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Engineering & Scientific Consulting

Michael Orella, Ph.D.

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Professional Profile

Dr. Orella is a Manager in Exponent's Thermal Science Practice with a background in electrochemical systems and electrocatalysis. He consults primarily in the areas of chemical engineering, heat and mass transfer analysis, battery failure investigation and battery fires, fire and explosion investigations at residential, commercial, and industrial facilities, and chemical industry process safety.

During his time at Exponent, Dr. Orella has supported clients in the legal, insurance, automotive, and consumer electronics industries across a range of matters. He focuses on using fundamental principles of thermal sciences to solve complex multidisciplinary problems in applications including vehicle fires and explosions, chemical industry process safety, battery fires, battery thermal management and control systems, consumer product safety and burn injury risk, and release of flammable and/or toxic gases. In these contexts, he routinely evaluates the applicability of current and historical regulations to products or facilities of interest.

Dr. Orella has supported clients in international arbitrations concerning the design, engineering, construction, and commissioning of chemical plants. In such matters, he leverages his understanding of chemical engineering, thermodynamics, and heat and mass transfer, to work with clients to evaluate relevant process designs and historical process data.

He has also performed abuse testing and characterization of commercial and novel batteries, dust hazard analyses, and testing and characterization of explosible dusts. He has used fundamental image feature recognition techniques to analyze the plumes present during chemical releases. He specializes in the rigorous computational and experimental analysis of complex chemical-engineering systems with a focus on process safety and efficiency. Previously, Dr. Orella has worked deeply with electrolyzers to generate renewable biofuels and green chemicals from reaction systems involving lignin and other biomass-based compounds.

During his Ph.D. work in the department of Chemical Engineering at MIT, Dr. Orella developed numerical models to support research in multiple sustainable fuel and energy technologies. First, he utilized concepts from stochastic chemical kinetics to implement a Gillespie-based kinetic Monte Carlo analysis of lignin biosynthesis. Next, he worked to automate image analysis for surface characterization techniques in electrocatalytic devices so that high-throughput analysis of potential electrode materials could readily be classified. Dr. Orella then implemented statistical inference techniques to investigate the electrochemical kinetics present in carbon dioxide reduction processing. Dr. Orella has also developed and executed methods for techno-economic analysis of industrial electrochemical processes.

Academic Credentials & Professional Honors

Ph.D., Chemical Engineering, Massachusetts Institute of Technology (MIT), 2020

M.S., Chemical Engineering Practice, Massachusetts Institute of Technology (MIT), 2016

B.Ch.E., Chemical Engineering, University of Delaware, 2014

Licenses and Certifications

Blasting Certificate of Competency (MA)

Professional Affiliations

American Institute of Chemical Engineers-AIChE (Member)

American Chemical Society-ACS (Member)

Electrochemical Society-ECS (Member)

Publications

Orella MJ, Leonard ME, Román-Leshkov Y, Brushett FR. High-throughput Analysis of Contact Angle Goniometry Data using DropPy. SoftwareX 2021; 14: 100665.

Gao W, Orella MJ, Carney TJ, Román-Leshkov Y, Brushett FR. Understanding the Impact of Convective Transport on Intercalation Batteries through Dimensional Analysis. Journal of the Electrochemical Society 2020; 167: 140551.

Orella MJ, Brown SM, Leonard ME, Román-Leshkov Y, Brushett FR. A General Techno-Economic Model for Evaluating Emerging Electrolytic Processes. Energy Technology 2019; doi:10.1002/ente.201900994.

Orella MJ, Gani TZH, Vermaas JV, Stone ML, Anderson EM, Beckham GT, Brushett FR, Román-Leshkov Y. Lignin-KMC: A Toolkit for Simulating Lignin Biosynthesis. ACS Sustainable Chemistry & Engineering 2019; 7:18313-18322.

Gani TZH, Orella MJ, Anderson EM, Stone ML, Brushett FR, Beckham GT, Román-Leshkov Y. Computational Evidence for Kinetically Controlled Radical Coupling During Lignification. ACS Sustainable Chemistry & Engineering 2019; 7: 13270-13277.

Orella MJ, Román-Leshkov Y, Brushett FR. Emerging Opportunities for Electrochemical Processing to Enable Sustainable Chemical Manufacturing. Current Opinion in Chemical Engineering 2018; 20: 159-167.

Tsilomelekis G, Orella MJ, Lin Z, Cheng Z, Zheng W, Nikolakis V, Vlachos DG. Molecular Structure, Morphology and Growth Mechanisms and Rates of 5-Hydroxymethyl Furfural (HMF) Derived Humins. Green Chemistry 2016; 18: 1983-1993.

Presentations

Orella MJ, Wechsung A, Stern M, Kytomaa HK. An Electrofuel Revolution: How Direct Carbon Reduction can Electrify the Future. AIChE Annual Meeting, Boston, MA, 2021.

Orella MJ, Román-Leshkov Y, Brushett FR. Assessing the Feasibility of Conceptual Electrocatalytic Processes through Inverse Techno-Economic Modeling. AIChE Annual Meeting, Orlando, FL, 2019.

Orella MJ, Román-Leshkov Y, Brushett FR. Cost-Constrained Design of Electrochemical Hydrogenation Processes. 236th Electrochemical Society National Meeting, Atlanta, GA, 2019.

Orella MJ, Gani TZH, Vermaas JV, Stone ML, Anderson EM, Brushett FR, Román-Leshkov Y. Lignin-KMC: A Simulation of in planta Lignification. Poster presentation, Center for Bioenergy Innovation Annual Meeting, Asheville, NC, 2019.

Orella MJ, Gani TZH, Stone ML, Anderson EM, Brushett FR, Román-Leshkov Y. Lignin-KMC: An Open-Source Platform for Simulating Lignification. ACS Spring National Meeting, Orlando, FL, 2019.

Orella MJ, Brown SM, Román-Leshkov Y, Brushett FR. Evaluating the Economic Feasibility of Valorizing Lignocellulosic Biomass through Electrochemical Hydrogenation, AIChE Annual Meeting, Pittsburgh, PA, 2018.

Orella MJ, Gani TZH, Anderson EM, Stone ML, Brushett FR, Román-Leshkov Y. Developing Platforms for Understanding Lignin Polymerization and Fractionation. Poster presentation, Lignin Gordon Research Conference, Easton, MA, 2018.

Orella MJ, Brown SM, Román-Leshkov Y, Brushett FR. Towards a Generalized Framework for Quantifying the Economic Viability of Electrocatalytic Hydrogenation. Industrial and Engineering Chemistry Division Graduate Symposium in the ACS Fall National Meeting, Boston, MA, 2018.

Orella MJ, Brown SM, Román-Leshkov Y, Brushett FR. Understanding the Economic Feasibility of Valorizing Lignocellulosic Biomass Through Electrochemical Hydrogenation. 232nd Electrochemical Society National Meeting, National Harbor, MD, 2017.

Peer Reviews

ChemSusChem