller, M. W.; Shaw, J. M.; Rice, K. P.; Keller, R. R.; Diederichsen, K. M. Giant Secondary Grain Growth in Cu Films on Sapphire. AIP Adv. 2013, 3, 082105.

Presentations

“Continuous systems driven by electrochemistry to capture CO2 from dilute streams.” Intelligence Community Annual Research Symposium, 2022. Virtual

“Redox-Active Liquid Sorbent for Electrochemically Mediated Carbon Capture.” ACS Annual Meeting, 2022. Virtual.

“Understanding Multiscale Transport Challenges in Electrochemically Mediated Carbon Capture.” Intelligence Community Annual Research Symposium, 2021. Virtual.

“Influence of Backbone Solvation on Polyelectrolyte Solution Transport Properties.” AIChE. November 11, 2019. Orlando, FL.

“High Transference Number Polymer – Based Electrolytes.” Departmental Colloquium. December 5, 2018. Berkeley, CA.

“Investigation of Solvent Composition and Salt Addition in High Transference Number Nonaqueous Polyelectrolyte Solutions.” Invited Talk. Excellence in Graduate Polymer Research Section at AIChE. October 30, 2018. Pittsburgh, PA.

“Investigation of Solvent Type and Salt Addition in High Transference Number Nonaqueous Polyelectrolyte Solutions.” Poster. Polymer Physics Gordon Research Conference. July 2018. Mt. Holyoke, MA.

“Breaking the Compensation Effect within the Vogel-Tammann-Fulcher Equation for Polymer-Based Electrolytes.” AIChE. November 1, 2017. Minneapolis, MN

“Charged Polysulfone Based Polymer Electrolytes for Lithium-Ion Batteries.” Poster. AIChE. November 14, 2016. San Francisco, CA.

Peer Reviews

J. Phys. Chem. Lett.

Batteries

Energies

Soft Materials

ChemEngineering

Applied Sciences

Coatings

Membranes