FIKILE R. BRUSHETT

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Research Summary

The objective of my research program is to advance the science and engineering of electrochemical technologies (e.g., batteries, electrolyzers) needed for a sustainable energy economy. My group seeks to understand and control the fundamental processes that govern the performance, cost, and lifetime of present day and next-generation electrochemical systems for energy storage and conversion. Our approach combines synthesis and characterization of redox active materials, design and engineering of electrochemical reactors, and techno-economic modeling of electrochemical systems. We place a strong emphasis on connecting system-level performance and cost goals to materials-level property requirements and on leveraging this knowledge to guide exploration of new chemistries and reactor designs. Ultimately, we aim to develop robust and portable guiding principles for the design of materials, processes, and devices that harness electrochemical phenomena. Pursuant to this goal, I have established a diverse and innovative research portfolio consisting of projects tackling important challenges in grid energy storage, environmental stewardship, and the role of electrochemical processing in chemical manufacturing. My teaching and service contributions focus on educating engineers to develop electrochemical solutions to critical global energy and sustainability challenges.

Education and Training

University of Pennsylvania	Chemical & Biomolecular Eng.	B.S.E., 2006
Univ. of Illinois at Urbana-Champaign	Chemical Engineering	M.S., 2009
Univ. of Illinois at Urbana-Champaign	Chemical Engineering	Ph.D., 2010
Argonne National Laboratory	Electrochemical Energy Storage Group	Postdoc, 2010-2012

Graduate Advisor: Paul J.A. Kenis, University of Illinois at Urbana-Champaign

Postdoctoral Advisor: John T. Vaughey, Argonne National Laboratory, Chemical Sciences Division

Select Awards and Honors

NESACS/NENOBCChE Henry A. Hill Lecturership	2021
NOBCChE Lloyd N. Ferguson Young Scientist Award for Excellence in Research	2020
ECS Supramaniam Srinivasan Young Investigator Award	2018
U.S. Department of Energy, Secretary of Energy Achievement Award	2018
Chemical and Engineering News Talented 12 Chemist	2017
Scialog Fellow for Advanced Energy Storage	2017
C. Michael Mohr Outstanding Faculty Award, MIT	2014, 2017
Director's Postdoctoral Fellowship, Argonne National Laboratory	2010
GEM Fellowship for Ph.D. in Engineering	2006

Select refereed publications - * *indicates corresponding author(s)*

W. Gao, M.J. Orella, T.J. Carney, Y. Roman-Leshkov, J. Drake, F.R. Brushett*. "Understanding the impact of convective transport on intercalation batteries through dimensional analysis," *J. Electrochem. Soc.*, **2020**, 167

(14), 140551. DOI: 10.1149/1945-7111/abbce3

Z. Cheng, K.M. Tenny, A. Pizzolato, A. Forner-Cuenca, V. Verda, Y.-M. Chiang, F.R. Brushett*, R. Behrou*. "Data-driven electrode parameter identification for vanadium redox flow batteries through experimental and numerical methods," *Applied Energy*, **2020**, 279, 115530. DOI: 10.1016/j.apenergy.2020.115530

K.E. Rodby, T.J. Carney, Y. Ashraf Gandomi, J.L. Barton, R.M. Darling, F.R. Brushett*. "Assessing the levelized cost of vanadium redox flow batteries with capacity fade and rebalancing," *J. Power Sources*, **2020**, 460, 227958. DOI: 10.1016/j.jpowsour.2020.227958

A. Forner-Cuenca, E.E. Penn, A.M. Oliveira, F.R. Brushett*. "Exploring the role of electrode microstructure on the performance of non-aqueous redox flow batteries," *J. Electrochem. Soc.*, **2019**, 166: A2230-A2241. DOI: 10.1149/2.0611910jes

J.L. Barton, F.R. Brushett*. "A one-dimensional stack model for redox flow battery analysis and operation," *Batteries*, **2019**, 5(1), 25. DOI: 10.3390/batteries5010025

K.V. Greco, A. Forner-Cuenca, A. Mularczyk, J. Eller, F.R. Brushett*. "Elucidating the nuanced effects of thermal pretreatment on carbon paper electrodes for vanadium redox flow batteries," *ACS Appl. Mater. Interfaces*, **2018**, 10: 44430-44442. DOI: 10.1021/acsami.8b15793

V. Dieterich, J.D. Milshtein, J.L. Barton, T.J. Carney, R.M. Darling, F.R. Brushett*. "Estimating the cost of organic battery active materials: a case study on anthraquinone disulfonic acid," *Transl. Mater. Res.*, **2018**, 5: 034001. DOI: 10.1088/2053-1613/aacb0e

J.D. Milshtein, K.M. Tenny, J.L. Barton, J. Drake, R.M. Darling, F.R. Brushett*. "Quantifying mass transfer rates in redox flow batteries," *J. Electrochem. Soc.*, **2017**, 164: E3265-E3275. DOI: 10.1149/2.0201711jes

Z Li, M.S. Pan, L. Su, P.C. Tsai, A.F. Badel, J.M. Valle, S.L. Eiler, K. Xiang, F.R. Brushett, Y.M. Chiang*. "Air-Breathing Aqueous Sulfur Flow Battery for Ultralow-Cost Long-Duration Electrical Storage," Joule, 2017, 1, 306-327. DOI: 10.1016/j.joule.2017.08.007

T.J. Carney, S.J. Collins, J.S. Moore, F.R. Brushett*. "Concentration-dependent dimerization of anthraquinone disulfonic acid and its impact on charge storage," *Chem. Mater.*, **2017**, 29: 4801-4810. DOI: 10.1021/acs.chemmater.7b00616

J.D Milshtein, S.L. Fisher, T.M. Breault, L.T. Thompson*, F.R. Brushett*. "Feasibility of a supporting salt free non-aqueous redox flow battery utilizing ionic active materials," *ChemSusChem*, **2017**, 10: 2080-2088. DOI: 10.1002/cssc.201700028

J.D. Milshtein, A.P. Kaur, M.D. Casselman, J.A. Kowalski, S. Modekrutti, P. Zhang, N.H. Attanayake, C.F. Elliot, S.R. Parkin, C. Risko, F.R. Brushett*, S.A. Odom*. "High current density, long duration cycling of soluble organic active species for non-aqueous redox flow batteries," *Energy Environ. Sci.*, **2016**, 9: 3531-3543. DOI: 10.1039/C6EE02027E

R. Dmello, J.D. Milshtein, F.R. Brushett, K.C. Smith*. "Cost-driven materials selection criteria for redox flow battery electrolytes," *J. Power Sources*, **2016**, 330, 261-272. DOI: 10.1016/j.jpowsour.2016.08.129

J.D. Milshtein, J.L. Barton, R.M. Darling, F.R. Brushett*. "4-acetamido-2,2,6,6-tetramethylpiperidine-1-oxyl as a model organic redox active compound for nonaqueous flow batteries," *J. Power Sources*, **2016**, 327: 151-159. DOI: 10.1016/j.jpowsour.2016.06.125

R. Darling*, K.G. Gallagher*, J.A. Kowalski, S. Ha, F.R. Brushett. "Pathways to low-cost electrochemical energy storage: a comparison of aqueous and nonaqueous flow batteries," *Energy Environ Sci.*, **2014**, 7 , 3459-3477. DOI: 10.1039/C4EE02158D

Professional Membership: ECS, AIChE, ACS, NSBE, NOBBChE