

ERIC M. DAVIS

Assistant Professor
Department of Chemical and Biomolecular Engineering
Clemson University
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Education

PhD, Drexel University, 2013, Chemical Engineering
BS, Clemson University, 2008, Chemical Engineering

Professional Experience

Assistant Professor, Department of Chemical & Biomolecular Engineering, Clemson University, 2015–present
NRC Postdoctoral Fellow, Functional Polymers Group, NIST, 2013–2015

Honors and Awards

NSF CAREER Award, Polymers Program, 2019
NRC Postdoctoral Fellowship, National Research Council, 2013–2015
Nobel Laureates Meeting Award, Council for the Lindau Nobel Laureate Meeting, 2012
George Hill, Jr. Fellowship, Drexel University, 2012
NSF/FDA Scholar in Residence, National Science Foundation, 2011
Excellence in Polymer Graduate Research Award, American Chemical Society, 2011
Università di Bologna Research Fellow, National Science Foundation, 2010
FDA/ORISE Biomedical Devices Fellowship, Food and Drug Administration, 2009
William A. Casey Memorial Scholarship, Drexel University, 2008
Dean's Fellowship, Drexel University, 2008

Research Interests

Polymer Membranes (Ionomers, Green Hydrogels), Transport Phenomena, Polymer Thermodynamics, Poromechanics

Current Research Funding

1. “Uncovering Fundamental Transport Principles in Novel, Ultraclean Lignin-Based Hydrogels for Bioseparations”, NSF CBET, Molecular Separations, \$465,746 (PI, 67%, \$312,050), August 2019–June 2022.
2. “Elucidating Fundamental Structure-Property Relationships in Ionomer Nanocomposites for Redox Flow Batteries”, NSF CAREER, NSF DMR, Polymers, \$566,359 (PI, 100%), July 2019–June 2024.
3. “Supporting Involvement of Underrepresented Minorities and Women in Research Related to Stimuli-Responsive Polymers”, SC EPSCoR/IDeA, \$10,000 (PI, 100%), May 2019–April 2020.
4. “Improving Graduate Student Diversity in Chemical Engineering at Clemson University via Recruiting and Retention”, SC EPSCoR/IDeA, \$10,000 (PI, 100%), July 2018–June 2019.

PUBLICATIONS (>420 citations, *h-index* = 12; *Google Scholar*)

Publications (*Peer-Reviewed, Archival Manuscripts*)

1. Balwani, A.; Davis, E.M. Anomalous, Multi-Stage Liquid Water Diffusion and Swelling Kinetics in Nafion Nanocomposites. *ACS Applied Polymer Materials* (*under review*). **Invited Contribution, Special Issue on Young Investigators in Applied Polymers Research.**

2. Domhoff, A.; Balwani, A.; Martin, T.B.; Davis, E.M. Leveraging Nanoparticle Dispersion State to Tune Vanadium Ion Selectivity of Nanophase-Segregated Ionomer Nanocomposites for Redox Flow Batteries. *ACS Applied Energy Materials* (under review)
3. Balwani, A.; Faraone, A.; Davis, E.M. Impact of Nanoparticles on the Swelling and Chain Dynamics of Ionomer Nanocomposites. *Macromolecules* **2019**, *52*, 2120-2130.
4. Singh, M.; Haring, A.; Tong, Y.; Cesewski, E.; Ball, E.; Jasper, R.; Davis, E.; Johnson, B. Additive Manufacturing of Mechanically Isotropic Thin Films and Membranes via Microextrusion 3D Printing of Polymer Solutions. *ACS Applied Materials & Interfaces* **2019**, *11*, 6652-6661.
5. Jansto, A.; Davis, E.M. Role of Surface Chemistry on Nanoparticle Dispersion and Vanadium Ion Crossover in Nafion Nanocomposites Membranes *ACS Applied Materials & Interfaces* **2018**, *10*, 36385-36397.
6. Xiang, F.; Parviz, D.; Givens, T.M.; Tzeng, P.; Davis, E.M.; Stafford, C.M.; Green, M.J.; Grunlan, J.C. Transparent Multilayer Thin Films Prepared Through Hydrogen-Bonding Layer-by-Layer Assembly of Graphene and Polymer. *Advanced Functional Materials* **2016**, *26*, 2143-2149.
7. Nykaza, J.R.; Ye, Y.; Nelson, R.L.; Jackson, A.C.; Beyer, F.L.; Davis, E.M.; Page, K.A.; Sharick, S.; Winey, K.I.; Elabd, Y.A. Polymerized Ionic Liquid Diblock Copolymers: Impact of Water/Ion Clustering on Ion Conductivity. *Soft Matter* **2016**, *12*, 1133-1144.

Prior to Clemson

8. Davis, E.M.; Kim, J.; Oleshko, V.P.; Page, K.A.; Soles, C.L. Uncovering the Structure of Nafion-SiO₂ Hybrid Ionomer Membranes for Prospective Large-Scale Energy Storage Devices. *Advanced Functional Materials* **2015**, *25*, 4064-4075.
9. Nadermann, N.K.; Davis, E.M.; Page, K.A.; Stafford, C.M.; Chan, E.P. Using Indentation to Quantify Transport Properties of Nanophase-Segregated Polymer Thin Films. *Advanced Materials* **2015**, *27*, 4924-4930.
10. Davis, E.M.; Stafford, C.M.; Page, K.A. Elucidating Water Transport Mechanisms in Nafion Thin Films. *ACS Macro Letters* **2014**, *3*, 1029-1035.
11. Forrey, C.; Saylor, D.M.; Silverstein, J.S.; Douglas, J.F.; Davis, E.M.; Elabd, Y.A. Prediction and Validation of Diffusion Coefficients in a Model Drug Delivery System Using Microsecond Atomistic Molecular Dynamics Simulation and Vapor Sorption Analysis. *Soft Matter* **2014**, *10*, 7480-7494.
12. Davis, E.M.; Elabd, Y.A. Water Clustering in Glassy Polymers. *The Journal of Physical Chemistry B* **2013**, *117*, 10629-10640.
13. Davis, E.M.; Elabd, Y.A. Prediction of Water Solubility in Glassy Polymers Using Nonequilibrium Thermodynamics. *Industrial & Engineering Chemistry Research* **2013**, *52*, 12865-12875.
14. Davis, E.M.; Minelli, M.; Giacinti Baschetti, M.; Elabd, Y.A. Non-Fickian Diffusion of Water in Polylactide. *Industrial & Engineering Chemistry Research* **2013**, *52*, 8664-8673. **Invited Contribution, Professor Giulio Sarti Festschrift**
15. Ye, Y.; Wang, S.; Davis, E.M.; Winey, K.I.; Elabd, Y.A. Highly Hydroxide Conductive Polymerized Ionic Liquid Block Copolymers. *ACS Macro Letters* **2013**, *2*, 575-580.

16. Davis, E.M.; Minelli, M.; Giacinti Baschetti, M.; Sarti, G.C.; Elabd, Y.A. Nonequilibrium Sorption of Water in Polylactide. *Macromolecules* **2012**, 45, 7486-7494.
17. Davis, E.M.; Winey, K.I.; Regnault, W.F.; Benetatos, N.M.; Elabd, Y.A. Influence of Thermal History on Structure and Water Transport in Parylene C Coatings. *Polymer* **2011**, 52, 5378-5386.
18. Davis, E.M.; Theyo, G.; Hillmyer, M.A.; Cairncross, R.A.; Elabd, Y.A. Liquid Water Transport in Polylactide Homo and Graft Copolymers. *ACS Applied Materials & Interfaces* **2011**, 3, 3997-4006.

PRESENTATIONS

Oral Presentations (*Speaker/Presenter is underlined*)

1. Davis, E.M.; Balwani, A.; Domhoff, A. Tuning Transport and Segmental Dynamics in Ionomer Nanocomposites via Membrane-Nanoparticle Interactions. *AICHE Fall Meeting*, Orlando, FL, November 2019. **Invited Speaker (Diffusion in Polymers Session)**
2. Gregorich, N.; Ding, J.; Thies, M.C.; Davis, E.M. Characterizing Network Structure in Lignin-Based Hydrogel Composites for Membrane-Based Separations. *AICHE Fall Meeting*, Orlando, FL, November 2019.
3. Domhoff, A.; Balwani, A.; Martin, T.; Jones, R.L.; Davis, E.M. Impact of Nanoparticle Aggregation on Ion Transport and Nanostructure in Ionomer Nanocomposite Membranes. *AICHE Fall Meeting*, Orlando, FL, November 2019.
4. Balwani, A.; Domhoff, A.; Faraone, A.; Davis, E.M. Impact of Nanoparticle Dispersion and Surface Chemistry on the Segmental Dynamics and Transport Properties of Ionomer Nanocomposites. *AICHE Fall Meeting*, Orlando, FL, November 2019.
5. Davis, E.M. Impact of Nanoparticles on Transport and Segmental Dynamics in Ionomer Nanocomposite Membranes. Notre Dame, Notre Dame, IN, April 2019. **Invited Speaker**
6. Balwani, A.; Jansto, A.; Faraone, A.; Davis, E.M. Uncovering How the Nanoparticle-Polymer Interface Affects Segmental Dynamics and Water Transport in Ionomer Nanocomposites. *ACS Spring Meeting*, Orlando, FL, April 2019.
7. Jansto, A.; Balwani, A.; Martin, T.; Jones, R.; Davis, E.M. Interplay of Electrostatic Interactions, Nanoparticle Dispersion, and Ion Transport in Ionomer Nanocomposites for Vanadium Redox Flow Batteries. *ACS Spring Meeting*, Orlando, FL, April 2019.
8. Gregorich, N.; Ding, J.; Thies, M.C.; Davis, E.M. Characterizing Network Structure and Protein Separation in Lignin-Based Hydrogel Composites. *APS March Meeting*, Boston, MA, March 2019.
9. Jansto, A.; Balwani, A.; Martin, T.; Jones, R.; Davis, E.M. Effect of Electrostatic Interactions Between Nafion and Functionalized Nanoparticles on Ionomer Morphology and Nanoparticle Dispersion. *APS March Meeting*, Boston, MA, March 2019.
10. Balwani, A.; Faraone, A.; Davis, E.M. Elucidating the Impact of Silica Nanoparticles on Water Transport and Local Chain Relaxation Dynamics in Ionomer Nanocomposites. *APS March Meeting*, Boston, MA, March 2019.
11. Balwani, A.; Faraone, A.; Davis, E.M. Interplay of Local Chain Dynamics and Viscoelastic Properties on Liquid Water Transport in Ionomer Nanocomposite Membranes. *AICHE National Meeting*, Pittsburgh, PA, October 2018.

12. Davis, E.M. Impact of Nanoparticles on Transport and Segmental Dynamics in Ionomer Nanocomposite Membranes. University of Virginia, Charlottesville, VA, October 2018. **Invited Speaker**
13. Davis, E.M. Impact of Nanoparticles on Transport and Segmental Dynamics in Ionomer Nanocomposite Membranes. Texas A&M, College State, TX, September 2018. **Invited Speaker**
14. Jansto, A.; Davis, E.M. Surface Functionalization of Silica (SiO₂) Nanoparticles in Nafion Nanocomposite Membranes for Vanadium Redox Flow Batteries. *ACS Spring National Meeting*, New Orleans, LA, March 2018.
15. Balwani, A.; Faraone, A.; Davis, E.M. Elucidating the Impact of Silica Nanoparticles on Water Transport and Local Chain Relaxation Dynamics in Ionomer Nanocomposites. *APS March Meeting*, Los Angeles, CA, March 2018.
16. Balwani, A.; Faraone, A.; Davis, E.M. Segmental Dynamics and Water Transport in Nafion-SiO₂ Hybrid Membranes. *AIChE National Meeting*, Minneapolis, MN, October 2017.
17. Jansto, A.; Davis, E.M. Tailoring Surface Functionalization of Silica Nanoparticles in Nafion Nanocomposites for Improved Ion Selectivity in Vanadium Redox Flow Batteries. *AIChE National Meeting*, Minneapolis, MN, October 2017.
18. Davis, E.M.; Balwani, A.; Jansto, A.; Faraone, A. Nafion Nanocomposite Membranes for Use in Prospective Large-Scale Energy Storage Devices. *AIChE National Meeting*, San Francisco, CA, November 2016.
19. Davis, E.M.; Nadermann, N.K.; Page, K.A.; Stafford, C.M.; Chan, E.P. Using Indentation to Characterize Water Transport and Structure in Nafion Thin Films. *APS March Meeting*, Baltimore, MD, March 2016.
20. Davis, E.M.; Kim, J.; Oleshko, V.; Soles, C.L.; Page, K.A. Uncovering the Structure of Nafion-SiO₂ Hybrid Membranes for Prospective Large-Scale Energy Storage Devices. *AIChE National Meeting*, Salt Lake City, UT, November 2015.

Prior to Clemson

21. Davis, E.M., Nadermann, N.K.; Chan, E.P.; Stafford, C.M.; Page, K.A. Elucidating the Role of Confinement on Structure and Water Transport in Nafion Thin Films. *APS March Meeting*, San Antonio, TX, March 2015.
22. Davis, E.M.; Nadermann, N.K.; Chan, E.P.; Stafford, C.M.; Page, K.A. Water Sorption and Transport in Nafion Thin Films: Understanding the Effect of Confinement. *AIChE National Meeting*, Atlanta, GA, November 2014.
23. Stafford, C.M.; Page, K.A.; Davis, E.M.; Kim, S.; Dura, J.; Yager, K.; Kusoglu, A.; Soles, C. Confinement Effects on the Structure and Transport of Nafion Ultrathin Films. *ECS and SMEQ International Meeting*, Cancun, Mexico, October 2014.
24. Page, K.A.; Davis, E.M.; Stafford, C.M.; Dura, J.; Yager, K.; Kusoglu, A.; Kim, J.; Soles, C. Roles of Interfaces, chemistry, and morphology on the structure, water distribution/transport, and physical properties of multicomponent polyelectrolyte membranes for fuel cell applications. *ACS National Meeting*, San Francisco, CA, August 2014.
25. Davis, E.M.; Nadermann, N.K.; Chan, E.P.; Stafford, C.M.; Page, K.A. Water Transport in Nafion Thin Film Membranes Using Time-Resolved Polarization Modulation Infrared Reflection Absorption Spectroscopy (PM-IRRAS). *ACS National Meeting*, San Francisco, CA, August 2014.

26. Chan, E.P.; Nadermann, N.K.; Davis, E.M.; Stafford, C.M. Structure/Property Measurements of Polymer Membranes via Poromechanics. *ACS National Meeting*, San Francisco, CA, August 2014.
27. Davis, E.M.; Kim, J.; Page, K.A. Structure of Nafion Nanocomposite Membranes for Vanadium Flow Batteries. *ACNS National Meeting*, Knoxville, TN, June 2014.
28. Davis, E.M.; Page, K.A. Structure of Nafion Hybrid Membranes for Vanadium Redox Flow Battery Applications. *APS March Meeting*, Denver, CO, March 2014.
29. Davis, E.M.; Elabd, Y.A. Water Sorption and Diffusion in Glassy Polymers: Nonequilibrium Thermodynamics and States of Water. *AIChE National Meeting*, San Francisco, CA, November 2013.
30. Davis, E.M.; Elabd, Y.A. States of Water in Non-Equilibrium Glassy Polymers. *APS March Meeting*, Baltimore, MD, March 2013.
31. Davis, E.M.; Minelli, M.; Giacinti Baschetti, M.; Elabd, Y.A. Non-Equilibrium Sorption and Anomalous Diffusion of Water in Glassy Polymers. *AIChE National Meeting*, Pittsburgh, PA, October 2012.
32. Davis, E.M.; McDermott, M.K.; Benetatos, N.M.; Elabd, Y.A. Drug Delivery in Biodegradable Polymer Coatings Used in Drug-Eluting Medical Devices: An Infrared Spectroscopic Investigation. *ACS National Meeting*, San Diego, CA, March 2012.
33. Davis, E.M.; Minelli, M.; Giacinti Baschetti, M.; Sarti, G.C.; Elabd, Y.A. Non-equilibrium Water-Glassy Polymer Dynamics. *APS March Meeting*, Boston, MA, March 2012.
34. Davis, E.M.; Minelli, M.; Giacinti Baschetti, M.; Sarti, G.C.; Elabd, Y.A. Sorption and Diffusion of Water Vapor in Polylactide: Experiments and Model Predictions. *AIChE National Meeting*, Minneapolis, MN, October 2011.
35. Ye, Y.; Mace, E.J.; Davis, E.M.; Elabd, Y.A. Stable Hydroxide Anion Exchange Polymerized Ionic Liquid. *ACS National Meeting*, Anaheim, CA, March 2011.
36. Davis, E.M.; Elabd, Y.A.; Winey, K.I.; Regnault, W.F.; Benetatos, N.M. New Characterization Techniques for Assessing the Structure and Water Transport Properties of Parylene Coatings. *ACS National Meeting*, San Francisco, CA, March 2010.

Poster Presentations (*Speaker/Presenter is underlined*)

1. Jansto, A.; Davis, E.M. Surface Functionalization of SiO₂ Nanoparticles in Nafion Nanocomposite Membranes for Use as Proton Exchange Membranes in Vanadium Redox Flow Batteries. *AIChE National Meeting*, Pittsburgh, PA, October 2018.
2. Jansto, A.; Davis, E.M. Elucidating How Interactions Between Functionalized Nanoparticles and Nafion Alter the Dispersion State and Vanadium Ion Permeability in Ionomer Nanocomposite Membranes. *AIChE National Meeting*, San Francisco, CA, November 2016.
3. Balwani, A.; Faraone, A.; Davis, E.M. Relaxation Dynamics and Water Transport in Nafion-SiO₂ Nanocomposite Membranes. *AIChE National Meeting*, San Francisco, CA, November 2016.

Prior to Clemson

4. Davis, E.M. Polymer Membranes for Energy Storage and Delivery. *AIChE National Meeting*, Atlanta, GA, November 2014.

5. Davis, E.M.; Nadermann, N.K.; Chan, E.P.; Stafford, C.W.; Page, K.A. Water Sorption and Transport in Nafion Thin Films: Understanding the Effect of Confinement. *GRC: Polymer Physics Meeting*, South Hadley, MA, July 2014.
6. Davis, E.M.; Elabd, Y.A. Water Sorption and Diffusion in Glassy Polymers. *20th Annual NIST Sigma Xi Postdoctoral Poster Presentation*, Gaithersburg, MD, February 2014.
7. Davis, E.M. Polymer Membranes for Energy Storage and Delivery. *AIChE National Meeting*, San Francisco, CA, November 2013.
8. Davis, E.M.; Minelli, M.; Giacinti Baschetti, M.; Sarti, G.C.; Elabd, Y.A. Sorption and Diffusion of Water Vapor in Polylactide: Experiments and Model Predictions. *ACS National Meeting*, Anaheim, CA, March 2011.
9. Davis, E.M.; Elabd, Y.A.; Regnault, W.F.; Benetatos, N.M. Non-Fickian Transport in Glassy Polymers: Diffusion-Relaxation Phenomena. *GRC: Polymer Physics*, South Hadley, MA, June 2010.
10. Davis, E.M., Theyro, G.; Hillmyer, M.A.; Cairncross, R.A.; Elabd, Y.A. Liquid Water Transport in Polylactide (PLA) Using Time-Resolved Fourier Transform Infrared-Attenuated Total Reflectance (FTIR-ATR) Spectroscopy. *AIChE National Meeting*, Nashville, TN, November 2009.

Current Graduate Students

1. Balwani, A. (PhD), “Chain Dynamics and Water/Ion Diffusion in Nafion Nanocomposite Membranes”, May 2020
2. Jansto, A. (PhD), “Characterizing Nanostructure and Transport in Nanophase Segregated Block Copolymers Using Poroelastic Relaxation Indentation”, May 2020
3. Gregorich, N. (PhD), “Transport and Network Structure in Composite Hydrogels”, May 2022

Current Undergraduate Students

1. Johnson, K. (B.S.) “Stimuli-Responsive Lignin-Based Hydrogels for Aqueous Separations”, May 2021
2. Lee, A. (B.S.), “Surface Functionalization of Nanoparticles for Use in Ionomer Nanocomposites”, May 2020
3. Miller, E. (B.S.) “Stimuli-Responsive Lignin-Based Hydrogels for Aqueous Separations”, May 2021
4. Steele, J. (B.S.), “Hydrogel Nanocomposites for Oil/Water Separations”, May 2020

Past Undergraduate Students

5. Barr, D. (B.S.), “Synthesis of Porous Polybenzimidazole Membranes for Redox Flow Batteries”, graduated May 2019, Eastman
6. Ball, E. (B.S.), “Water Transport in 3D Printed Polymers” (Honors Thesis), graduated May 2018, Savannah River Site
7. Bowers, A. (B.S.) “Hydrogel Nanocomposites for Oil/Water Separations”, graduated May 2019, SNF Holdings
8. Jasper, R. (B.S.), “Water Transport in 3D Printed Glassy Polymers”, graduated May 2019
9. Little, J. (B.S.), “Tuning Transport in Surface Functionalized Nanoporous Membranes”, graduated May 2019, Eastman

10. McDaniel, T. (B.S.), “Surface Functionalization of Nanoparticles for Use in Ionomer Nanocomposites”, May 2020

11. Sears, E. (B.S.), “Network Structure in Lignin-Based Hydrogels”, graduated May 2019

Teaching Experience

Courses Taught at Clemson University (Beginning Fall 2015)

CHE 8030, Graduate Transport Phenomena, F16, F17, F18, F19
CHE 2300/2301, Fluid Flow & Heat Transfer, S16, S17, S18, S19
CHE 3070/3071, Unit Operations Laboratory I, Summer18
CHE 4070/4071, Unit Operations Laboratory II, F15

University and Public Service

Continuing Education

Session Chair, Fluid Mechanics for Soft Matter I: Flows, *APS March Meeting*, March 2018
Session Chair, Diffusion in Polymers, *AIChE Annual Meeting*, October 2017
Session Chair, Diffusion in Polymers, *AIChE Annual Meeting*, November 2016
Process Safety Workshop, Cargill Corporation, June 2016
Session Chair, Transport in Polymer Membranes, *ACS Fall Meeting*, August 2014

Educational Outreach Activities

- Faculty advisor for Clemson Student Chapter of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE). I worked with two undergraduate students found a Clemson Student Chapter of NOBCChE in Spring 2018. (2018–present)
- Since joining the department, I have spearheaded the department’s effort towards educational outreach activities. I am currently the faculty leader for a group of about 20 graduate students and 5 undergraduate students who have participated in outreach activities (2015–present). With this, I have participated/organized ~10 individual outreach events including events with WISE/Girl Scouts, The Boy Scouts, Navy STEAM Camp, and many more. (2016–present)
- Member of the Clemson University founded group EMAGINE; a group founded to inspire K-12 students in the state of South Carolina to see value in science, technology, engineering, and mathematics (STEM) fields. (2015–present)

SERVICE

Departmental Service

Coordinator, Denmark Technical University Summer Lab Program, 2015–present
Faculty Advisor, CBE Departmental Outreach Team, 2016–present
Faculty Advisor, Clemson Student Chapter of NOBCChE, 2018–present
Undergraduate Committee, 2018–present
Facilities, Space, and Safety Committee, 2015–2017
Faculty Recording Secretary, 2015–2018
Faculty Search Committee, Fall/Spring 2016/2017

University Service

CECAS Global Engagement Committee, 2018–present
Faculty Senate, 2017–present
Ad Hoc Committee on the Status of Women, 2018–2019
Research Committee, 2017–present
Conflict of Interest Committee, 2017–2019

Updated October 2019