DREXEL UNIVERSITY
Chemical and Biological Engineering
College of Engineering

DEPARTMENT OF

Chemical & Biological Engineering

ANNUAL REPORT

JULY 1, 2017 – JUNE 30, 2018

CONTENTS

Welcome to the FY2018 Annual Report of the Department of Chemical and Biological Engineering at Drexel. Please use this report to learn more about our department through metrics and faculty profiles, and to get a glimpse of the varied and exciting activities undertaken by members of our community. This has been a year of transition and accomplishments that saw the promotions of Profs. Lau and Baxter, Prof. Fafarman's AIChE DVS Faculty of the Year Award, and Prof. Tang's NSF CAREER Award, among many other highlights.The quality embodied in these accomplishments is reflected by the generosity of our alumni who this year made CBE the best-performing department in the College in terms of alumni engagement and philanthropy, and third best in the entire University. This signifies the broadly held belief among CBE Dragons worldwide in the value of the Drexel Chemical Engineering degree, which inspires me and the rest of the faculty and staff to continuously improve our mission towards excellence in instruction and research. Our curriculum revision has now entered its pre-junior year, with enhanced computation in thermodynamics and transport core courses now in place. I'm also happy to report on the continued success among our faculty at winning research grants and producing publications and PhD graduates that go on to become research leaders in our discipline. However, as I am fond of saying, Drexel moves quickly, so this report represents a snapshot that will fade quickly as we plow headlong into this next academic year without slowing down. I hope you find this report enlightening and look forward to the next!

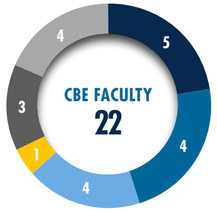
Sincerely,

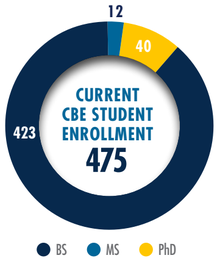
Cameron F. Abrams
Professor and Department Head

FACTS & FIGURES

The Department of Chemical and Biological Engineering (CBE) at Drexel University consists of 13 tenure and tenure-track faculty members, 3 teaching faculty, 43 PhD students, 12 MS students, and 423 undergraduate students. The department is currently engaged in externally funded research with over $4.6 million in annual research expenditures using state-of-the-art facilities.

CBE's research program is built upon the following areas of core competency: (a) chemical kinetics, transport and thermodynamics, (b) polymer science and engineering and (c) systems engineering, modeling and computation. These competencies support the research themes of Energy and Sustainability and Health and Medicine, which are directly linked to solving present-day societal challenges. Funding sources for research include NSF, NIH, DOD, USDA, EPA, CertainTeed Corporation, DuPont, Environmental Fuel Research, Exxon Mobil, FMC, General Motors, PPG, TDL Innovations, W.L. Gore and Associates, Zzyzx Polymers, American Chemical Society Petroleum Research Fund and The Electrochemical Society. Recently, we were awarded a $3 million grant for a cooperative project funded by the Army Research Laboratory entitled "Thermoset Design for Additive Manufacturing." Members of the CBE faculty have received multiple young investigator awards, including 7 CAREER Awards and 1 PECASE award.





ENROLLMENT STATISTICS

	UNDERGRADUATE	GRADUATE MS	GRADUATE PhD
DREXEL UNIVERSITY	15,498	5,389	1,021
COLLEGE OF ENGINEERING	3,255	446	287
CHEMICAL ENGINEERING	423	12	43

NEW ENROLLMENT DIVERSITY STATISTICS

	UNDERGRADUATE	GRADUATE MS	GRADUATE PhD
UNDERREPRESENTED MINORITY	5%	13%	0%
OTHER/WHITE	81%	37%	22%
INTERNATIONAL	13%	50%	78%
WOMEN	29%	50%	22%
MEN	71%	50%	78%

CURRENT ENROLLMENT DIVERSITY STATISTICS

	UNDERGRADUATE	GRADUATE MS	GRADUATE PhD
UNDERREPRESENTED MINORITY	9%	1%	2%
OTHER/WHITE	79%	25%	44%
INTERNATIONAL	13%	67%	53%
WOMEN	34%	41%	26%
MEN	66%	59%	74%

RESEARCH IMPACT

EXPENDITURES: **$4.6 MILLION**

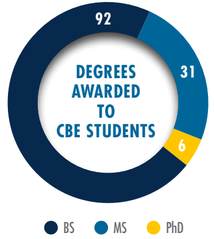
AWARDS: **$5.7 MILLION**

DEGREES AWARDED

	UNDERGRADUATE	GRADUATE MS	GRADUATE PhD
COLLEGE OF ENGINEERING	803	328	47
CHEMICAL ENGINEERING	92	31	6

DEGREES AWARDED TO UNDER-REPRESENTED MINORITY STUDENTS

	UNDERGRADUATE	GRADUATE MS	GRADUATE PhD
ETHNIC DIVERSITY	5%	3%	17%
GENDER DIVERSITY	30%	39%	17%



UNDERGRADUATE ENTERING STUDENT SAT SCORES

	MATH	VERBAL	TOTAL
COLLEGE OF ENGINEERING	667	636	1302
CHEMICAL ENGINEERING	679	645	1324

GRADUATE ENTERING STUDENT GRE SCORES

	QUANTITATIVE	VERBAL
COLLEGE OF ENGINEERING	162	150
CHEMICAL ENGINEERING	164	152

Data taken from Fall 2017

RESEARCH AREAS

BIOLOGICAL ENGINEERING:

Biochemical Engineering, Biomaterials Engineering, Biological Colloids, Biomedical Engineering, Complex Fluids, Biosensors, Cellular Biophysics

ENERGY & THE ENVIRONMENT:

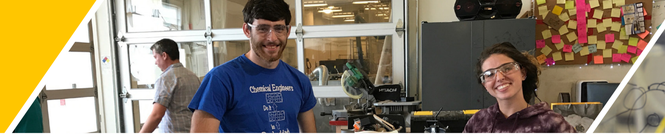
Solar Cells, Nanowires, Biodegradable Polymers, Renewable Fuels and Energy,Fuel Cells, Electrocatalysts, Polymers and Composites from Renewable Sources

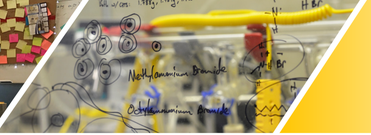
MULTISCALE MODELING & PROCESS SYSTEMS ENGINEERING:

Drug Delivery, Fuel Cells, Process Control and Modeling, Transport Phenomena, Molecular Simulation, Safety Analysis, Fluid Mechanics of Multi-phase Systems

POLYMER SCIENCE & ENGINEERING:

Materials from Renewable Sources, Membranes, Nanomaterials, Polymer Composites, Polymer Processing and Rheology, Polymer Nano-composites, Interfacial Phenomena, Diffusion in Polymers, Pyrolysis of Polymers, Polymer Thermodynamics





Cameron F. Abrams

Professor and Department Head
PhD, University of California, Berkeley

cfa22@drexel.edu

Cameron F. Abrams earned a BS in Chemical Engineering from North Carolina State University in 1995 and a PhD in Chemical Engineering from the University of California, Berkeley in 2000. After two years of postdoctoral work at the Max-Planck-Institute for Polymer Research in Mainz, Germany, he joined the Department of Chemical and Biological Engineering at Drexel as an Assistant Professor in 2002. Abrams was tenured in 2008 and promoted to Full Professor and given a secondary appointment in the Department of Biochemistry and Molecular Biology in 2012. He was appointed Department Head in January, 2017. Abrams' research interests involve development of novel molecular simulation methods and their applications in design of high-performance materials, protein-related kinetics and thermodynamics, and HIV-1 entry inhibitor development. Abrams is the recipient of an NSF CAREER Award and an ONR Young Investigator Award. He is a Fellow of the American Institute of Medical and Biological Engineering and is the 2015 Impact Awardee in Computational Molecular Sciences and Engineering from the American Institute of Chemical Engineers. Abrams has authored or co-authored ~100 original articles and has graduated nine PhD students to date. Abrams previously served the University as the founding Chair of the Board of Governance of the University Research Computing Facility.

EXTERNAL RESEARCH FUNDING

"Transition Path Theory and Markovian Milestoning for Prediction of Protein-Ligand Binding Kinetics in Molecular Simulations", NIH R01 GM100472 (1st renewal), (Co-I Eric Vanden-Eijnden, NYU), 9/1/17-5/31/21

"Dual-action virolytic entry inhibitors against HIV-1", NIH R01 GM115249, Co-PI (Multiple-PI grant; other Co-PI's are Irwin Chaiken, DUCOM, and Amos B. Smith III, UPenn Chemistry), 7/1/15 – 6/30/19

EXTERNAL RESEARCH FUNDING (Continued)

"Structure-based antagonism of HIV-1 envelope function in cell entry", NIH P01 GM056550, Co-I (PI: Irwin Chaiken, DUCOM) 9/1/18 – 8/31/23. Abrams is the leader of the Computational Core of this program project.

"Thermosets for Agile Manufacturing," Army Research Lab W911NF-17-2-0227, Co-I (PI: G. R. Palmese). 9/1/17-8/31/20. Abrams' share supports one FTE PhD student and ½ of a postdoc.

JOURNAL PUBLICATIONS (Peer Reviewed)

Gardner, J.; Abrams, C.F. Lipid Flip-Flop vs. Lateral Diffusion in the Relaxation of Hemifusion Diaphragms. *Biochim. Biophys. Acta, Biomembr.* **2018**, *1860*, 1452-1459.
DOI: 10.1016/j.bbamem.2018.04.007

Gossert, S.; Parajuli, B.; Chaiken, I.; Abrams, C.F. Roles of Conserved Tryptophans in Trimerization of HIV-1 Membrane-Proximal External Regions: Implications for Virucidal Design via Alchemical Free-Energy Molecular Simulations. **2018**, *Proteins, 86*, 707–711.
DOI: 10.1002/prot.25504
PMCID: PMC6013385

Paz, S.A.; Maragliano,L.; Abrams, C.F.; The Effect of Intercalated Water on Potassium Ion Transport Through Kv1.2 Channels Studied via On-the-fly Free-Energy Parameterization. J. Chem. Theory. *Comput.* **2018**, 14, 2743–2750.
DOI: 10.1021/acs.jctc.8b00024

Sridhar, A.; Vergara, J.; Kinaci, E.; Palmese, G.R.; Abrams, C.F. The Effect of Alkyl Chain Length on Mechanical Properties of Fatty-Acid-Functionalized Amidoamine-Epoxy System. *Comput. Mater. Sci.* **2018**, 150, 70-76.
DOI: 10.1016/j.commatsci.2018.03.073

Paz, S.A.; Abrams, C.F. Testing Convergence of Different Free-Energy Methods in a Simple Analytical System with Hidden Barriers. *Computation* **2018**, 6, 27.
DOI: 10.3390/computation6020027

Parajuli, B.; Acharya, K.; Bach, H.C.; Parajuli,B.; Zhang, S.; Smith, A.B., III; Abrams, C.F.; Chaiken, I.; Restricted HIV-1 Env Glycan Engagement by Lectin-Reengineered DAVEI Protein Chimera is Sufficient for Lytic Inactivation of the Virus. *Biochem. J.* **2018**, 475, 931-957.
DOI: 10.1042/BCJ20170662
PMCID: PMC5944358

Moraca, F.; Rinaldo, D.; Smith, A.B.,III; Abrams, C.F. Specific Non-Covalent Interactions Determine Optimal Structure of a Buried Ligand Moiety: QM/MM and Pure QM Modeling of Complexes of the Small-Molecule CD4 Mimetics and HIV-1 Gp120. *ChemMedChem* **2018**, 13, 627-633.
DOI: 10.1002/cmdc.201700728
PMCID: PMC5901908

Gardner, J.; Abrams, C.F.; Rate of Hemifusion Diaphragm Dissipation and Ability to Form Three-Junction Bound HD Determined by Lipid Composition *J. Chem. Phys.* **2017**, 147, 134903.
DOI: 10.1063/1.4994320

Gordon, R.; Stober, S.; Abrams, C.F.; Effects of Optical Purity and Finite System Size on Self-Assembly of 12-Hydroxystearic Acid in Hexane: Molecular Dynamics Simulations. *J. Phys. Chem. B* **2017**, 121, 9223-9233.
DOI: 10.1021/acs.jpcb.7b05246

Herschhorn, A.; Gu, C.; Moraca, F.; Ma, X.; Farrell, M.; Smith, A.B., III; Pancera, M.; Kwong, P.; Schön, A.; Freire, E.; Abrams, C.F.; Blanchard, S.; Mothes, W.; Sodroski, J.G. The β20-β21 of gp120 is a Regulatory Switch for HIV-1 Env. *Nature Comm.* **2017**, 8, 1049.
DOI: 10.1038/s41467-017-01119-w
PMCID: PMC5648922-w

Raj Mutharasan

Frank A. Fletcher Professor
PhD, Drexel University

mutharasan@drexel.edu

Raj Mutharasan received his bachelor's degree in Chemical Engineering from the Indian Institute of Technology Madras (India) and a PhD in Chemical Engineering from Drexel University in 1973. After a post-doctoral year at the University of Toronto, he joined Drexel University on the faculty and has been there since 1974. He is the Frank A. Fletcher Professor of Chemical and Biological Engineering. During 2014-2017, he served as the Program Director of NanoBioSensing and managed a new program on Advanced Biomanufacture of Therapeutic Cells at the National Science Foundation. He has served in many administrative capacities at Drexel including as the Interim Dean of College of Engineering (1997-2000). He led the Engineering Curriculum Innovation Program – a seven-university coalition on engineering education - at Drexel funded by the National Science Foundation during 1995-2004. He is a Fellow of American Institute of Chemical Engineers (2000), Fellow of American Institute for Medical and Biological Engineering (2006) and Fellow of the American Association of Advancement of Science (2011). He serves on the Editorial Board of Applied Biochemistry and Biotechnology, a Springer journal. His research interests are in biosensors and process biotechnology. He has published extensively in the areas of biosensors, bioreactors and materials processing. He has directed 29 PhD and 47 MS students. At Drexel, Raj directs research on cantilever, fiber optic and magneto-elastic sensors for detecting pathogens, proteins and DNA. His biosensors research was funded by the NSF, USDA, EPA, Pennsylvania Department of Health, and by the Department of Transportation/Department of Homeland Security. Mutharasan's inventions have resulted in several patents – in the area of aluminum processing and biosensors. The biosensor patents have been licensed by two start-up companies.

JOURNAL PUBLICATIONS (Peer Reviewed)

Johnson, Blake N.; Mutharasan, R. Acoustofluidic particle trapping, manipulation, and release using dynamic-mode cantilever sensors. *The Analyst* **2017**, 142 (1), 123-131.
DOI: 10.1039/C6AN01743F

Giuseppe R. Palmese

George B. Francis Professor
PhD, University of Delaware

grp27@drexel.edu

Giuseppe R. Palmese is the George B. Francis Professor of Engineering after having served 12 years as Head of the Department of Chemical and Biological Engineering at Drexel University. He is a Professor of Chemical and Biological Engineering and a Professor (by courtesy) of Materials Science and Engineering. He holds a BSE ('86) Princeton University and a PhD ('92) from the University of Delaware, both in Chemical Engineering. Before joining Drexel University in 2000, he was the Assistant Director of University of Delaware's Center for Composite Materials. Dr. Palmese's research focuses on processing-structure-property relationships of thermosetting polymer systems. Current research thrusts include: multifunctional systems, nanocomposites, materials from renewable sources and materials for biomedical applications. While at Drexel, Dr. Palmese has obtained grants from agencies including ARO, AFOSR, ARL, NASA, DARPA and USDA. He was the PI and Director of the Army Materials Center of Excellence (MCOE) for polymers. Dr. Palmese has more than 200 publications to his credit and is an inventor on 18 issued patents. His intellectual property involving materials from renewable sources has been licensed twice and is being commercialized by Dixie Chemicals. Dr. Palmese's industrial experience includes process engineering for the design, construction and startup of a 100 Kg/h polyolefin pilot plant, participation in numerous successful SBIR and STTR projects and consulting work in the field of polymers. Dr. Palmese has mentored 18 PhD students to graduation; two of them now hold faculty appointments at other universities. He currently maintains a research group comprised of six PhD students and two post-doctoral fellows, as well as numerous talented undergraduates.

EXTERNAL RESEARCH FUNDING

"Center for Sustainable Corrosion Protection", Department of Army, 9/26/13 – 9/25/18

"Materials in Extreme Dynamic Environment (MEDE) Collaborative", University of Delaware, 1/01/17 – 12/31/17

"Materials in Extreme Dynamic Environments (MEDE) Collaborative Research Alliance (CRA)", University of Delaware, 1/1/18 – 12/30/17

"Materials in Extreme Dynamic Environments (MEDE) Collaborative Research Alliance (CRA)", University of Delaware, 1/1/18 – 12/31/18

"Tailored Universal Feedstock for Forming (TUFF)",University of Delaware, 3/1/16 – 3/30/19

"SERDP MDA-Free Polyimides", Department of Army,1/16/15 – 1/15/19

"Biobased Thermosetting Polymers for Composite, Adhesiveand, Coating Applications", Department of Army, 9/28/16 – 9/28/19

"Thermosets for Agile Manufacturing", PPG, 10/10/17 – 9/30/20

JOURNAL PUBLICATIONS (Peer Reviewed)

Srikanth, A.; Kinaci, E.; Vergara, J.H.; Palmese, G.R.; Abrams, C.F. The Effect of Alkyl Chain Length on Mechanical Properties of Fatty-Acid-Functionalized Amidoamine-Epoxy Systems. *Comput. Mater. Sci.* **2018**, 150, 70-76.
DOI: 10.1016/j.commatsci.2018.03.073

Throckmorton, J.A.; Feldman, G.; Palmese, G.R.; Guenthner, A.J.; Lamison, K.R.; Redeker, N.D.; Ruth, P.N. Hydrolytic Degradation Kinetics of Bisphenol E Cyanate Ester Resin and Composite. *Polym. Degrad. Stab.* **2018**, 151, 1-11.
DOI: 10.1016/j.polymdegradstab.2018.02.009

Yadav, S.K.; Hu, F.; La Scala, J.J.; Palmese, G.R. Toughening Anhydride-Cured Epoxy Resins Using Fatty Alkyl-Anhydride-Grafted Epoxidized Soybean Oil. *ASC Omega* **2018**, 3 (3), 2641-2651.
DOI: 10.1021/acsomega.7b02042

Yadav, S.K.; Schmalbach, K.M.; Kinaci, E.; Stanzione, J.F.; Palmese, G.R. Recent Advances in Plant-Based Vinyl Ester Resins and Reactive Diluents. *Eur. Polym. J.* **2018**, 98, 199-215.
DOI: 10.1016/j.eurpolymj.2017.11.002

Vergara, J.H.; La Scala, J.J.; Henry C.K.; Sadler, J.M.; Yadav, S.K.; Palmese, G.R. The Effect of Pendant Alkyl Chain Length on the Barrier Properties of Epoxy/Amine Crosslinked Networks. *Polymer,* **2017**, 132, 133-142.
DOI: 10.1016/j.polymer.2017.10.042

Vergara, J.H.; Tian, Y.; La Scala, J.J.; Sadler, J.M.; Palmese, G.R. Synthesis and Characterization of Fatty Acid Modified Amines with Improved Water Barrier Properties. *Eur. Polym. J.* **2017**, 97, 112-119.
DOI 10.1016/j.eurpolymj.2017.09.035

Han, B.; Ma, T.; Vergara, J.H.; Palmese, G.R.; Yin, J.; Lee, D.; Han, L. Non-Additive Impacts of Covalent Cross-Linking on the Viscoelastic Nanomechanics of Ionic Polyelectrolyte Complexes. *RSC Adv.* **2017**, 7 (84), 53334-53345.
DOI: 10.1039/c7ra08514a

Masoud Soroush

Professor
PhD, University of Michigan

ms1@drexel.edu

Masoud Soroush received his BS in Chemical Engineering in 1985 from Abadan Institute of Technology, Iran, his MS in Chemical Engineering in 1988, a second MS in Electrical Engineering: Systems in 1991, and a PhD in Chemical Engineering in 1992, all from the University of Michigan, Ann Arbor. After one year of postdoctoral research in systems engineering at Michigan, in 1993 he joined Drexel University where he is now a Professor of Chemical and Biological Engineering. He was a Visiting Scientist at DuPont Marshall Lab, Philadelphia, 2002-03 and a Visiting Professor at Princeton University in 2008. His current research interests are in polymer reaction engineering, polymer membranes, process systems engineering, probabilistic modeling, inference and risk assessment, model-predictive safety systems, and mathematical modeling, analysis and optimization of renewable power generation and storage systems. Masoud is the recipient of an NSF CAREER Award and the O. Hugo Schuck Best Paper Award of the American Automatic Control Council, an elected Fellow of the American Institute of Chemical Engineers, and a senior member of the Institute of Electrical and Electronics Engineers. He has authored or co-authored more than 180 refereed articles and has graduated 13 PhD students to date.

EXTERNAL RESEARCH FUNDING

"GOALI: Collaborative Research: On-Demand Continuous-Flow Production of High Performance Acrylic Resins: from Electronic-Level Modeling to Modular Process Intensification", National Science Foundation, August 2018–July 2021

"GOALI: Collaborative Research: Model-Predictive Safety Systems for Predictive Detection of Operation Hazards", National Science Foundation, September 2017–August 2020

JOURNAL PUBLICATIONS (Peer Reviewed)

Rahimpour, A.; Seyedpour, S.F.; Aghapour Aktij, S.; Dadashi Firouzjaei, M.; Zirehpour, A.; Shamsabadi, A.A.; Khoshhal Salestan, S.; Jabbari, M.; Soroush, M. Simultaneous Improvement of Antimicrobial, Antifouling, and Transport Properties of Forward Osmosis Membranes with Immobilized Highly-Compatible Nano-Polyrhodanines. *Environ. Sci. Technol.* **2018**, 52(9), 5246–5258.
DOI: 10.1021/acs.est.8b00804

Dadashi Firouzjaei, M.; Shamsabadi, A. A.; Sharifian Gh., M.; Rahimpour, A.; Soroush, M. A Novel Nanocomposite with Superior Antibacterial Activity: a Silver-Based Metal Organic Framework Embellished with Graphene Oxide. *Adv. Mater. Interfaces* **2018**, 5 (11), 1701365.
DOI: 10.1002/admi.201701365

Sadeghi, M.; Talakesh, M. M.; Shamsabadi, A. A.; Soroush, M. Novel Application of a Polyurethane Membrane for Efficient Separation of Hydrogen Sulfide from Binary and Ternary Gas Mixtures. *ChemistrySelect* **2018**, 3, 3302-3308.
DOI: 10.1002/slct.201703170

Riazi, H.; Shamsabadi, A.A.; Grady, M.C.; Rappe, A.M.; Soroush, M. On the Thermal Self-Initiation Reaction of n-Butyl Acrylate in Free-Radical Polymerization. *Processes* **2018**, 6 (1), 3–14.
DOI: 10.3390/pr6010003

Riazi, H., Shamsabadi, A.A.; Grady, M.C.; Rappe, A.M.; Soroush, M. Experimental and Theoretical Study of the Self-Initiation Reaction of Methyl Acrylate in Free-Radical Polymerization. *Ind. Eng. Chem. Res.* **2018**, 57 (2), 532–539.
DOI: 10.1021/acs.iecr.7b04648

Shamsabadi, A.A.; Seidi, F.; Nozari, M.; Soroush, M.; A New Pentiptycene-Based Dianhydride and its High-Free-Volume Polymer for CO2 Removal. *ChemSusChem* **2018**, *11*(2), 472–482.
DOI: 10.1002/cssc.201701491

Sadeghi, M.; Shamsabadi, A.A.; Ronasi, A.; Isfahani, A.P.; Dinari, M.; Soroush, M. Engineering the Dispersion of Nanoparticles in Polyurethane Membranes to Control Membrane Physical and Transport Properties. *Chem. Eng. Sci.* in press **(2018)**.
DOI: 10.1016/j.ces.2018.08.030

Steven P. Wrenn

Professor
PhD, University of Delaware

✉ spw22@drexel.edu

Steven P. Wrenn earned a BS in Chemical Engineering with honors from Virginia Tech in 1991, an MS in Chemical Engineering from the University of Delaware in 1996 and a PhD in Chemical Engineering from the University of Delaware in 1999. Wrenn's industrial experience includes one year as a co-op with GE Plastics and three years as a Process Engineer with Zeneca, Inc. He spent a year abroad as an Alexander von Humboldt Research Fellow at Ruhr University in Bochum, Germany. He has served as Associate Department Head and Assistant Dean of Graduate Affairs and currently serves on the Faculty Senate. Wrenn's research interests involve fundamental studies of the interactions that arise when ultrasound acts on complex fluids, biological membranes, bacteria, and microbubbles with an eye toward clinical applications. For example, by understanding how colloidal systems influence acoustic phenomena such as stable and inertial cavitation and the associated effects arising therefrom - microstreaming and shockwaves – one can tailor colloidal phase behavior and microstructure for a given application (e.g., to achieve enhanced ultrasound contrast in particular regions of the body or to achieve localized drug release using ultrasound as a remote, mechanical stimulus). Wrenn is the recipient of an NSF CAREER Award and a Whitaker Foundation Biomedical Research Grant. Wrenn's work has been supported by NSF, NIH, the USDA, and the Coulter Foundation, among others. Wrenn has authored or co-authored over 50 original articles and has graduated nine PhD students to date.

EXTERNAL RESEARCH FUNDING

"Ultrasound Assisted Technologies for Improving Food Quality and Safety", United States Department of Agriculture (via University of Maryland), 1/01/16 –12/31/18

"Collaborative Research: Acoustic Micro-Streaming in the Aqueous Core of Bubble-Containing Liposomes for Controlled Release Via Shear-induced Bilayer Reorganization", National Science Foundation, 7/01/16 – 6/30/19

"Physiologically-Activated Intravenous Ultrasound Contrast Agent", Coulter-Drexel Translational Research Partnership,Collaborative Translational Research Grant, 7/1/16 –6/30/19

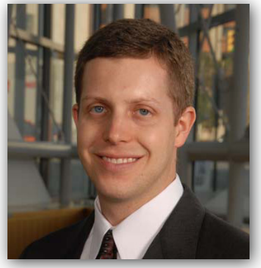
"GAANN: Engineering for Pharmaceutical Applications", United States Department of Education, 9/1/15 – 8/31/18

JOURNAL PUBLICATIONS (Peer Reviewed)

Cimorelli, M.; Angel, B.; Fafarman, A.T.; Kohut, A.; Andrien, B.; Barrett, K.; Wrenn, S. Introducing a Nested Phase Change Agent with an Acoustic Response That Depends on Electric Field: A Candidate for Myocardial Perfusion Imaging and Drug Delivery. *Applied Acoustics* **2018**, 138, 9 – 17.
DOI: 10.1016/j.apacoust.2018.03.028

Bastarrachea, L.J.; Walsh, M.; Wrenn, S.P.; Tikekar, R. V. Enhanced Antimicrobial Effect of Ultrasound by the Food Colorant Erythrosin B. *Food Res. Intl.* **2017**,100, 344-351.
DOI: 10.1016/j.foodres.2017.07.012

Huang,K.; Wrenn, S.; Tikekar, R.; Nitin, N. Efficacy of Decontamination and a Lowered Risk of Cross-Contamination During Ultrasound-Assisted Washing of Fresh Produce. *J. Food Eng.* **2018**, 224, 95 – 104.
DOI: 10.1016/j.jfoodeng.2017.11.043



Jason B. Baxter

Associate Professor
PhD, University of California, Santa Barbara

✉ jbaxter@drexel.edu

Jason B. Baxter earned a BS in Chemical Engineering from the University of Delaware in 2000 and a PhD in Chemical Engineering from the University of California Santa Barbara in 2005. After two years of postdoctoral work at Yale University, he joined the Department of Chemical and Biological Engineering at Drexel as an Assistant Professor in 2007. Baxter was tenured in 2013 and promoted to full professor in 2018. His research group focuses on solar energy conversion, including materials chemistry of oxide and chalcogenide thin films and nanostructures, fabrication and characterization of photovoltaic cells and photoelectrochemical cells, and ultrafast photophysics of solar energy materials. Baxter has received the NSF CAREER Award and Drexel's College of Engineering Outstanding Teacher Award. He has authored or co-authored ~50 original articles and has graduated six PhD students to date. Baxter is the Chair of CBE Undergraduate Committee, where he has led the department's effort to develop the innovative new curriculum that debuted with the 2016 incoming class.

EXTERNAL RESEARCH FUNDING

"Collaborative Research: Ultrafast Carrier Dynamics to Link Processing, Structure and Performance in High-Efficiency Cu2Zn(S,Se)4 Thin Film Photovoltaics", National Science Foundation (DMR), 7/1/15 – 6/30/19

"Collaborative Research: Directing Charge and Energy Flow in Discrete Nanocrystal-Dendrimer Hybrids and in Their Assemblies", National Science Foundation (CHEM), 7/1/17 – 6/30/20

"Collaborative Research: SusCHEM: Environmental Sustainability of Lead Perovskite Solar Cells", National Science Foundation (CBET), 7/1/17– 6/30/20

JOURNAL PUBLICATIONS (Peer Reviewed)

Smolin, S. Y.; Choquette, A. K. ; Wang, J. ; May, S. J.; Baxter, J. B. Distinguishing Thermal and Electronic Effects in Ultrafast Optical Spectroscopy Using Oxide Heterostructures. *J. Phys. Chem. C* **2018**, 122, 115.
DOI: 10.1021/acs.jpcc.7b09592

Edley, M. E.; Opasanont, B.; Conley, J.; Tran, H. ; Smolin, S. Y. ; Li, S.; Dillon, A. D. ; Fafarman, A. T.; Baxter, J.B. Solution Processed CuSbS2 Films for Solar Cell Applications. *Thin Sol. Films* **2018**, 646, 180.
DOI: 10.1016/j.tsf.2017.12.002

Antunez, P. D. ; Li, S.; Bishop, D. M.; Farmer, D. B.; Gershon, T. S.; Baxter, J. B.; Haight, R. Passivation and Thickness Control of Highly Efficient Kesterite Solar Cells. *Appl. Phys. Lett.* **2018**, 113, 033903.
DOI: 10.1063/1.5037093

Dastidar, S.; Li, S.; Smolin, Y.; Baxter, J. B.; Fafarman, A. T.; Slow Electron-Hole Recombination in Lead Iodide Perovskites Does Not Require a Molecular Dipole *ACS Energy Lett.* **2017**, 2, 2239.
DOI:10.1021/acsenergylett.7b00606

Richard A. Cairncross

Associate Professor
PhD, University of Minnesota

✉ cairncra@drexel.edu

Richard Cairncross earned a BS in Chemical Engineering from the University of Rochester in 1989 and a PhD in Chemical Engineering from the University of Minnesota in 1994. He spent one year as a postdoctoral associate at Sandia National Laboratories and two years as a visiting professor at the University of Delaware before joining Drexel University in 1997. Professor Cairncross' research group works on topics related to sustainability and renewable energy with recent projects focused on developing processes to produce biofuels from waste materials and assessing the techno-economic and environmental impacts of waste-to-fuel processes. Cairncross is a recipient of a PECASE Award, a Fulbright Lectureship (on renewable energy in El Salvador), an EPA P3 (People, Prosperity and the Planet) Award, the LE Scriven Young Investigator Award from the International Coating Science and Technology Society, and the Carl Dahlquist Best Paper Award from the Pressure Sensitive Tape Council. Cairncross has authored or co-authored over 50 original research articles and graduated nine PhD students. Cairncross has been very active in Engineers Without Borders and sustainable development projects in El Salvador. Cairncross is also a partner in Environmental Fuel Research, LLC, a small business that was formed to explore commercialization of waste grease to biodiesel processes based on his research at Drexel.

JOURNAL PUBLICATIONS (Peer Reviewed)

Hughes, M.; Jones, K.; Hums, M.; Cairncross, R.; Wyatt, V. Identification of Sulfur-Containing Impurities in Biodiesel Produced From Brown Grease. *J. Am. Oil Chem. Soc.* **2018**, 95, 407-420.
DOI: 10.1002/aocs.12048

Hums, M.; Amin, H.; Tsao, Y.; Olson, M.; Spatari, S.; Cairncross, R. Longitudinal Study of Wastewater Greases and Their Potential for the Production of Biofuels. *Energy Fuels* **2018**, 32, 1831-1842.
DOI: 10.1021/acs.energyfuels.7b03550

Vibha Kalra

Associate Professor
PhD, Cornell University

✉ vk99@drexel.edu

Vibha Kalra received her Bachelor of Science in Chemical Engineering from the Indian Institute of Technology, Delhi, India in 2004. She earned her PhD in Chemical Engineering from Cornell University in 2009. Prior to joining Drexel in the Fall of 2010, she worked at Intel Corporation in the electronic packaging research division. Kalra has been an Associate Editor of Chemical Engineering Science since Sept. 2013. Kalra's research interests involve the design of new nanoscale materials for efficient energy storage devices such as batteries and supercapacitors. Her work includes material synthesis, fabrication, characterization, device assembly and testing, and in-situ spectroscopy to understand the physical and chemical phenomena that govern energy storage. She is a recipient of several awards including the NSF CAREER award (2012), ONR summer faculty fellowship award (2013), AICHE DVS Outstanding Faculty of the Year Award (2015), and Outstanding Research Award, COE, Drexel University (2015).

EXTERNAL RESEARCH FUNDING

"CAREER: Highly-ordered Electrode/Catalyst Assembly in Proton Exchange Membrane Fuels for Enhanced Catalyst Utilization", National Science Foundation, 9/1/12 – 8/31/19

"Hybrid Supercapacitators Based on Electroactive Polymer Shrink-Wrapped Mesoporous Carbon Nanofibers", National Science Foundation, 9/1/15 – 8/31/19

"MRI: Development of a Direct Detection Energy Loss Spectroscopy System", National Science Foundation, 8/1/14 – 7/31/18

"Confined Self Assembly of Conjugated Rod-Rod Diblock Copolymers in Nanofibers: Experiments and Simulations", National Science Foundation, 1/1/16 – 12/31/18

"Binder-free Carbon/Sulfur Cathodes for Lithium-sulfur Batteries", Murata Manufacturing Co., Ltd., 10/2017-18

"Effects of Electrode Microstructure and Li2O2 Growth on Li-air Battery Performance", National Science Foundation, 7/1/18 – 6/30/21

JOURNAL PUBLICATIONS (Peer Reviewed)

Dillard, C.; Singh, A.; Kalra, V. Polysulfide Speciation and Electrolyte Interactions in Lithium–Sulfur Batteries with in Situ Infrared Spectroelectrochemistry. *J. Phys. Chem. C* **2018**, 122, 18195-18203.
DOI: 10.1021/acs.jpcc.8b02506

Dillard, C.; Chung, S-H.; Singh, A.; Manthiram, A.; Kalra, V. Binder-Free, Freestanding Cathodes Fabricated with an Ultra-Rapid Diffusion of Sulfur into Carbon Nanofiber Mat for Lithium Sulfur Batteries. *Materials Today Energy* **2018**, 9, 336-344.
DOI: 10.1016/j.mtener.2018.06.004

Li,X.; Rafie, A.; Yuriy, S.; Simotwo, S.; Kalra, V.; Lau, KKS. Engineering Conformal Nanoporous Polyaniline via Oxidative Chemical Vapor Deposition and its Potential Application in Supercapacitors. *Chem. Eng. Sci.* **2018**.
DOI: 10.1016/j.ces.2018.06.053 (Invited Special Issue Article)

Pai, R.N.; Kalra, V. High Performance Aqueous Asymmetric Supercapacitor based on Iron Oxide Anode and Cobalt Oxide Cathode. *J. Mater. Res.* **2018**, 33, 1199-1210.
DOI: 10.1557/jmr.2018.13 (Invited Special Issue Article)

Pai, R.N.; Singh, A.; Simotwo, S.; Kalra. V., In-Situ Grown Iron Oxides on Carbon Nanofibers as Freestanding Anodes in Aqueous Supercapacitors. *Adv. Eng. Mater.* **2018**, 20, 1701116.
DOI: 10.1002/adem.201701116

Simotwo, S.; Kalra, V. Polyaniline-Carbon Based Binder-Free Asymmetric Supercapacitor in Neutral Aqueous Electrolyte. *Electrochim. Acta* **2018**, 268, 131-138.
DOI: 10.1016/j.electacta.2018.01.157

Simotwo, S.; Chinnam, PR.; Wunder, S. L.; Kalra, V. Highly Durable, Self-Standing Solid-State Supercapacitor Based on Ionic Liquid-Rich Ionogel and Activated Carbon Nanofiber Electrodes. *ACS Appl. Mater. Interfaces* **2017**, 9, 33749-33757.
DOI: 10.1021/acsami.7b07479

Kenneth K. S. Lau

Professor
PhD, Massachusetts Institute of Technology

✉ klau@drexel.edu

Kenneth K. S. Lau received a B.Eng. (Chemical) from the National University of Singapore in 1995 and a PhD in Chemical Engineering from MIT in 2000. After postdoctoral work at MIT, he joined the Department of Chemical and Biological Engineering at Drexel University as an Assistant Professor in 2006. Lau was tenured and promoted to Associate Professor in 2012, and promoted to Professor in 2018. He was appointed the Graduate Academic Advisor of the department in 2014 and was further appointed the Associate Department Head in 2017. Lau's research centers on polymer thin films and devices, particularly pursuing novel chemical vapor deposition pathways for polymer synthesis and device fabrication for applications in energy capture, energy storage, latent heat transfer, biomedicine, and fabrics. Lau is the recipient of an NSF CAREER Award and was the lead PI on a $1.125M NSF Major Research Instrumentation Grant. To date, Lau has produced 76 original research products, including 4 book chapters and 2 patents, and has graduated 4 PhD and 3 MS students. Lau is a member of the International Advisory Committee of the International Hot Wire Chemical Vapor Deposition Conference, and chaired the 9th International HWCVD Conference in 2016.

EXTERNAL RESEARCH FUNDING

"Engineering of Polymer Electrolytes for Energy Storage", National Science Foundation, 7/1/15 – 6/30/19

"Spatial Control of Condensate and Wetting Regimes using Heterogeneous and Hierarchical Surface Structures for Enhanced Heat Transfer", National Science Foundation, 9/1/15 – 8/31/19

"Hybrid Carbon-Polymer Supercapacitors for High Energy Storage and Power Delivery", National Science Foundation, 9/1/15 – 8/31/19

"Thermoset Design for Additive Manufacturing", U.S. Army Research Laboratory, 7/1/17 – 6/30/20

"Engineering Water and Oil Repellent Coatings for High Performance Fabrics", W. L. Gore and Associates, 7/1/16 – 6/30/18

"Collaborative Research: Optimal Design and Operation of Dye Sensitized Solar Cells Using an Integrated Strategy Involving First-Principles Modeling, Synthesis, and Characterization", National Science Foundation, 8/1/12 – 7/31/17

"Synthesis and Processing of Electroactive Polymers in Nanostructured Energy Devices", National Science Foundation, 7/1/13 – 6/30/17

JOURNAL PUBLICATIONS (Peer Reviewed)

Li, X.; Rafie, A.; Smolin, Y.Y.; Simotwo, S.; Kalra, V.; Lau, K.K.S. Engineering Conformal Nanoporous Polyaniline via Oxidative Chemical Vapor Deposition and Its Potential Application in Supercapacitors. *Chem. Eng. Sci.* **2018**.
DOI: 10.1016/j.ces.2018.06.053

Hanak, B.W.; Hsieh, C.-Y.; Donaldson, W.; Browd, S.R.; Lau, K.K.S.; Shain, W. Reduced Cell Attachment to Poly (2- hydroxyethyl methacrylate)-Coated Ventricular Catheters In Vitro. *J. Biomed. Mater. Res., Part B.* **2018**, 106 (3), 1268-1279.
DOI: 10.1002/jbm.b.33915

Nicolas J. Alvarez

Assistant Professor
PhD, Carnegie Mellon University

nja49@drexel.edu

Nicolas J. Alvarez earned a BS in Chemical Engineering from the University of Florida in 2006 and a PhD in Chemical Engineering from Carnegie Mellon University in 2011. After three years of postdoctoral work at the Technical University of Denmark in Lyngby, he joined the Department of Chemical and Biological Engineering at Drexel as an Assistant Professor in 2014. Alvarez's research interests involve development of unique experimental tools to understand and characterize the behavior of polymers and surfactants in nonlinear flows, at interfaces, and in bulk. These tools are used to understand how certain processing windows lead to advantageous material properties. One such tool, used for the characterization of extensional rheology, has been commercialized by Alvarez and colleagues. Alvarez is developing a consortium of companies interested in the development of analytical tools to better understand the relationship between chemical structure, processing, and material performance. Alvarez teaches an elective course on non-Newtonian fluid mechanics that introduces students to real-world materials encountered in modern day chemical plants.

EXTERNAL RESEARCH FUNDING

Tailored Universal Formulation Feedstock", DARPA, 4/1/16 – 3/31/19

"Correlations between Extensional Rheology and Processing for Commercial Systems", Dupont, 05/01/18 – 03/31/19

"Hydrogel-Talc Foam Improves Delivery for Treatment of a Malignant Pleural Effusion", NIH Cancer Institute, 4/1/18 – 03/31/19

"From Pitch to Carbon Fiber", Exxon Mobil Corporation, 07/01/18 – 06/31/19

"Photo-Deformable Polymer Films from Block Copolymers (Photoswitch)", Danish Research Council, 9/1/15 – 8/31/19

"Materials for Extreme Environments", Army Research Laboratory, 1/1/15 – 12/31/19

"Identifying the Rules Governing Tripeptide Gelation in Aqueous Solution", NSF-DMR, 8/15/17 – 7/31/20

"Thermosets for Agile Manufacturing", Army Research Laboratory, 11/1/17 – 10/30/22

JOURNAL PUBLICATIONS (Peer Reviewed)

O'Connor, T.C.; Alvarez, N.J.; Robbins, M.O. Relating Chain Conformations to Extensional Stress in Entangled Polymer Melts *Phys. Rev. Lett.* **2018**, 121, 047801.
DOI: 10.1103/PhysRevLett.121.047801

Morelly, S.L.; Alvarez, N.J.; Tang, M.H. Short-Range Contacts Govern the Performance of Industry-Relevant Battery Cathodes. *J. Power Sources* **2018**, 387, 49-56
DOI: 10.1016/j.jpowsour.2018.03.039

Akuzum, B.; Maleski, K.; Anasori, B.; Lelyukh, P.; Alvarez, N.J.; Kumbur, E.C.; Gogotsi Y. Rheological Characteristics of 2D Titanium Carbide (MXene) Dispersions: A Guide for Processing MXenes. *ACS Nano* **2018**, 12, 2685-2694.
DOI: 10.1021/acsnano.7b08889

DiGuiseppi, D.; Schweitzer-Stenner, R.; Alvarez, N.J. Exploring the Tunability of the Aggregation and Gelation Process of Tripeptides. *Biophys. J.* **2018**, 114 (3, Supl. 1), 589a.
DOI: 10.1016/j.bpj.2017.11.3222

Wagner, M.H.; Wingstrandt, S.L.; Alvarez, N.J.; Narimissa, E. The Peculiar Elongational Viscosity of Concentrated Solutions of Monodisperse PMMA in Oligomeric MMA. *Rheologica Acta* **2018**, 57, 591-601.
DOI: 10.1007/s00397-018-1098-4

Shabbir, A.; Huang, Q.; Baeza, G.P.; Vlassopoulos, D.; Chen, Q.; Colby, R.H.; Alvarez, N.J.; Hassager, O. Nonlinear Shear and Uniaxial Extensional Rheology of Polyether-Ester-Sulfonate Copolymer Ionomer Melts. *J. Rheol.* **2017**, 61(6), 1279-1289.
DOI: 10.1122/1.4998158

Morelly, S.L.; Tang, M.H.; Alvarez, N.J. The Impotence of Non-Brownian Particles on the Gel Transition of Colloidal Suspensions. *Polymers* **2017**, 9, 461.
DOI: 10.3390/polym9090461

Aaron Fafarman

Assistant Professor
PhD, Stanford University

atf37@drexel.edu

Aaron Fafarman earned a BS in Chemistry from the University of California, Berkeley in 2000 and a PhD in Physical Chemistry from Stanford University in 2010. After a postdoc in Electrical Engineering at the University of Pennsylvania, he joined the Department of Chemical and Biological Engineering at Drexel as an Assistant Professor in 2013. His lab seeks to develop new wet-chemical techniques for the fabrication of energy-conversion materials and to deepen our understanding of the coupling between synthesis, nanoscale structure and function. Of particular interest are the effects of nanostructure and compositional heterogeneity on the density of electronic defects in semiconducting materials and the discovery of novel, defect-tolerant materials. Dr. Fafarman has been recognized with an Outstanding Faculty award from the Delaware Valley Section of AIChE, an Outstanding Early-Career Research Achievement Award from Drexel's College of Engineering, an Outstanding STAR Mentor award from Drexel University and the Linus Pauling Chemistry Teaching award from Stanford University. He is currently the chair of the Electronic and Photonic Materials program of AIChE, co-Chair of the Department Safety Committee and is the faculty advisor for the Drexel AIChE Student Chapter. He has authored or co-authored 33 peer-reviewed papers and has five patents issued.

EXTERNAL RESEARCH FUNDING

"Low-Voltage, Low-Waste Fabrication of Inorganic Semiconducting Thin Films by Electrophoretic Deposition Under Flow", National Science Foundation, 9/1/15 – 8/31/19

"Nanocrystal Precursors to Doped Cesium Metal Halide Perovskite Photovoltaics", National Science Foundation, 6/15/16 – 5/31/19

JOURNAL PUBLICATIONS (Peer Reviewed)

Dillon, A. D.; Mengel, S.; Fafarman, A. T. Influence of Compact, Inorganic Surface Ligands on the Electrophoretic Deposition of Semiconductor Nanocrystals at Low Voltage. *Langmuir* **2018**, 34 (33), 9598–9605.
DOI: 10.1021/acs.langmuir.8b00787

Dastidar, S.; Li, S.; Smolin, S.; Baxter, J. B.; Fafarman, A. T. Slow Electron–Hole Recombination in Lead Iodide Perovskites Does Not Require a Molecular Dipole. *ACS Energy Lett.* **2017**, 2 (10), 2239–2244
DOI: 10.1021/acsenergylett.7b00606

FACULTY PROFILES

TEACHING PROFESSORS

Joshua D. Snyder

Assistant Professor
PhD, Johns Hopkins University

✉ **jds43@drexel.edu**

Joshua D. Snyder earned a BS and MS in Chemical and Biological Engineering from Drexel University in 2006 and a PhD in Chemical and Biomolecular Engineering from Johns Hopkins University in 2012. After two years at Argonne National Lab as a Director's Postdoctoral fellow, he joined the Department of Chemical and Biological Engineering at Drexel University in 2014. Professor Snyder's research interests include the study of interfacial phenomena in nanoscale materials and development of catalysts for next generation renewable energy conversion and storage technologies. Professor Snyder was awarded the 2016 Electrochemical Society Toyota Young Investigator Award and has authored or co-authored more than 20 peer reviewed publications.

EXTERNAL RESEARCH FUNDING

"Electrocatalytic Interface Engineering to Address Scaling Relations in Multi-Intermediate Electrochemical Reactions", Electrochemical Society, 9/1/16 – 8/31/17

"Bottom-up Design of Earth-Abundant Catalysts for Reversible Hydrogen Oxidation and Reduction in Alkaline", National Science Foundation, 7/1/16 – 6/30/19

"Electrochemical Reformation of Methane to High Purity Hydrogen", American Chemical Society Petroleum Research Fund, 9/1/17 – 8/31/19

"Highly-Accessible Catalysts for Durable High-Power Performance", DOE EERE, 07/01/16 – 06/31/19

JOURNAL PUBLICATIONS (Peer Reviewed)

Li, Y.; Polakovic, T.; Curtis, J.; Shumlas, S.; Chatterjee, S.; Intikhab, S.; Chareev, D.; Volkova, O.; Valsiliev, A.; Karapetrov, G.; Snyder, J.; Tuning the Activity/Stability Balance of Anion Doped CoSxSe2-x Dichalcogenides. *J. Catal.* **2018**, 366, 50-60.
DOI: 10.1016/j.jcat.2018.07.030

Meshkian, R.; Dahlqvist, M.; Lu, J., Wickman; B., Halim, J., Thornberg, J.; Tao, Q.; Li, S.; Intikhab, S.; Snyder, J.; Barsoum, M.; Yildizhang, M.; Palisaitis, J.; Hultman, L.; Persson, P; Johanna, R.; W-Based Atomic Laminates and Their 2D Derivative W1.33C MXene with Vacancy Ordering. *Adv. Mater.* **2018**, 30, 1706409.
DOI: 10.1002/adma.201706409

Intikhab, S.; Snyder, J.; Tang, M.H.; Adsorbed Hydroxide does not Participate in the Volmer Step of Alkaline Hydrogen Electrocatalysis. *ACS Catal.* **2017**, 7, 8314-8319.
DOI: 10.1021/acscatal.7b02787

Li, Y.; Hart, J.; Taheri, M.; Snyder, J. Morphological Instability in Topologically Complex, Three-Dimensional Electrocatalytic Nanostructures. *ACS Catal.* **2017**, 7, 7995-8005.
DOI: 10.1021/acscatal.7b02398

Kim, Y.; Lopes, P.; Park, S.; Lee, A.; Lim, J.; Lee, H.; Back, S.; Jung, Y.; Danilovic, N.; Stamenkovic, V.; Erlebacher, J.; Snyder, J.; Markovic, N. Balancing Activity, Stability and Conductivity of Nanoporous Core-Shell Iridium/Iridium Oxide Oxygen Evolution Catalysts. *Nat. Commun.* **2017**, 8, 1449.
DOI: 10.1038/s41467-017-01734-7

Maureen Tang

Assistant Professor
PhD, University of California, Berkeley

✉ **mht38@drexel.edu**

Maureen Tang joined the faculty of Chemical and Biological Engineering at Drexel University in fall 2014. She received her BS in Chemical Engineering from Carnegie Mellon University in 2007 and her PhD from the University of California, Berkeley in 2012. While at Berkeley, she received a NSF Graduate Research Fellowship, an NSF East Asia Pacific Summer Fellowship, and the Daniel Cubiciotti Student Award of the Electrochemical Society. Dr. Tang completed postdoctoral work at Stanford University and research internships at Kyoto University, the University of Dortmund, and DuPont. She is the recipient of a NSF CAREER award. Her research at Drexel develops materials, architectures and fundamental insight for electrochemical energy storage and conversion.

EXTERNAL RESEARCH FUNDING

"Functional Carbon Surfaces for Stable Passivation of sodium-ion Battery Electrodes", National Science Foundation, 7/1/16 – 6/30/19

"Bottom-up Design of Earth-Abundant Catalysts for Reversible Hydrogen Oxidation and Reduction in Alkaline Electrolytes", National Science Foundation, 7/1/16-6/30/19

"CAREER: Predicting Battery Lifetime from Direct Measurements of Inter-Electrode Communication," National Science Foundation, 1/1/2018-12/31/2022

JOURNAL PUBLICATIONS (Peer Reviewed)

Intikhab, S.; Snyder, J.; Tang, M.H. Adsorbed Hydroxide Does Not Participate in the Volmer Step of Alkaline Hydrogen Electrocatalysis. *ACS Catal.* **2017**, 7, 8314-8319.
DOI: 10.1021/acscatal.7b02787

Morelly, S.L.; Tang, M.; Alvarez, N.J.; The Impotence of Non-Brownian Particles on the Gel Transition of Colloidal Suspensions. *Polymers* **2017**, 9, 461.
DOI: 10.3390/polym9090461

Morelly, S.L.; Alvarez, N.J.; Tang, M.H. Short-Range Contacts Govern the Performance of Industry-Relevant Battery Cathodes. *J. Power Sources* **2018**, 387, 49-56.
DOI: 10.1016/j.jpowsour.2018.03.039

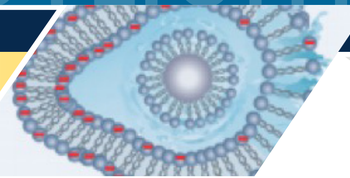
Ardo, Shane, et al. Pathways to Electrochemical Solar-Hydrogen Technologies. *Energy Environ. Sci.* **2018**.
DOI: 10.1039/C7EE03639F

John Speidel

John Speidel earned his BS degree in Chemical Engineering from the University of Delaware and his MS degree in Chemical Engineering from Illinois Institute of Technology. John's career path began in the local Philadelphia refinery of Atlantic Richfield. He moved to the Harvey Technical Center near Chicago, IL where he was involved in the design of hydrodesulfurization, isomerization, and catalytic reforming units. From there, he moved to ARCO Chemical (then a division of Atlantic Richfield). At ARCO Chemical, John was involved with designing plants for Olefins manufacturing, Propylene Oxide Production, Butanediol, and a number of the associated derivatives and polymers. Through acquisitions, the company name changed to Lyondell then Lyondell Basell. John held job titles such as Process Engineer, Technical Services Engineer, Senior Process Design Engineer, Process Manager for Asia, and Process Design Manager. John joined the Department of Chemical and Biological Engineering in 2011 as a Teaching Professor. He teaches seniors Process Design and Chemical Process Safety.

Michael J. Walters

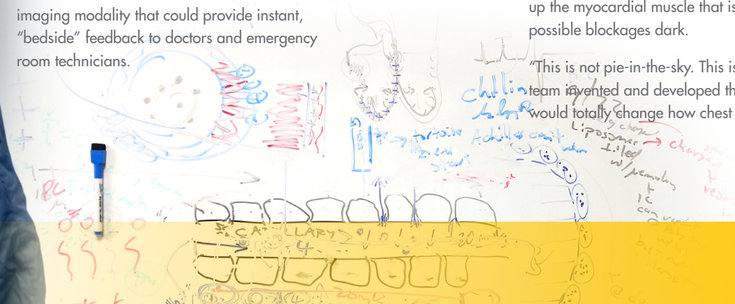
Michael J. Walters earned a BS in Chemical Engineering from Bucknell University in 2000. He earned his MS in Chemical Engineering from Northeastern University in 2005 and a PhD in Chemical Engineering from Drexel University in 2010. Additionally, Michael received postdoctoral training in biochemistry and pathology at the University of Pennsylvania. He also worked in the pharmaceutical industry at Merck in a management rotational program and as a vaccine-manufacturing supervisor. Michael's research experience includes liposome colloid science, atherosclerosis pathophysiology, protein purification, and lipid-protein interactions. In 2016, he joined the Department of Chemical and Biological Engineering at Drexel as an Assistant Teaching Professor, where he focuses on the undergraduate fluid mechanics, heat transfer, and mass transfer laboratory courses and has also taught Process Energy Balances and Freshman Design. In 2017 Michael received the Drexel Chemical and Biological Engineering Outstanding Teaching Award.



CBE Researchers Develop Novel

VOLTAGE-ACTIVATED CONTRASTING AGENT

The US Centers for Disease Control and Prevention has initiated a new national effort called "Million Hearts 2022," with the goal of preventing a million heart attacks and strokes by the year 2022. In a coincidental, potentially groundbreaking contribution to that mission, Department of Chemical and Biological Engineering (CBE) researchers have developed a novel voltage-activated ultrasound contrast enhancing agent called ELECTRAST that detects the presence of blockages in the myocardium by "brightening" healthy regions while leaving blocked areas dark. ELECTRAST uses the heart's own electrical activity to become visible with ultrasound, a non-invasive imaging modality that could provide instant, "bedside" feedback to doctors and emergency room technicians.



As featured in the September issue of *Applied Acoustics*, ELECTRAST is being developed under the direction of Steven Wrenn, PhD, professor, CBE; Michael Cimorelli, doctoral candidate, CBE; Aaron Fafarman, PhD, assistant professor, CBE; Brett Angel, MD, cardiologist, Drexel College of Medicine; and Andrew Kohhut, MD, cardiologist, University of Pennsylvania, Perelman School of Medicine. The technology has been validated in the laboratory, in human-tissue-mimicking-hydrogels, in rats, and in pigs. Acoustic attenuation and scattering studies are underway to fully characterize the unique ultrasound response of ELECTRAST. High-speed imaging studies will soon be performed in collaboration with the University of Pittsburgh. Two patents are pending.

ELECTRAST is scientifically interesting because of the way it utilizes the heart's electric field. It is also of practical interest and clinically relevant because it utilizes ultrasound, which means ELECTRAST is potentially a safer, faster, and less expensive tool than those currently used to determine whether a patient is having or is at-risk for having a heart attack. Conventional diagnostics are often expensive, inadequate to the task, and use ionizing radiation. ELECTRAST selectively activates to brighten or light up the myocardial muscle that is responsible for the pumping action of the heart – leaving the areas of possible blockages dark.

"This is not pie-in-the-sky. This is working. And the implications are huge," said Professor Wrenn, whose team invented and developed the agent over the past three years. "It doesn't seem outlandish that we would totally change how chest pain is diagnosed and treated. That's our intention."

As an imaging agent, ELECTRAST is:

- voltage-sensitive, so it is selectively activated by the electrical activity of the heart;
- becomes visible with ultrasound upon entering the coronary circulation;
- brightens the myocardium while leaving the heart's ventricle dark by comparison, so that blockages are readily apparent;
- avoids ionizing radiation.

The agent comprises liquid droplets nested inside a liposome, which means it remains dormant until acted upon by the heart's depolarization wave. The agent remains largely inactive outside the myocardium and also inside the myocardium in regions that are either not functional or not perfused with blood. Regions that turn bright under ultrasound are therefore both perfused and functional; in other words, healthy.

ELECTRAST could have applications not only as a non-invasive emergency room diagnostic for individuals complaining of chest pain and other symptoms, but as an annual screening device that locates and tracks areas that could potentially lead to a heart attack.

CBE

UNDERGRADUATE ACTIVITY

The 2017-2018 academic year was filled with activity for CBE undergraduates. Students kept busy organizing events to benefit the undergraduate community, participating in several outreach activities to engage local children and building a network of fellow chemical engineers.

In the fall, AIChE members planned, hosted and participated in their 3rd Annual Career Forum Dinner. The popular event boasted high attendance and offered all CBE undergraduate students the chance to meet with potential co-op and future full-time employers. Eager volunteers also participated in CBE's annual alumni event, where they provided tours of campus and connected with alums over their shared Drexel experience.

Undergraduates took part in several promising outreach activities during the winter term. At the 7th annual Philly Materials Day, volunteers led children in a chalk-making activity with the goal of getting kids excited about STEM. Volunteers were at it again at the Franklin Institute's Plastics Chemistry Fair where they planned several creative activities for both children and adults and at the 2018 "Introduce a Girl to Engineering Day" where girls were invited to make lip-gloss with our students.

This year, AIChE hosted their inaugural career trajectories event. Inspired by the Drexel co-op program, the impetus for this event was to make clear to undergraduates all of the career paths open to them. The professionals in attendance shared their real-world experiences including their best and toughest moments. This event provided students with a clearer vision of the work life of a chemical engineer.

In addition to being honored at the AIChE Delaware Valley Section Awards, AIChE members attended the regional AIChE conference this spring held at Princeton University. There students learned about new developments in the field and had the opportunity to meet with other student members in the area. As the year came to a close, students from both co-op cycles came together for the very first inter-cycle mixer, an event organized for students from opposite class cycles to meet up and wish each other well at the beginning of a new term.

CBE Alumni Events

ANNUAL EVENT

On Saturday, October 7, 2017, the Department of Chemical and Biological Engineering hosted its fifth Alumni Annual Event. CBE has been taking the initiative to reunite alumni with the department, while creating a sense of community among students, faculty, and alumni.

During the reception, Dr. Cameron Abrams provided an overview and update of the department, discussing all of the year's efforts to generate increased alumni initiatives, including the mentoring program, the annual event, and the spring panel discussion. Following his presentation, Dr. Abrams presented Ed Andjeski '87 with the Alumni of the Year award, noting his outstanding engagement efforts and commitment to the department.

Interim Dean, Giuseppe R. Palmese, delivered the keynote lecture on bio-based materials as building blocks for new classes of polymers with unique performance characteristics inspired by nature. The presentation spanned twenty years of research and commercialization activities.

PANEL EVENT

On Saturday, April 28, 2018, the CBE department in cooperation with Drexel's AIChE student group, hosted CBE's fourth Spring Panel Event, "Leadership in Chemical Engineering". Undergraduate and graduate students as well as alumni and faculty attended the event. Michael Barry '81, Chairman and CEO of Quaker Chemical Corporation, was the moderator and keynote speaker. Panelists included Robert Summerhayes of Operational Improvement Services, Amber Shook '98 of Catalent Pharma, Robert Stewart '89 of Croda and Jennifer McIntyre '87 Univar.

Chris Owens '03, CBE Industrial Advisory Board president, delivered a presentation on "Networking Basics" which included a how-to on making an elevator pitch as well as tips for using LinkedIn to build your network. The panel discussion centered on the following questions: "How has leadership changed within your industry and what should young engineers expect as they develop skills?" and "How can individuals whose personality traits don't align with natural leadership skills manage the hurdles of leadership?"

We would like to recognize our Industrial Advisory Board members for their dedication to the Drexel University Department of Chemical and Biological Engineering.

2018

Chemical & Biological Engineering
INDUSTRIAL ADVISORY BOARD

Ed Andjeski '87
Associate Director of Engineering and Facilities
Endo Pharmaceuticals

Ron Connolly '91
COO
Frontida BioPharm, Inc.

Julia Cutler '09
Customer Service & Logistics Manager
Colgate Oral Pharmaceuticals

Cynthia DeBisschop, PhD '93
Senior Cyber Security Engineer
MAR Division of Oasis Systems

Garland Fussell, PhD
Senior Research and Development Scientist
PolyOne Corporation

Kaustubh Ghorpade '06
Process Improvement Manager
Sekisui Specialty Chemicals

Michael C. Grady '82
Global Process Development Manager
Axalta Coating Systems

Deborah L. Grubbe, PE, CEng, NAC
Owner and President
Operations and Safety Solutions, LLC

Padma Narayan, PhD '99
IAB Vice President
Director, Formulation Development, Tech Ops Development, SAGE Therapeutics

Chris R. Owens '03
IAB Board President
President
OppNex

Eric Perakslis, PhD '07
Chief Science Officer
Datavant

Christopher Peterson '09
Life Sciences Consultant
Latham BioPharm Group

Steven Schon, MS '84
Engineering Fellow
Arkema Inc.

THANK YOU

We are dedicated to fostering an environment of continuous innovation in which our students can develop their engineering and professional expertise. Our donors help is achieve this vision with donations funding initiatives aimed at improving laboratories, providing scholarships to deserving students, maintaining state-of-the-art facilities, and attracting and retaining the highest quality faculty. Most important, however, is the belief in our mission and the quality of our programs that these donations affirm.

INDIVIDUAL DONORS

Edmond Chidi Akubuiro
Mr. J. Craig Allen
Mr. Glenn R. Beachy
Mr. Wyn V. Davies*
Mr. Richard Edward DeFreyre
Mr. Gerard J. Donnelly
Peter Frattarelli, Esq.
Dr. Mehmet A. Gencer
Mrs. Judith E. Goldman
Mr. Louis F. Guarini
Mr. David S. Hammond
Mr. Philip M. Hittner
Mr. Larry E. Hoch
Mr. George R., Jr. Kinsley
Ms. Joan F. Lindenau
Mr. John McCallion
Ms. Mary P. McGuiness
Mr. Daniel J. McKenna
Mr. Chuck W. McLaughlin**
Mr. Timothy F. Nicholl
Mr. William Earl Noel
Dr. Earnest W. Porta
Mr. Barry G. Reid
Miss Margaret Schillinger
Mr. Jayant R. Shroff**
Dr. Norman H. Sweed*
Mr. Xing Zhuge

CORPORATE DONORS

ExxonMobil Corporation
Tyco Electronics Foundation
ExxonMobil Foundation
Reh Fund at Schwab Charitable
Mainline Biosciences LLC

** Friends of CBE - $500+* *** AJ Drexel Society - $1,000+*

How to Make a Gift

ONLINE:
drexel.edu/cbe/about/GivetoCBE

US MAIL:
Mail a check, payable to Drexel University, to the address below. Please indicate that your gift should be directed to the Department of Chemical and Biological Engineering.

Drexel University
Office of Institutional Advancement
P.O. Box 8215
Philadelphia, PA 19101-9684

CBE STAFF

Sean Blake
Business Manager
seb353@drexel.edu

Katie Brumbelow
Director of Undergraduate Affairs
kms88@drexel.edu

Andrea Falcone
Program Manager
amf369@drexel.edu

Vince Hatton
Lab Manager
vfh24@drexel.edu

Samantha Pearsall
Office Coordinator
sjp365@drexel.edu

Drexel University
Chemical & Biological Engineering
3141 Chestnut Street
Philadelphia, PA 19104

215.895.2227
drexel.edu/cbe

DREXEL UNIVERSITY
Chemical and Biological Engineering
College of Engineering