

Title: Sustainable Water through Innovation in Membranes & Materials (SWIMM)

Lead Faculty: Stephen Martin (Chemical Engineering); Robert Moore (Chemistry)

Faculty Member	Department	College
Stephen Martin	Chemical Engineering	COE
Donald Baird	Chemical Engineering	COE
Luke Achenie	Chemical Engineering	COE
Sanket Deshmukh	Chemical Engineering	COE
Johan Foster	Materials Science & Engineering	COE
Jason He	Civil & Environmental Engineering	COE
Peter Vikesland	Civil & Environmental Engineering	COE
Marc Edwards	Civil & Environmental Engineering	COE
Andrea Dietrich	Civil & Environmental Engineering	COE
David Dillard	Biomedical Engineering & Mechanics	COE
Jack Lesko	Biomedical Engineering & Mechanics	COE
Robert Moore	Chemistry	COS
Tim Long	Chemistry	COS
Judy Riffle	Chemistry	COS
Amanda Morris	Chemistry	COS
Shengfeng Cheng	Physics	COS
Kevin Edgar	Sustainable Biomaterials	CNRE
Klaus Moeltner	Agricultural & Applied Economics	CALS
Kang Xia	Crop & Soil Environmental Sciences	CALS
Ryan Stewart	Crop & Soil Environmental Sciences	CALS
Brian Badgley	Crop & Soil Environmental Sciences	CALS
Valisa Hedrick	Human Nutrition, Foods, and Exercise	CALS
Julia M. Gohlke	Population Health Sciences	Vet Med
Susan Duncan	Food Science and Technology	CALS

1. Vision Statement

In 2012, the United Nations reported that water scarcity affects every continent.¹ Around 700 million people in 43 countries currently face water shortages or lack access to clean drinking water. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions. Water scarcity is mainly caused by overwhelming human consumption and contamination, from production of water-thirsty meats and vegetables, biofuel crop production, industrial uses, and rapid urbanization.² The scale of water scarcity makes it an interconnected global issue and efforts to minimize the gap between water supply and demand are critical. Although over 70% of the surface of the earth is covered with water, less than 1% is easily accessible fresh water. Moreover, the distribution of fresh water is not even over the globe.³ Fresh water sources (e.g., rivers, lakes, groundwater) are increasingly being degraded below a usable quality for agriculture, industry, and drinking from anthropogenic inputs of inorganic (Anning and Flynn, 2012) and organic (Koplin et al 2002) contaminants. The generation and distribution of freshwater from non-potable fresh and saline sources has direct linkages to regional stability and global economic development.

Materials have an important role to play in water production, water reuse, and wastewater treatment, particularly for water purification via filtration, membrane separations, and advanced techniques such as electrodialysis. For example, total global desalination capacity has grown rapidly over the last decade and was projected to be over 100 million cubic meters (m³) per day in 2016. This capacity is two-fold higher than global water production by desalination in 2008.⁵⁻⁷ Properly designed and implemented membrane processes can be energy efficient and easily scalable, thus making them an ideal replacement for more energy intensive processes such as multi-effect distillation. Significant materials challenges still remain to the production of economical membranes with high flux, high selectivity, and good chemical and physical stability. In addition, the specific requirements vary based on the source water (i.e., sea water, brackish water, wastewater, hydraulic fracturing water, degraded fresh water) and the application (i.e., drinking water, industrial cooling water, agricultural and irrigation water, and water for food production.) This demands a multidisciplinary approach wherein application area experts work closely with researchers synthesizing new materials and fabricating novel membranes.

2. Relevance

Virginia Tech is uniquely positioned for prominence in the development and application of materials for water purification and processing due to our internationally acknowledged strengths in polymer science and engineering (MSE, Chemistry, Chemical Engineering, Materials Science and Engineering), water quality and treatment (Civil and Environmental Engineering, Water Interface IGEP, Crop & Soil Environmental Sciences, Biological Systems Engineering), and sustainability (Sustainable Nanotechnology IGEP, Sustainable Biomaterials, Green Engineering). For this effort we bring together the broad expertise of a diverse group of researchers, many of whom are well-known on the national and international stages. The research team is composed of faculty spread across a number of departments and colleges, and many are already involved in ongoing research collaborations and in current interdisciplinary initiatives. The team includes faculty from the colleges of Engineering, Science, Natural Resources & the Environment, and Agriculture & Life Sciences, and departments including those identified above as well as Physics, Materials Science & Engineering, Biomedical Engineering & Mechanics, Human Nutrition, Foods, & Exercise, and Agricultural & Applied Economics.

The goal of this program is to approach materials research for water applications for the broad range of water users and consumers. The breadth of the research team provides the capacity to link together research from diverse disciplines and over multiple scales from experimental and computational to molecular design of new materials through device fabrication, scale-up and manufacturing, process and system level modeling, and economic, environmental, and health impact and life-cycle analysis.

Relevance to GSS, the Materials SGA, and other Destination Areas: SWIMM is directly aligned with the “abundance and quality of fresh water” critical problem area identified in the GSS destination area. In addition, SWIMM is aligned with the “Environment” research pillar in the nascent Materials

SGA, and has been selected as one of 5 core research thrusts for further development. SWIMM will contribute to both the research and teaching goals of the GSS destination area. The group will leverage existing expertise, facilities, and collaborations to develop a broad, interdisciplinary research initiative in the development of new materials, devices, and systems in the critical area of sustainable water production and processing.

The proposed research area is complementary to three current Destination Areas: Intelligent Infrastructure for Human Centered Communities (IIHCC), Global System Science (GSS), Data Analytics & Decision Sciences. We envision potential interactions with IIHCC through their efforts in Smart Design and Construction, as water purification, delivery, and wastewater treatment are key elements in this area. The quantification of impacts of water production, quality, and distribution requires the analysis of large data sets, so there is clear potential for interactions with DADS.

Opportunities for Extramural Funding: Interest in water purification cuts across multiple funding sources, including government agencies and industrial sponsors. NSF has recently instituted a program for Innovations at the Nexus of Food, Energy and Water Systems (INFEWS) and this is a natural fit for the SWIMM effort. NSF has also funded Engineering Research Centers in the water area, such as the ERC on Nanofiltration at Rice University. Our approach is distinct in that we are focused on membrane-based technologies for reverse osmosis, forward osmosis, and electrodialysis applications. The USDA has recently announced an Agriculture and Food Research Initiative (AFRI) RFP in the “Water for Food Production Systems Challenge Area”, which is a natural fit for the program. In addition, there are several programs at the DOE and DOE that can be targeted. Current interdisciplinary funding in these areas at Virginia Tech include the REU program in research at the Food-Energy-Water Nexus run by the Macromolecules Innovation Institute, and the NSF REU and RET programs in Water Science. With some investment, Virginia Tech will be well positioned to apply for a Center level grant (ERC or MRSEC) in the area of membrane-based water purification within the next 3-5 years.

3. Curriculum Opportunities

The SWIMM focus lends itself well to the development of interdisciplinary curricular programs in sustainable water production – efforts that tie in directly to ongoing initiatives such as Pathways to Knowledge, and the VT-shaped student concept of undergraduate education. Such an effort could include the development of a Pathways minor that ties together the social, economic, scientific, and policy issues associated with the production of potable water and the treatment of wastewater. In addition, faculty in SWIMM would take a lead role in the development of an interdisciplinary curriculum at both the undergraduate level aimed at providing students with the tools and knowledge necessary to tackle both the technical and non-technical issues associated with water production and treatment.

4. Resource Needs

Current Resources to be Leveraged for SWIMM:

- ***Experimental Facilities and Expertise:***

- o Materials Synthesis: Laboratory facilities for new materials synthesis are available in CHE, Chemistry, Sustainable Biomaterials, and CEE.
- o Materials Characterization: Extensive capabilities for materials analysis and testing are available in CHE, Chem, CEE, and BEAM. In addition, the Nanoscale Characterization and Fabrication Laboratory (NCFL - ICTAS), the NSF sponsored NanoEarth Center, and the Macromolecular Materials Discover Center (MMDC - MII) provide state of the art characterization facilities accessible to users from around the university.
- o Membrane fabrication: Fabrication facilities for lab-scale membrane production are available in CHE, Chemistry, and CEE.
- o Membrane Testing: Equipment for testing of lab-scale membranes (i.e., membrane permeation and selectivity) is available in CHE, CEE, and Chemistry.
- o Water purification system testing: Equipment for evaluating small-commercial scale membranes in water purification systems are available in CEE.

- o Water quality analysis: The Environmental Organic Chemical Analysis Service Center at CSES has state-of-the-art UPLC/tandem mass spectrometry, GC/tandem mass spectrometry, molecular microbiology lab for analyzing microbial indicators and microbiomes, and other essential equipments for water testing of for analyzing organic and microbial contaminants. CEE has a state-of-the-art environmental and water resources laboratory and analytical instrumentation for detection of inorganic and organic water and air quality parameters at part per trillion concentrations and above.
- **Modeling and Analysis:**
 - o Significant expertise and capacity in molecular scale modeling (e.g., DFT, MD, CGMD), multi-scale modeling, optimization based approaches to inverse modeling, materials design and optimization, and process modeling exists in CHE and Physics.
 - o Economic Modeling and Analysis expertise is drawn primarily from Agricultural and Applied Economics.
- **Social and Environmental Impact:**
 - o VT has a strong track record in tying technology issues to relevant societal and environmental needs. We have identified faculty in various departments (e.g., CEE, Crop & Soil Environmental Science, Population Health Sciences, Food Science & Technology) whose expertise will allow SWIMM to identify needs and link developments in membrane materials and technology to specific social and environmental impacts.

New resources needed: Two primary interrelated gaps have been identified that must be filled in order to position SWIMM for national prominence. These gaps relate to the ability to transition materials and technologies from the lab scale to the pilot scale. First, only limited expertise is currently available in the area of large-scale membrane processing and manufacturing. *A targeted faculty hire, preferably at the Associate or Full Professor rank, in the area of advanced manufacturing of membranes would fill this knowledge gap.* Second, while lab scale membrane fabrication and testing facilities are available in several laboratories on campus, there are currently no larger pilot-scale facilities available. These facilities would allow the scale-up of new technologies from the lab scale (i.e., new membrane discovery) to the industrial scale, and would significantly increase VT's visibility in the area. In addition, these facilities would increase the potential for collaboration with and funding from industrial partners. It is hoped that these facilities could be developed in collaboration with the Materials SGA and IIHCC destination area.

5. Expected Outcomes

Milestones and deliverables: A significant goal of SWIMM is to foster increased interactions aimed at expanding current efforts in water purification, water quality, and membrane separations. As such, SWIMM will aim to hold quarterly meetings to generate dialog between interested faculty, as well as to identify specific opportunities for funding and outreach. These efforts will begin with a workshop this summer. We also anticipate the submission of a number of small (2-5 faculty) proposals starting in the first year of the program (e.g. NSF INFEWS, USDA-AFRI). These will be aimed at increasing collaborative research interactions between faculty across department and college boundaries.

Impact: SWIMM will impact the VT Materials community by fostering interdisciplinary collaboration and funding in the area of materials for water purification, in the hiring of a new faculty member focused on advanced manufacturing of membranes, through the development of a pilot-scale membrane fabrication and testing facility, and through the submission of numerous funding proposals culminating in Center-level proposals. These efforts will also serve to raise the national profile of VT's research efforts in sustainable water and in materials development more generally.

Dr. Stephen M. Martin

Professional Preparation

- *Princeton University*; Chemical Engineering, B.S.E. 1999
- *University of Minnesota – Twin Cities*; Chemical Engineering, Ph.D. 2004
- *Massachusetts Institute of Technology*; Chemical Engineering, Post-doc 2004 – 2006

Appointments

- *Associate Professor*; Chemical Engineering, Virginia Tech 8/2013 - present
- *Assistant Professor*; Chemical Engineering, Virginia Tech 8/2006 – 8/2013
- *Station Director – Novartis Station*; David H. Koch School of Chemical Engineering Practice (MIT), 2006

Products Most Relevant to the Current Research

- Wai-Fong Chan, E. Marand, **S. M. Martin**, Novel Zwitterion Functionalized Carbon Nanotube Nanocomposite Membranes for Improved RO performance and Surface Anti-Biofouling Resistance, *J. Membrane Science*, **2016**, 509, pp 125-137
- A. Surapathi, J. M. Herrera – Alonso, F. Rabie, **S. M. Martin**, E. Marand, Fabrication and gas transport properties of SWNT/polyacrylic nano-composite membranes, *Journal of Membrane Science*, 2011, 375, 150-156.
- F. Rabie, Z. Sedlakova, S. Sheth, E. Marand, **S. M. Martin**, L. Poláková, (Meth)acrylate liquid crystalline polymers for membrane applications, *J. Applied Polymer Science*, **2015**, 132(43), 42694.
- S. Han, **S. M. Martin**, Enantioselective Cholesteric Liquid Crystalline Membranes Characterized using Nonchiral HPLC with Circular Dichroism Detection, *Journal of Membrane Science*, **2011**, 362(1-2), 1-6
- S. Han, S. M. Martin, Diffusivity and Solubility of Organic Solutes in Supported Liquid Crystal Membranes, *Journal of Physical Chemistry, B*, **2009**, 113, 12696-12703.

Other Significant Products

- S. Han, F. Rabie, E. Marand, **S. M. Martin**, Enantioselective Separations Using Supported Cholesteric Liquid Crystalline Membranes, *Chirality*, **2012**, 24(7), 519-525.
- S. Han, **S. M. Martin**, Effect of Molecular Packing Density and Intermolecular Interactions on Solute Transport in Supported Liquid Crystalline Membranes, *Liquid Crystal*, **2012**, 39(4), 441-449.
- Ninad Dixit, Alicia Pape*, Lixia Rong, Eugene Joseph, **S. M. Martin**, “Isothermal Microphase Separation Kinetics in Blends of Asymmetric Styrene – Isoprene Block Copolymers”, *Macromolecules*, **2015**, 48 (4), pp 1144–1151.
- M. J. Heinzer, S. Han, J. A. Pople, D. G. Baird, **S. M. Martin**, In situ Tracking of Domain Growth During the Drying of Solution-cast Block Copolymer Films using Small Angle X-Ray Scattering: Ordering Kinetics, *Macromolecules*, **2012**, 45(8), 3480-3486.
- M. Dion, M. Rapp, N. Rorrer, D. Shin, **S. M. Martin**, W. A. Ducker, The Formation of Hydrophobic Films on Silica with Alcohols, *Colloids and Surfaces A*, **2010**, 362, 65-70.

Appendix I: Biosketches

Synergistic Activities

- Developed and teaching a new course in *Soft Materials and Self-Assembly* at Virginia Tech taught in 2006, 2008, and 2014. The course has attracted students from a wide variety of technical backgrounds (e.g. chemical engineering, mechanical engineering, polymer science, chemistry, wood science).
- Instructor for the C-Tech² and Inspires summer programs at Virginia Tech – providing high school girls and middle school students with experiences in science and engineering in order to increase participation in STEM education.
- Session chair for sessions in the Interfacial Phenomena, Membranes, and Polymers divisions at the National Meeting of the American Institute of Chemical Engineering (2008 -2016).
- Reviewer of papers for ACS, Wiley, and Elsevier journals.
- Reviewer of proposals for NSF and ACS-PRF.

Collaborators and co-authors (last 48 months)

Amanda Morris, Virginia Tech	Lixia Ruong, NSLS, NY
Donald G. Baird, Virginia Tech	Lenka Polakova, Inst. Macr. Sci., Czech Republic
William Ducker, Virginia Tech	Zdenka Sedlakova, Inst. Macr. Sci., Czech Republic
Eugene Joseph, Virginia Tech	John Pople, SSRL, CA
Eva Marand, Virginia Tech	
Robert Moore, Virginia Tech	
Michael Bortner, Virginia Tech	

Graduate Advisors and Postdoctoral Sponsors

T. Alan Hatton (Post-Doc Advisor), Massachusetts Institute of Technology, MA
Michael D. Ward (Graduate Advisor), New York University, NY

Graduate Advisees

Christine J. Erdy, Savannah River National Lab, SC
Dr. Sangil Han, Assistant Professor, Changwon National University, South Korea
Dr. Michael J. Heinzer, Intel Corp., AZ
Dr. Feras Rabie, PhD 2014
Dr. Du Hyun Shin, PhD 2013, LG Chemical, South Korea
Dr. Ninad Dixit, PhD 2015, Henkel Corp., NJ
Dr. Waifong Chan, PhD 2015, Intel Corp, OR
Dr. Carlos Landaverde, PhD 2016
Alicia Pape, Virginia Tech (PhD est. spring 2016)
Ethan Smith, Virginia Tech (PhD est. fall 2020)

Appendix I: Biosketches

Marc Andrew Edwards, Ph.D.

NRT Director

Charles Lunsford Professor of Civil & Environmental Engineering
Virginia Tech
edwardsm@vt.edu

(a) Professional Preparation

SUNY at Buffalo	Buffalo, NY	Bio-Physics	B.S., 1986
University of Washington	Seattle, WA	Environmental Engineering	M.S.E, 1988
University of Washington	Seattle, WA	Environmental Engineering	Ph.D., 1990
University of Washington	Seattle, WA	Environmental Engineering	Postdoc, 1991

(b) Appointments

2001-Present	Civil/Environmental Engineering, Virginia Tech	Professor/Chaired Professor
1997-2001	Civil/Environmental Engineering, Virginia Tech	Associate Professor
1992-1997	Civil/Environmental Engineering U. of Colorado	Assistant Professor
1991-1992	Civil/Environmental Engineering U. of Washington	Post-Doctoral Research
1990-1991	James M. Montgomery Consulting Engineers	Senior Engineer

(c) Five Most Significant Peer Reviewed Publications (out of 180 total)

i. Five Most Closely Related Publications

1. Brazeau, R., and Edwards, M. Role of Hot Water System Design on Factors Influential to Pathogen Regrowth: Temperature, Chlorine Residual, Hydrogen Evolution and Sediment. *Environmental Engineering Science*. **2013**, 30(10), 617-627. doi:10.1089/ees.2012.0514
2. Brazeau, R.H., and Edwards, M. Optimization of Electric Hot Water Recirculation Systems for Comfort, Energy and Public Health. *Journal of Green Building*, **2013**, 8(2), 73-85. doi:10.3992/jgb.8.2.73
3. Edwards, M. Fetal Death and Reduced Birth Rates Associated with Exposure to Lead-Contaminated Drinking Water. *Environmental Science & Technology*. **2013**, 48(1), 739-746. doi:10.1021/es4034952
4. Nguyen, C., Elfland, C., and Edwards, M. Impact of Advanced Water Conservation Features and New Copper Pipe on Rapid Chloramine Decay and Microbial Regrowth. *Water Research*, **2012**, 46(3), 611-621. doi:10.1016/j.watres.2011.11.006
5. Edwards, M., Triantafyllidou, S., and Best, D. Elevated Blood Lead in Washington D.C. Children from Lead Contaminated Drinking Water: 2001-2004. *Environmental Science & Technology*. **2009**, 43, 5 1618-1623. doi: 10.1021/es802789w

ii. Five Other Significant Publications

1. Wang, H., Masters, S., Edwards, M., Falkinham, J.O. III, and Pruden, A. Effect of Disinfectant, Water Age, and Pipe Materials on Bacterial and Eukaryotic Community Structure in Drinking Water Biofilm. *Environmental Science & Technology*. **2014**, 48(3), 1426-1435. doi:10.1021/es402636u
2. Wang, H., Edwards, M., Falkinham, J.O. III, and Pruden, A. Probiotic Approach to Pathogen Control in Potable Water Systems? *Environmental Science & Technology*. **2013**, 47(18), 10117–10128. doi:10.1021/es402455r
3. Rhoads, W., Pruden, A., and Edwards, M. Anticipating Challenges with In-Building Disinfection for Control of Opportunistic Pathogens. *Water Environment Research*. **2013**, 86(6), 540-549. doi:10.2175/106143014X13975035524989
4. Williams, K., Pruden, A., Falkinham, J., and Edwards, M. Relationship between Organic Carbon and Opportunistic Pathogens in Simulated Glass Water Heaters. *Pathogens*. **2015**. 4(2), 355-372; doi:10.3390/pathogens4020355
5. Rhoads, W.J. P. Ji, A. Pruden and M. Edwards. Water heater temperature set point and water use patterns influence *Legionella pneumophila* and associated microorganisms at the tap. **2016**. *Microbiome*.

Appendix I: Biosketches

(d) Synergistic Activities

1. *Science and Engineering Ethics Education*: Co-creator of graduate class “CEE 5804: *Engineering Ethics and the Public*” on a National Science Foundation Ethics Education in Science and Engineering (EESE) grant with DC Citizen Science collaborator Lambrinidou. The class won a National Academy of Engineering Ethics Education Exemplar award 2016. Taught 6 ethics education full and half-day workshops to industry and academic audiences. Assisted Congressional Committee Investigations of the U.S. Centers for Disease Control (CDC) and United States Environmental Protection Agency (US EPA) and testified to Congress on unethical behavior of U.S. public health agencies in 2004, 2010 and [2016](#). Representative recorded public science-ethics addresses include VT Commencement (2008), TED^xVirginiaTech (2013), [Hurley Medical Center \(2015\)](#) and [Virginia Tech Flint Water Study Team Presentation \(2016\)](#). Citizen Science and social justice research work has been highlighted by the 2013 IEEE Barus Award for defending the public interest at great personal and professional risk, the NAE on-line engineering and science ethics center, Villanova University Praxis Award, the book *Engineering Peace and Justice*, the American Civil Liberties Union-Michigan, and others.
2. *Public-Inspired Science Research Collaborations and Advising*: Applying a Public-Inspired Science approaches to advising Dissertations and MS Thesis over the last 25 years, produced research collaborations with dozens of citizen scientists and industries including the American Water Works Association, Water Research Foundation, Copper Development Association, Mueller, International Associates of Plumbing & Mechanical Officials (IAPMO), Plumbing and Mechanical Institute, National Sanitation Foundation, United States Green Building Council, Green Building Alliance Beach Builders, Inc., Greenplumbers, Timmons, Alliance for Healthy Homes, U.S. Navy, hundreds of individual water utilities and building owners. Edwards’ 56 advisees have won 26 nationally recognized research awards for their graduate work. As a member of the VT Academy of Teaching and Advising Excellence, Edwards mentors junior faculty in research advising best practices.
3. *Virginia Tech Research Management*: Director of ICTAS Thrust Area Leader for Sustainable Water Research (2011-present). Seeded research efforts leading to over \$15 million dollars of external funding for over 100 faculty on Virginia Tech campus.
4. *Practical Dissemination of Research: Invited Keynote/Endowed Platform Presentations* (illustrative from last 2 years): The Brown School of Public Health, Washington Univ. (2014); Addressing the Waterborne Disease Challenges of the 21st Century with Applied Biology and Chemistry: Opportunistic Premise Plumbing Pathogens (OPPPs), American Chemical Society (2014); U.S. Water Use and Opportunistic Premise Plumbing Pathogens (OPPPs), Chinese Academy of Sciences Keynote (2014); Water Use in the U.S. – Balancing Needs and Conservation. Veterans Health Administration Infectious Disease Workshop (2014); Plumbing Leadership Coalition Workshop (2014); The Washington D.C. Lead Crisis: Prelude to Flint 2015. Hurley Medical Center Grand Rounds (2015); Interview with Smith College Engineering for Everyone Course (2015); Sacred Obligation of Engineers and Scientists to the Public. Distinguished Lecturer. Cornell University (2015); Lessons Learned from the Washington D.C. Lead Crisis (so far). Association of Environmental Engineering and Science Professors Annual Conference. Yale University (2015);
5. Sloan Foundation Microbiology of the Built Environment (microBE) advisor on “Water Systems Microbiomes” and National Sanitation Foundation Committee 444 Prevention of Injury and Diseases Associated with Building Water Systems.

Donald G. Baird

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PROFESSIONAL PREPARATION

University of Wisconsin-Madison	ESM/ChE	PhD	1974
Michigan State University	Materials and Mechanics	MS	1970
Michigan State University	ChE/Mat	BS	1969

APPOINTMENTS

2009-present	Virginia Tech, Giacco Chair of Chemical Engineering
1997 - 2003	Virginia Tech, Co-director for the Center for Composite Materials and Structures
1990 - 2009	Virginia Tech, Harry C. Wyatt Professor of Chemical Engineering
1984 -1990	Virginia Tech, Professor of ChE
1981 -1984	Virginia Tech, Associate Professor of ChE
1978 -1981	Virginia Tech, Assistant Professor of ChE
1974 -1978	Monsanto Textiles Company, Pensacola, FL, research chemical engineer (high performance fibers)

Publications Most Relevant to Proposed Research

1. C. D. McGrady and D. G. Baird, Note: Method for Overcoming Ductile Failure in Uniaxial Extensional Measurements, *J. Rheol.*, **53**, 539-545(2009).
2. C. W. Seay and D. G. Baird, "The Influence of Sparse Long Chain Branching on the Film-casting Behavior of Polyethylene Resins ", *Int'l Polym. Proc.*,**24**, 41-50(2009).
3. M. Lee , J. Park, H. Lee , O. Lane, R. B. Moore, J. E. McGrath, D. G. Baird, "Effects of Block Length and Solution-casting Conditions on the Final Morphology and Properties of Disulfonated Poly(arylene ether sulfone) Multi-block Copolymer Films for Proton Exchange Membranes", *Polymer*, **50**, 6129-6138(2009).
4. Christopher D. McGrady, Christopher W. Seay, Syed M. Mazahir, Donald G. Baird, Effect of Sparse Long-Chain Branching on the Step-Strain Behavior of a Series of Well-Defined Polyethylenes", *Polym. Engr. Sci.*, **50**(7), 1424-1432 (2010).
5. Michael J. Heinzer, Sangil Han, John A. Pople, Donald G. Baird, and Stephen M. Martin,"In situ Measurement of Block Copolymer Ordering Kinetics during the Drying of Solution-cast Films Using Small Angle X-Ray Scattering", *Macromolecules*, **45**(8), 3471-3479(2012) .

Other Significant Publications

1. Matthew D. Wilding and Donald G. Baird, "Melt processing and rheology of an acrylonitrile

Appendix I: Biosketches

- copolymer with absorbed carbon dioxide”, *Polym. Eng. Sci.*, **49(10)**, 1990-2004(2009).
2. Matthew D. Wilding, Donald G. Baird, and Aaron P.R. Eberle, “Melt processing and rheology of high molecular weight polyethylenes with absorbed carbon dioxide”, *Int’l Polym. Proc.*, 23:2, 228-237(2008).
 3. D. G. Baird, “Primary Normal Stress Difference Measurements for Polymer Melts at High Shear Rates in a Slit-Die Using Hole and Exit Pressure Data”, *J. Non-Newt. Fluid Mech.*, **148**, 13-23 (2008).
 4. M. J. Heinzer, S. Han, J.A. Pople, S. M. Martin, and D. G. Baird, “Iso-concentration Ordering Kinetics Of Block Copolymers In Solution During Solvent Extraction Using Dynamic Oscillatory Measurements”, *Polymer*, **53(15)**, 3331-3340(2012).
 5. Michael J. Heinzer, Sangil Han, John A. Pople, Donald G. Baird, and Stephen M. Martin, “In Situ Tracking of Microstructure Spacing and Ordered Domain Compression during the Drying of Solution-Cast Block Copolymer Films Using Small-Angle X-ray Scattering”, *Macromolecules*, **45(8)**, 3480-3486(2012).

Synergistic Activities

- Textbook: *Polymer Processing: Principles and Design*, Wiley, 1995(1st edition), 2014(2nd edition) (Co-authored with Dimitris Collias)
- Consulting and teaching of short courses to numerous companies: e.g. DuPont, Himont, Exxon/Mobil, Foster-Miller, Dutch State Mines(Netherlands), Himont(Italy), Corning, Coca-Cola, Procter & Gamble, Dow, Pactiv, 3M
- Editor of *Polymer Composites Journal* and on the editorial board of *Polymer Technology*
- J. Huang, D. Baird, and J. McGrath, U.S. patent application 60/447,727, “Highly Conductive Thermoplastic Composites for Rapid Production of Fuel Cell Bipolar Plates”
- Awards and Recognitions: e.g., Society of Plastics Engineer’s International (2009), Society of Plastics Engineer’s International Award for Research(2003); Society of Plastics Engineer’s International Award for Education(2002); Dean's Award for Excellence in Teaching; Dean’s Award for Excellence in Research(2002); Alumni Research Award(1991)

Collaborators Over Last 48 Months

Amod Ogale, Clemson; Ken Walters, Aberystwyth, Wales; T. McLeish, Leeds Univ.; Peter Foss, General Motors; Vlastimil Kunc, ORNL;

THESIS ADVISOR/SPONSOR(LAST 5 YEARS)

K. C. Ortman(PhD), Dow; M. Heinzer(PhD),Intel; C. Chen(PhD), SABIC; G. M. Velez-Garcia(PhD), ORNL; S. Mazahir(PhD), Celanese; J.T. Hofmann(PhD), Eastman; K.J. Meyers(PhD), Exxon-Mobil; J. Quigley(PhD), Eastman; M. Cieslinski(PhD), BASF; K. Herrington(PhD), Braskem; C. Qian(PhD), Exxon-Mobil. Total students advised: 61 Postdoctoral Associates: 13

Brian D. Badgley

Crop & Soil Environmental Science, Virginia Tech
1880 Pratt Drive, Room 1121; Blacksburg, VA 24061
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(a) Professional Preparation

University of Georgia	Zoology	B.S., 1995
University of Maryland	Marine-Estuarine-Environmental Sciences	M.S., 2002
University of South Florida	Biology	Ph.D., 2009
University of Minnesota	Environmental Microbiology	Post-doc, 2009-12

(b) Appointments

2012-	Assistant Professor, Crop & Soil Environmental Science, Virginia Tech
2009-12	Post-Doctoral Associate, BioTechnology Institute, University of Minnesota
2002-04	Coastal Training Coordinator, Rookery Bay National Estuarine Research Reserve
2001-02	Sea Grant Fellow, NOAA, Estuarine Reserves Division
1996-97	Environmental Education Instructor, Jekyll Island 4-H Center, Jekyll Island, Georgia

(c) Products

(i) Related products (*student co-authors)

Liao H, Krometis LA, Hession WC, *Benitez R, *Sawyer R, *Schaberg E, *Von Wagoner E, Badgley BD (2015) Storm loads of culturable and molecular fecal indicators in an inland urban stream. *Sci Tot Env* 530:347-356.

Harwood VJ, Staley C, Badgley BD, Borges K, Korajkic A. (2014) Microbial source tracking markers for detection of human sewage and fecal contamination in environmental waters: relationships to pathogens and human health outcomes. *FEMS Microbiol Rev.* 38:1-40.

Ebentier DL, Hanley KT, Cao Y, Badgley BD, Boehm AB, Ervin JS, Goodwin KD, Gourmelon M, Griffith JF, Holden PA, Kelly CA, Lozach S, McGee C, Peed LA, Raith M, Ryu H, Sadowsky MJ, Scott EA, Santo Domingo J, Schriewer A, Sinigalliano CD, Shanks OC, Van De Werfhorst LC, Wang D, Wuertz S, Jay JA (2013) Evaluation of the repeatability and reproducibility of a suite of qPCR-based microbial source tracking methods. *Water Res* 47:6839-6848.

Badgley BD, Thomas FIM, Harwood VJ (2011) Quantifying environmental reservoirs of fecal indicator bacteria associated with sediment and submerged aquatic vegetation. *Environ Microbiol* 13:932-942.

Badgley BD, Thomas FIM, Harwood VJ (2010) The effects of submerged aquatic vegetation on the persistence of environmental populations of *Enterococcus* spp. *Environ Microbiol* 12:1271-1281.

(ii) Other Significant Products

Li X, *Sun S, Badgley BD, He Z (2016) Long-term performance and microbial community characterization of an osmotic anammox system for removing reverse-fluxed ammonium. *Bioresour Tech* 211:628-635.

Li X, *Sun S, Badgley BD, Sung S, Zhang H, He Z (2016) Nitrogen removal by granular nitrification - anammox in an upflow membrane-aerated biofilm reactor. *Water Res* 94:23-31.

Cao Y, Van De Werfhorst LC, Dubinsky EA, Badgley BD, Sadowsky MJ, Andersen GL, Griffith JF, Holden PA (2013) Evaluation of molecular community analysis methods for discerning fecal sources and human waste. *Water Res* 47:6862-6872.

Badgley BD, Ferguson J, Hou Z, Sadowsky MJ (2012) A model laboratory system to study the synergistic interaction and growth of environmental *Escherichia coli* with macrophytic green algae. *J Great Lakes Res* 38:390-395.

Badgley BD, Nayak BS, Harwood VJ (2010) The importance of sediment and submerged aquatic vegetation as potential habitats for persistent strains of enterococci in a subtropical watershed. *Water Res* 44:5857-5866.

(d) Educational and Synergistic Activities

- Virginia Tech Teacher of the Week (2016)
- Participant in a year-long faculty development program delivered by the VT Network Learning Initiative focused on design and implementation of digital game-based learning tools for classroom instruction (2015-16)
- Participant in a year-long pilot program designed to explore and facilitate the use of inclusive teaching practices in the classroom for faculty with the College of Agriculture and Life Sciences (2015-16)
- Co-organized and hosted a workshop entitled "Strategies for sequence-based analyses of microbial communities (and the caveats)" which was attended by over 35 students, post-docs, and faculty from eight different departments across the Virginia Tech campus (2013)
- Cofounded a microbial ecology networking group of students and faculty at Virginia Tech to facilitate collaboration, discussion, and project development on campus (2012-ongoing)

KLAUS MOELTNER

Professor, Department of Agricultural and Applied Economics
Virginia Tech, Blacksburg, VA 24061; Tel: (540) 231-8249; email: moeltner@vt.edu

Professional Preparation

Univ. of Life Sciences, Vienna, Austria	MS	Environmental Planning & Engineering, 1990
Monterey Institute of International Studies	MA	International Policy Studies, 1994
University of Washington	MA	Economics, 1998
University of Washington	Ph.D.	Economics, 2000

Appointments

2015- Professor, Department of Agricultural and Applied Economics, Virginia Tech
2011-2015 Associate Professor, Department of Agricultural and Applied Economics, V.Tech
2006-2010 Associate Professor, Department of Resource Economics, University of Nevada,
2000-2006 Assistant Professor, Department of Resource Economics, University of Nevada,

Publications

Related to Water:

Vinoles, V., K. Moeltner, S. Stoddard (2015). Length of Residency and Water Use in an Arid Urban Environment, *Water Resources and Economics*, 12 (Oct.), p. 52-66
Castledine, A., K. Moeltner, M.K. Price, S. Stoddard (2014), Free to Choose: Promoting Conservation by Relaxing Outdoor Watering Restrictions. *Journal of Economic Behavior & Organization*, 107(A), 324-343.
Moeltner, K., R. Woodward (2009). Meta-Functional Benefit Transfer for Wetland Valuation: Making the Most of Small Samples. *Environmental and Resource Economics*, 42 (1), p. 89-109.
Moeltner, K, S. Stoddard. (2004) A Panel Data Analysis of Non-Residential Customers' Water Price Responsiveness Under Block Rates, *Water Resources Research*, 40(1).

Other Recent:

Moeltner, K., C. Blinn, T. Holmes (forthcoming). Forest Pests and Home Values: The Importance of Accuracy in Damage Assessment and Geocoding of Properties, *Journal of Forest Economics*
Cohen, J., K. Moeltner, J. Reichl, M. Schmidthaler (forthcoming). Linking the Value of Energy Reliability to the Acceptance of Energy Infrastructure: Evidence from the EU, *Resource and Energy Economics*
Cohen, J., K. Moeltner, J. Reichl, M. Schmidthaler (forthcoming). An Empirical Analysis of Local Opposition to new Transmission Lines across the EU-27, *Energy Journal*, 37(3)
Cohen, J., C. Blinn, K. Boyle, T. Holmes, K. Moeltner (2016). Hedonic Valuation with Translating Commodities: Mountain Pine Beetles and Host Trees in the Colorado Front Range. *Environmental and Resource Economics*, 63(3), 613-642
Yu, L., S. B. Ball, C. E. Blinn, K. Moeltner, S. Peery, V.A. Thomas, R. H. Wynne (2015). CloudSourcing: Using an Online Labor Force to Detect Clouds and Cloud Shadows in Landsat Images. *Remote Sensing*, 7(3), 2334-2351

- Castledine, A., K. Moeltner, M.K. Price, S. Stoddard (2014), Free to Choose: Promoting Conservation by Relaxing Outdoor Watering Restrictions. *Journal of Economic Behavior & Organization*, 107(A), 324-343
- Johnston, R., K. Moeltner, (2014). Meta-Modeling and Benefit Transfer: The Empirical Relevance of Source-Consistency in Welfare Measures. *Environmental and Resource Economics*. 59, 337-361
- Moeltner, K, R.S. Rosenberger, (2014). Cross-Context Benefit Transfer: A Bayesian Search for Information Pools. *American Journal of Agricultural Economics*, 96(2), 469-488
- Moeltner, K, M.K. Kim, E. Zhu, W. Yang, (2013). Wildfire Smoke and Health Impacts: A Closer Look at Fire Attributes and their Marginal Effects. *Journal of Environmental Economics and Management*, 66(3), 476--496

A. Synergistic Activities

- Co-editor, *Environmental and Resource Economics*, 2013 – current
- Editorial Council, *Journal of the Association of Environmental and Resource Economists*
- Keynote speaker: Symposium on the "Public acceptance of electricity infrastructure," Johannes Kepler University, Linz, Austria, June 3, 2014.
- Invited panelist and speaker at the 1st and 3rd Urban Water Roundtables, Global Institute of Sustainability, Arizona State University, 2013 and 2015.
- Scientific Advisory Panel, EU-funded project "Securing the European Electricity Supply against Malicious and Accidental Threats (SESAME)," 2012 – 2015.

Collaborators & Other Affiliations

G. Amacher, S. Ball, C. Blinn, K. Boyle, J. Campbell, J. He, R. Jin, N. Lau, D. Lee, L. Resler, Y. Shao, V. Thomas, R. Wynne, Virginia Tech; T. Holmes, USFS; R. Johnston, Clark University; M.K. Keun, Utah State University; M. Kobayashi, World Bank; M.K. Price, Georgia State University; J. Reichl, M. Schmidthaler, Energy Institute, Linz, Austria; K. Rollins, W. Yang, Univ. of NV, Reno; S.S. Stoddard, Truckee Meadows Water Association;

Graduate and Postdoctoral Advisors

G. Brown, R. Halvorsen, E. Rose, University of Washington

Thesis Advising (Chair or Co-chair)

O. Bagheri, S. Ehsan, V. Kesiz-Abnoui, L. Yu, Virginia Tech; A. Castledine, Public Utilities Commission, Carson City, NV; Jed Cohen (West Virginia University, post-doc.), Danielle Hagerty (Booz Allen Hamilton, Washington, D.C.), Yiheng Li (IXI Services, Washington, D.C.), Valeria Oscherov (Protiviti Inc. Consulting), Vanessa Vinales (Virginia Department of Taxation), Erquian Zhu (China Center of International Economic Exchanges, Zhejiang)

Total number of graduate students advised (as Chair or Co-chair): 1 Master's, 10 PhD

Appendix I: Biosketches

Dr. E. Johan Foster

(a) Professional Preparation

Simon Fraser University Department of Chemistry	Canada	Chemistry	BSc 2002
Simon Fraser University Department of Chemistry	Canada	Chemistry	PhD 2007

(b) Appointments

2016 - Present	Thomas G. Digges and Thomas G. Digges, Jr. Faculty Fellow in Materials Science and Engineering Department of Materials Science and Engineering Virginia Polytechnic Institute and State University (Virginia Tech)
2014 - Present	Associate Professor , Macromolecules Innovation Institute (MII) Virginia Tech Center for Sustainable Nanotechnology (VTSuN) Department of Materials Science and Engineering Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, Virginia, United States of America
2014 - Present	Long Term Tec21 Visiting Professor , Université Grenoble Alpes (Grenoble INP – PAGORA), Ecole internationale du papier, de la communication imprimée et des biomatériaux, Grenoble, France
2010 - 2014	Maître-Assistant , Head of the Advanced Materials Group Polymer Chemistry and Materials, Adolphe Merkle Institute (AMI) University of Fribourg (UniFr), Fribourg, Switzerland
2007 - 2009	Postdoctoral Research Fellow (w. Prof. Dr. E. W. ‘Bert’ Meijer), Department of Chemical Engineering and Chemistry, Technical University Eindhoven (TUE), Eindhoven, The Netherlands
2006	Independent Lecturer , Department of Chemistry Simon Fraser University, Burnaby, Canada

(c) Publications

Top 5 publications most related to this proposal:

1. A. Nicharat, J. Sapkota, C. Weder and **E.J. Foster*** Melt-Processing of Nanocomposites of Polyamide 12 and Cellulose Nanocrystals. *Journal of Applied Polymer Science*. **2015**. 132, 42752 (10 pages) DOI: 10.1002/app.42752. I.F. 1.600. Times cited: 3.
2. J. Sapkota, S. Kumar, C. Weder and **E.J. Foster*** Influence of Processing Conditions on Properties of Poly (Vinyl acetate)/Cellulose Nanocrystal Nanocomposites. *Macromolecular Materials and Engineering*. **2015**, 300 (5) pp 562-571. DOI: 10.1002/mame.201400313 (*Journal's top 10 most accessed paper for Feb-April 2015*). I.F. 2.781. Times cited: 10.
3. S. Mueller, C. Weder and **E.J. Foster*** Water-insoluble Aerogels Made from Cellulose Nanocrystals and Poly (Vinyl Alcohol). *Green Materials*. **2014**, 2(4) pp 169-182. DOI: 10.1680/gmat.14.00012 (*Special Issue Invited Article*). I.F. N/A. Times cited: 4.
4. J. Sapkota, M. Jorfi, C. Weder and **E.J. Foster*** Reinforcing Hydrophobic Polymer Nanocomposites with Cellulose Nanocrystals. *Macromolecular Rapid Communications* **2014**, 35

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(20), 1747-1753. DOI: 10.1002/marc.201400382 (*Journal's top 15 most accessed articles for 09/2014*). I.F. 4.608. Times cited: 13.

5. M.V. Biyani, C. Weder and **E.J. Foster*** Photoswitchable Nanocomposites with Coumarin Functionalized Cellulose Nanocrystals. *Polymer Chemistry*. **2014**, *5*, 5501-5508 DOI: 10.1039/C4PY00486H. *Selected as a "2014 Polymer Chemistry Papers of the week"*. I.F. 5.520. Times cited: 11.

Top other 5 publications:

1. S. Camarero-Espinosa, B. Rothen-Rutishauser, **E.J. Foster**, and C. Weder. Articular cartilage: from formation to tissue engineering. *Biomaterials Science*. **2016**, *4*, pp 734-767. DOI: 10.1039/c6bm00068a (*Cover Article, Top 10 most-downloaded Biomaterials Science article from April to June 2016*). I.F. 3.614. Times cited: 2.
2. S. Camarero-Espinosa, B. Rothen-Rutishauser, C. Weder and **E.J. Foster*** Directed cell growth in multi-zonal scaffolds for cartilage tissue engineering. *Biomaterials*. **2016**, pp. 42-52. DOI: 10.1016/j.biomaterials.2015.09.033. I.F. 8.387. Times cited: 13.
3. T. Kuhnt, A. Herrmann, **E.J. Foster** and C. Weder. Functionalized cellulose nanocrystals as nanocarriers for sustained fragrance release. *Polymer Chemistry*, **2015**, *6*, 6553 - 6562. DOI: 10.1039/c5py00944h. I.F. 5.520. Times cited: 1.
4. S. Camarero Espinosa; T. Kuhnt; **E.J. Foster*** and C. Weder* Isolation of thermally stable cellulose nanocrystals by phosphoric acid hydrolysis. *Biomacromolecules*. **2013**. *14*(4):1223-30 DOI: 10.1021/bm400219u. I.F. 5.750. Times cited: 101.
5. S. Kumar; M. Hofmann; B. Steinmann; **E.J. Foster** and C. Weder, Reinforcement of Stereolithographic Resins for Rapid Prototyping with Cellulose Nanocrystals. *ACS Applied Materials & Interfaces* **2012**, *4*, (10), 5399-5407. DOI: 10.1021/am301321v. I.F. 7.145. Times cited: 34.

(d) Synergistic Activities

1. *Session chair* at 10 international symposia. Ranging from ACS to TAPPI meetings.
2. Organized 9 *international conference symposia*, selected such as: 253rd ACS National Meeting (March 2017), San Francisco, USA, POLY Division, Symposium on "Next generation smart materials: structure, function and application". Organizer of the 2016 TAPPI International Conference on Nanotechnology for Renewable Resources, Grenoble, France. June 13-16, 2016. Conference Chair. 252nd ACS National Meeting (August 2016), Philadelphia, USA, POLY Division, Symposium on "Advanced Functional Biopolymers and Biomaterials. 251st ACS National Meeting (March 2016), San Diego, USA, POLY Division, Symposium on "Supramolecular Polymers: From Structure to Advanced Functionality". 251st ACS National Meeting (March 2016), San Diego, USA, POLY Division, Symposium on "Responsive Nanostructures and Nanocomposites".
3. *Faculty advisor for exchange programs* to University of Fribourg (Switzerland), Université Grenoble Alpes (France) and University of Ghana, Legon (Ghana)
4. *Outreach events*: Roanoke Valley Governors School Visit to Virginia Tech; Virginia Science Festival "Nanotechnology is everywhere"
5. *Center for the Enhancement of Engineering Diversity* (CEED) talks and active membership, encouraging underrepresented minorities and women in STEM.

Appendix I: Biosketches

JUDY S. RIFFLE

a. Professional Preparation

Virginia Tech	Blacksburg, VA	Textiles	B.S./1973
Virginia Tech	Blacksburg, VA	Polymer Chemistry	Ph.D./1981

b. Appointments

2000-present	Professor of Chemistry, Virginia Tech, Blacksburg, VA
2001-2015	Director, Macromolecular Science and Engineering Education, Virginia Tech, Blacksburg, VA
1994-2000	Associate Professor of Chemistry, Virginia Tech, Blacksburg, VA
1988-1994	Assistant Professor of Chemistry, Virginia Tech, Blacksburg, VA
1987-1988	Research Scientist and Visiting Assistant Professor of Chemistry, Virginia Tech, Blacksburg, VA
1985-1987	Vice President of Research and Development, Thoratec Laboratories Corp., Cardiovascular Materials, Pleasanton, CA
1983-1985	Manager of Materials Division, Thoratec Laboratories Corp., Cardiovascular Materials, Pleasanton, CA
1982-1983	Research Scientist, Union Carbide Corporation, Charleston, WV

c. Products

Products Most Closely Related to the Proposed Project

1. B. J. Sundell, E.-S. Jang, J. R. Cook, B. D. Freeman, J. S. Riffle, J. E. McGrath, "Crosslinked Disulfonated Poly(arylene ether sulfone) Telechelic Oligomers. Part 2. Elevated Transport Performance with Increasing Hydrophilicity," *Industrial and Engineering Chemistry Research*, 55(5),1419-1426 (2016), DOI:10.1021/acs.iecr.5b04050.
2. Q. Liu, A. T. Shaver, Y. Chen, G. Miller, D. R. Paul, J. S. Riffle, J. E. McGrath, B. D. Freeman, "Effect of UV irradiation and physical aging on O₂ and N₂ transport properties in thin glassy poly(arylene ether ketone) films based on tetramethyl bisphenol A and 4,4'-difluorobenzophenone," *Polymer*, 87, 202-214 (2016), DOI:10.1016/j.polymer.2016.01.075.
3. A. Roy, M. Hickner, H.-S. Lee, T. Glass, M. Paul, A. Badami, J. S. Riffle, J. E. McGrath, "States of Water in Proton Exchange Membranes: Part A – Influence of chemical structure and composition," *Polymer*, 111, 297-306 (2017), DOI:10.1016/j.polymer.2017.01.021.
4. H. Borjigin, K. Stevens, R. Liu, J. Moon, A. Shaver, B. D. Freeman, J. S. Riffle, J. E. McGrath, "Synthesis and Characterization of Polybenzimidazoles derived from Tetraaminodiphenylsulfone for High Temperature Gas Separation Membranes," *Polymer*, 71, 135-142 (2015), DOI:10.1016/j.polymer.2015.06.021.
5. Mou Paul, Ho Bum Park, Benny D. Freeman, Abhishek Roy, James E. McGrath, J. S. Riffle, "Synthesis and Crosslinking of Partially Disulfonated Poly(arylene ether sulfone) Random Copolymers as Candidates for Chlorine Resistant Reverse Osmosis Membranes," *Polymer*, 49(9), 2243-2252 (2008), DOI:10.1016/j.polymer.2008.02.039.

Other Significant Products

1. N. Hu, A. Peralta, S. Roy Choudhury, R. M. Davis, J. S. Riffle, "Acrylamide Monomers and Polymers that Contain Phosphonate Ions," *Polymer*, 65, 124-133 (2015), DOI:10.1016/j.polymer.2015.03.065.
2. B. J. Sundell, A. T. Shaver, Q. Liu, A. Nebipasagil, P. Pisipati, S. J. Mecham, B. D. Freeman, J. S. Riffle, James E. McGrath, "Synthesis, Oxidation and Crosslinking of Tetramethyl Bisphenol F

Appendix I: Biosketches

- (TMBPF)-Based Polymers for Oxygen/Nitrogen Gas Separations,” *Polymer*, 55(22), 5623-5634 (2014), DOI:10.1016/j.polymer.2014.09.010.
3. Nipon Pothayee, Nikorn Pothayee, N. Hu, R. Zhang, D. F. Kelly, A. P. Koretsky and J. S. Riffle, “Manganese Graft Ionomer Complexes (MaGICs) for Dual Imaging and Chemotherapy,” *Journal of Materials Chemistry B*, 2(8), 1087-1099 (2014), DOI:10.1039/C3TB21299H.
 4. N. Hu, L. M. Johnson, Nikorn Pothayee, Nipon Pothayee, Y. Lin, R. M. Davis, J. S. Riffle, “Synthesis of Ammonium Bisphosphonate Monomers and Polymers,” *Polymer*, 54(13), 3188-3197 (2013), DOI:10.1016/j.polymer.2013.04.032.
 5. H. Borjigin, Q. Liu, W. Zhang, K. Gaines, J. S. Riffle, D. R. Paul, B. D. Freeman, J. E. McGrath, “Synthesis and Characterization of Thermally Rearranged (TR) Polybenzoxazoles: Influence of isomeric structure on gas transport properties,” *Polymer*, 75, 199-219 (2015), DOI:10.1016/j.polymer.2015.07.024.

d. Synergistic Activities

1. Graduate Education: Prof. Riffle strives to integrate research and education. She was the architect of Virginia Tech’s interdisciplinary graduate degree program in Macromolecular Science and Engineering (began accepting students in 2001), and she directed the program from its inception (2001-2015). She has served as PI and director of an IGERT program on high performance polymer composites for infrastructure. She has served as major professor for 42 PhD and 16 MS degrees. Of the 42 PhD degrees, 25 were to male students and 17 to female students. Six of the degrees were conferred to students from underrepresented groups. She now directs a graduate research group of 15 students. She has initiated 5 interdisciplinary graduate courses.
2. Undergraduate Education: Prof. Riffle is the PI and director of the Macromolecules and Interfaces Institute undergraduate NSF summer research programs (2015 marked the program’s 26 consecutive year).
3. Say YES (Youth Experiencing Science) to Science - K-12: Prof. Riffle has directed a middle school outreach summer program for the past 9 years. This comprises a week during each summer where the REU students mentor the K-12 students as they conduct science experiments and develop a project. The K-12 program culminates each summer when the young YES scientists present their projects to the community during Blacksburg’s annual Steppin’ Out street fair.
4. Contributions to Professional Societies: *American Chemical Society, Division of Polymer Chemistry*: Chair, Workshop Committee, 1999-2006; ACS National Awards Committee, 1998-2005; Chair, Nominations Committee, 1999; Chair, Long-Term Planning Committee, 1998; Past Chair, Division of Polymer Chemistry, 1998; Co-chair of Symposium on Dispersions: Fundamentals and Processing, 1997; Chair, Division of Polymer Chemistry 1997; Co-chair, National Graduate Research Conference, 1996; Chair, Macromolecular Secretariat Symposium on Composites, ACS National Meeting, 1995; Chair Elect, Division of Polymer Chemistry 1996; Vice Chair, Division of Polymer Chemistry 1995; Executive Board Member, 1991-2009; National Technical Programming Chair, 1991-93; Assoc. Editor, Polymer Preprints, 1986-1991.
5. Contributions to the Technical Community and Continuing Education: Co-chair, Workshops on Polymers in Medicine and Biology, 2005, '07, '09, '11, '13, '15 and upcoming in '17; co-chair, Workshop on From Anionic Polymerization to Aerospace Materials to Membranes, '14; co-chair, Symposium in honor of Jim McGrath, North American Membrane Soc., '15. She also teaches continuing education courses 3 time/yr on Polymer Chemistry, Principles and Practice (~2000-present).

Biographical Sketch: Amanda J. Morris

(a) PROFESSIONAL PREPARATION

Pennsylvania State University	Chemistry	B.S. May 2005
Johns Hopkins University	Chemistry	PhD August 2009
Princeton University	Chemistry	Postdoctoral Associate 9/09-8/11

(b) APPOINTMENTS

Virginia Tech	Chemistry	Assistant Professor 8/11 - present
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(c) PUBLICATIONS

(i) Five publications most closely related to the proposed project:

1. Lin, S.; Pineda-Galvan, Y.; Maza, W.A.; Epley, C.C.; Zhu, J.; Kessinger, M.C.; Pushkar, Y.; Morris, A.J.* "Electrochemical Water Oxidation by a Catalyst-Modified Metal Organic Framework Thin Film." *ChemSusChem*, 2017, 10, 514-522.
2. Landaverde-Alvarado, C.; Morris, A.J.; Martin, S.M.* "Gas Sorption and Kinetics of CO₂ Sorption and Transport in a Polymorphic Microporous MOF with Open Zn(II) Coordination Sites." *J. CO₂ Util.*, 2017, 19, 40-48.
3. Usov, P.M.; Ahrenholtz, S.R.; Maza, W.A.; Stratakes, B.; Epley, C.C.; Kessinger, M.C.; Zhu, J.; Morris, A.J. "Cooperative Electrochemical Water Oxidation by Zr Nodes and Ni-porphyrin Linkers of a PCN-224 MOF Thin Film." *J. Mater. Chem. A*, 2016, DOI: 10.1039/c6ta05877a.
4. Qin, M.; Maza, W.A.; Stratakes, B.M.; Ahrenholtz, S.R.; Morris, A.J.*; He, Z.* "Nanoparticulate Ni(OH)₂ Films Synthesized from Macrocyclic Nickel(II) Cyclam for Hydrogen Production in Microbial Electrolysis Cells." *J. Electro. Soc.*, 2016, 163 (5), F437-F442.
5. Ahrenholtz, S.R.; Landaverde-Alvarado, C.; Whiting, M.; Lin, S.; Slebodnick, C.; Marand, E.; Morris, A.J. "Thermodynamic Study of CO₂ Sorption by Polymorphic Microporous MOFs with Open Zn(II) Coordination Sites." *Inorg. Chem.* 2015, 54 (9), 4328-4336.

(ii) Five other significant publications:

1. Maza, W.A.; Padilla, R; Morris, A.J. "Concentration dependent dimensionality of resonance energy transfer in a post-synthetically doped morphologically homologous analogue of UiO-67 MOF with a ruthenium(II) polypyridyl complex." *J. Am. Chem. Soc.* 2015, 137, 8161–8168.
 2. Maza, W.A.; Ahrenholtz, S.R.; Epley, C.C.; Day, C.S.; Morris, A.J. "Solvothermal Growth and Photophysical Characterization of a Ruthenium(II) Tris-(2,2'-Bipyridine)-Doped Zirconium UiO-67 Metal Organic Framework Thin Film." *J. Phys. Chem. C*. 2014, 118, 14200-14210.
 3. Maza, W.A.; Morris, A.J. "Photophysical Characterization of a Ruthenium(II) Tris-(2,2'-Bipyridine)-Doped Zirconium UiO-67 Metal Organic Framework." *J. Phys. Chem. C*. 2014, 118, 8803-8817.
 4. Ahrenholtz, S.R.; Epley, C.C.; Morris, A.J. "Solvothermal Preparation of an Electrocatalytic Metalloporphyrin MOF Thin Film and its Redox Hopping Charge Transfer Mechanism" *J. Am. Chem. Soc.* 2014, 136, 2464-2472.
 5. Maza, W.A.; Haring, A.J.; Ahrenholtz, S.R.; Epley, C.C.; Lin, S.Y.; Morris, A.J. "Ruthenium(II)-polypyridyl metal-organic frameworks as a new class of sensitized solar cells." *Chem. Sci.* 2016, 7, pp 719-727.
-

(d) SYNERGISTIC ACTIVITIES

1. American Chemical Society – Expert in Sustainable Energy (2013-present)
2. Judge, Blue Ridge Science Fair – Energy & Environment and Chemistry Divisions (2011-present)
3. Member of Chemistry Women Mentorship Network (ChemWMN) (2014-present)
4. Develop Experiments and Co-Organize ChemFest, National Chemistry Week Outreach Events, “Energy Now and Forever” – 2013, “The Sweet Side of Chemistry” – 2014
5. Organized symposia for American Chemical Society Meetings:
 - a. Vice Chair – Energy Division, Physical Chemistry (2017)
 - b. Chair – Solid-State Division, Inorganic Chemistry (2017)
 - c. ACS San Francisco – “Renewable Energy at the Interface between Theory and Experiment”
 - d. ACS Denver – “Theoretical and Experimental Synergies at the Frontiers of Renewable Energy Catalysis”
 - e. ACS DC – “Fundamentals of Metal Organic Framework Catalysis”

Biographical Sketch

Shengfeng Cheng

Department of Physics, Virginia Tech, Blacksburg, Virginia 24061-0435

Phone: (540) 231-5767; fax: (540) 231-7511; email: chengsf@vt.edu

(a) Professional Preparation

Nanjing University	Nanjing, China	Physics	B.S. 2000
Nanjing University	Nanjing, China	Physics	M.S. 2003
Johns Hopkins University	Baltimore, MD	Physics	Ph.D. 2010
Sandia National Laboratories	Albuquerque, NM	Computational Materials and Data Science	2010-2013

(b) Appointments

Assistant Professor	Physics Dept., Virginia Tech	Since August 2013
Postdoctoral Appointee	Sandia National Laboratories	2010-2013

(c) Products

Relevant Publications

- N. Argibay, M. Chandross, S. Cheng, and J. R. Michael, *Linking microstructural evolution and macro-scale friction behavior in metals*, J. Mater. Sci. **52**, 2780 (2017).
- S. Cheng and G. S. Grest, *Dispersing nanoparticles in a polymer film via solvent evaporation*, ACS Macro Lett. **5**, 694 (2016).
- D. V. Gough, J. S. Wheeler, S. Cheng, M. J. Stevens, and E. D. Spörke, *Supramolecular assembly of asymmetric self-neutralizing amphiphilic peptide wedges*, Langmuir **30**, 9201 (2014).
- S. Cheng and G. S. Grest, *Molecular dynamics simulations of evaporation-induced nanoparticle assembly*, J. Chem. Phys. **138**, 064701 (2013).
- P. Mellado, S. Cheng, and A. Concha, *Mechanical response of a self-avoiding membrane: Fold collisions and the birth of conical singularities*, Phys. Rev. E **83**, 036607 (2011).

Other Significant Publications

- S. Cheng and M. O. Robbins, *Capillary adhesion at the nanometer scale*, Phys. Rev. E **89**, 062402 (2014).
- S. Cheng and M. J. Stevens, *Self-Assembly of chiral tubules*, Soft Matter **10**, 510 (2014).
- D. Meng, S. K. Kumar, S. Cheng, and G. S. Grest, *Simulating the miscibility of nanoparticles and polymer melts*, Soft Matter **9**, 5417 (2013).
- S. Cheng, A. Aggarwal, and M. J. Stevens, *Self-assembly of artificial microtubules*, Soft Matter **8**, 5666 (2012).
- S. Cheng and G. S. Grest, *Structure and diffusion of nanoparticle monolayers floating at liquid/vapor interfaces: A molecular dynamics study*, J. Chem. Phys. **136**, 214702 (2012).

(d) Synergistic Activities

Appendix I: Biosketches

- Referee for Phys. Rev. Lett., Phys. Rev. E, Soft Matter, Langmuir, J. Chem. Phys., J. Phys. Chem., Tribology Letters, ChemComm, RSC Advances, J. Biotechnology & Biomaterials, J. Phys. D, Phys. Chem. Chem. Phys., Nanotechnology, Materials Horizons, Materials Research Express, Appl. Phys. Lett., Physical Biology, Extreme Mechanics Lett., J. Appl. Phys., Advance Materials Interface, Electrophoresis, J. Phys. Chem. Lett., Molecular Systems Design & Engineering, Zeitschrift für Naturforschung A, Scientific Reports
- Proposal reviewer for the Petroleum Research Fund of American Chemical Society
- Session Chair of *Session W41: Polymer Nanocomposites II* at 2015 APS March Meeting and *Session U31: Focus Session: Assembly & Function of Biomimetic & Bioinspired Materials III* at 2013 APS March Meeting
- Co-Chair of 2014 Virginia Soft Matter Workshop II
- Discussion Leader of *Mechanics and Flow Far from Equilibrium* at 2011 Gordon Research Seminar on Soft Condensed Matter Physics

DAVID A. DILLARD

Adhesive and Sealant Science Professor of Biomedical Engineering and Mechanics
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0219
Phone: (540) 231-4714 Email: dillard@vt.edu

A. Professional Preparation

University of Missouri-Rolla, Engineering Mechanics, B.S., 1976
University of Missouri-Rolla, Engineering Mechanics, M.S., 1978
Virginia Polytechnic Institute and State University, Engineering Mechanics, Ph.D., 1981

B. Appointments

Aug. 2006 – Present	Adhesive & Sealant Science Professor of Eng. Sci. & Mech., Virginia Tech
Dec. 2004 – July 2005	Visiting Scientist, Oak Ridge National Laboratory (sabbatical)
Sept. 2004 – Dec. 2004	Visiting Scientist, GM Global Fuel Cell Center (sabbatical)
Jan. 2004 – June 2004	Founder and Interim Director, Macromolecules and Interfaces Institute, Virginia Tech
Jan. 1999 – Dec. 2003	Director, Center for Adhesive and Sealant Science, Virginia Tech
May 1993 – Aug. 2006	Professor of Engineering Science and Mechanics, Virginia Tech
Sept. 1992 - Dec. 1992	Visiting Professor, Institute of Applied Mechanics (sabbatical) National Taiwan University, Taipei, Taiwan, R.O.C.
Summer 1992	ASEE-NASA Fellow, NASA Langley Research Center
May 1988 - May 1993	Associate Prof., Engineering Science & Mechanics, Virginia Tech
Jan. 1985 - May 1988	Assistant Prof. of Engineering Science & Mechanics, Virginia Tech
Jan. 1981 – Dec. 1983	Assistant Prof. of Engineering Mechanics, University of Missouri -- Rolla

C. Publications:

(i) Five Publications Most Relevant to the Proposed Research

- T. Park, D. A. Dillard, and T. C. Ward, "Anisotropy in the Thermal Shrinkage of Polyimide Film," *J. of Polymer Science Part B: Polymer Physics*, **38**, 2000, 3222-3229.
- K. Patankar, D. A. Dillard, S. W. Case, M. W. Ellis, Y-H. Lai, M. K. Budinski, and C. S. Gittleman, "Hygrothermal Characterization of the Viscoelastic Properties of Gore® Select 57 Proton Exchange Membrane", *Mechanics of Time-Dependent Materials*, **12** (3) 2008, 221-236.
- Y. Li, Jennifer K. Quincy, Scott W. Case, Michael W. Ellis, David A. Dillard, Yeh-Hung Lai, Michael K. Budinski, Craig S. Gittleman, "Characterizing the Fracture Resistance of Proton Exchange Membranes Corresponding", *Journal of Power Sources*, **185** (1), 2008, 374-380.
- Y-H. Lai and D. A. Dillard, "Mechanical Durability Characterization and Modeling of Ionomeric Membranes", *Handbook of Fuel Cells Volumes 5 & 6*, John Wiley & Sons, Ltd., 27, 2009.
- D. A. Dillard, Y. Li, J.R. Grohs, S.W. Case, M.W. Ellis, Y.-H. Lai, M.K. Budinski, and C.S. Gittleman, "On the Use of Pressure-Loaded Blister Tests to Characterize the Strength and Durability of Proton Exchange Membranes", *Journal of Fuel Cell Science and Technology*, **6**(3) 2009, p. 031014-8.

(ii) Five Other Significant Publications

- Y. Li, D. A. Dillard, S. W. Case, M. W. Ellis, Y.-H. Lai, C. S. Gittleman and D. P. Miller, "Fatigue and creep to leak tests of proton exchange membranes using pressure-loaded blisters." *Journal of Power Sources*, **194**(2), 2009, 873-879.

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- Y-H. Lai, C. K. Mittelsteadt, C.S. Gittleman, D.A. Dillard, "Viscoelastic Stress Analysis of Constrained Proton Exchange Membranes Under Humidity Cycling," *ASME Journal of Fuel Cell Science and Technology*, **6**(2), 021002 (2009) .
- Grohs, J. R., Y. Li, D. A. Dillard, S. W. Case, M. W. Ellis, Y.-H. Lai and C. S. Gittleman , "Evaluating the time and temperature dependent biaxial strength of Gore-Select® series 57 proton exchange membrane using a pressure loaded blister test." *Journal of Power Sources*, **195**(2), 2010, 527-531.
- M. Pestrak, Y. Li, S. W. Case, D. A. Dillard, M. W. Ellis, Y.-H. Lai and C. S. Gittleman (2010). "The Effect of Mechanical Fatigue on the Lifetimes of Membrane Electrode Assemblies." *Journal of Fuel Cell Science and Technology*, **7**(4): 041009.
- Yongqiang Li, David A. Dillard, Yeh-Hung Lai, Scott W. Case, Michael W. Ellis, Michael K. Budinski, Craig S. Gittleman, "Experimental Measurement of Stress and Strain in Nafion Membrane during Hydration Cycles, *Journal of The Electrochemical Society*, **159** (2), 2012, B173-B184.

D. Relevant Synergistic Activities

1. **Broad experience:** Professor Dillard has been active in the area of characterizing, designing with, and predicting the durability of polymeric materials for nearly 40 years, having industrial, academic, and government laboratory experience in the field, with a special focus in the area of adhesion science, where he has worked on a range of structural, microelectronic, and pressure sensitive adhesives, as well as sealants and other elastomeric systems.
2. **Interdisciplinary research, teaching, and outreach:** His work is often of an interdisciplinary nature, involving other faculty members and students from engineering, materials science, and chemistry. He regularly co-teaches academic credit courses as well as numerous industrial short courses with instructors from other departments, providing broad, interdisciplinary foundations to students and short course attendees (typically disseminating information to over 200 industrial employees each year.)
3. **Knowledge transfer:** He has transferred knowledge from research to the scientific community through over 175 refereed journal publications and more than 360 presentations at national and international venues, a number of which were invited. Technology transfer is a key component in many of his funded research projects, as demonstrated through successful implementation of techniques he developed.
4. **Recognition in the field:** Prof. Dillard is widely recognized in the adhesion science and mechanics communities, as exemplified by his sitting on the Editorial Board for the Journal of Adhesion, being elevated to Robert L. Patrick Fellow in the Adhesion Society and Fellow of ASME, and receiving the Adhesion Society's 2010 Award for Excellence in Adhesion Science and the IOM3 2013 Wake Memorial Medal. Other recognition include a two-time winner of The Society of Wood Science and Technology's George G. Marra Award of Excellence, ASTM Best Paper Award, Society for Experimental Mechanics Best Paper Award, two-time recipient of the Dean's Award for Excellence in Research, and recipient of the Missouri University for Science and Technology's Professional Degree.
5. **Leadership:** For over six years, Dr. Dillard served as the Director of the Center for Adhesive and Sealant Science at Virginia Tech, an interdisciplinary group of engineers, chemists, and material scientists involved in annual research expenditures approaching \$4 million. In this role he worked to encourage the interdisciplinary collaboration that is required for many research aspects in the field of adhesion science. He continues to interact with many students and faculty, and has worked to develop programs to encourage participation by under-represented groups in activities of the Center and its successor, the Macromolecules and Interfaces Institute, which he led in founding. He is a past president of the Adhesion Society.

Appendix I: Biosketches

SUSAN E. DUNCAN, Ph.D., R.D.

Associate Director, Virginia Agricultural Experiment Station
Professor, Food Science and Technology
104C Hutcheson Hall
Virginia Tech
Blacksburg, VA 24061-0418; duncans@vt.edu

PROFESSIONAL PREPARATION

The Ohio State University	Food Technology (Honors)	B.S. 1981
Indiana University of Pennsylvania	Human Nutrition and Foods	M.S. 1987
The University of Tennessee	Food Science and Technology	Ph.D. 1989

RELATED QUALIFICATIONS

Registered Dietician

The American Dietetic Association, Commission on Dietetic Registration, 1987-present

APPOINTMENTS (All at Virginia Tech)

- **Associate Director**, Virginia Agricultural Experiment Station, 2016-present
- **Professor**, Department of Food Science and Technology, 2004-present
- **Co-Director**, Water INTERface Interdisciplinary Graduate Education Program, 2014-present
- **Director**, Macromolecular Interfaces with Life Sciences NSF IGERT Program, 2004-2011
- **Associate Professor**, Department of Food Science and Technology, 1996-2004.
- **Assistant Professor**, Department of Food Science and Technology, 1990-1996.

PUBLICATIONS (Selected, from last 5 years): graduate students and post-docs marked with +; undergraduates underlined.

Emphasis: Packaging + Water + Biological Fluids + Health

1. Potts⁺ H, Amin⁺ K, Duncan S. 2017. Retail lighting and packaging influences consumer acceptability of fluid milk. *Journal of Dairy Science*. 100(1):146-156.
2. **Wang⁺ A, Duncan SE, Knowlton KF, Ray WK, Dietrich AM. 2016. Milk protein composition and stability changes affected by iron in water sources. *Journal of Dairy Science* 99(6):4206-4219.**
3. **Wang⁺ A, Duncan SE, Dietrich AM. 2016. Effect of iron on taste perception and emotional response of sweetened beverage under different water conditions. *Food Quality & Preference* 54:58-66.**
4. Johnson⁺, D.S., S.E. Duncan, L.M. Bianchi⁺, H.H. Chang⁺, W.N. Eigel, and S.F. O'Keefe. 2015. Packaging modifications for protecting flavor of extended shelf-life milk from light. *J. Dairy Sci.* 98(4):2205-2214.
5. Mirlohi⁺, S., S.E. Duncan, M. Harmon, D. Case, G. Lesser, and A.M. Dietrich. 2014. Analysis of salivary fluid and chemosensory functions in patients treated for primary malignant brain tumors. *Clin. Oral Invest.* Published online March 5, 2014. doi:10.1007/s00784-014-1211-8.
6. Mann⁺, G.R., S. E. Duncan, K.F. Knowlton, A.D. Dietrich, and S.F. O'Keefe, 2013. Effects of mineral content of bovine drinking water: Does iron content affect milk quality? *J. Dairy Sci.* 96:7478-7083.
7. Leyrer, C., M. Chan, A. Peiffer, E. Horne, M. Harmon, A. Carter, W. Hinson, S. Mirlohi, S. Duncan, A. Dietrich, G. Lesser. 2013. Taste and smell disturbances after brain irradiation: A dose-volume histogram analysis of a prospective observational study. *Practical Radiation Oncology*. Mar-Apr 4(2):130-135; doi:10.1016/j.prro.2013.06.003. Epub 2013. July 25.
8. Feng, X., K.F. Knowlton, A. D. Dietrich, S. Duncan. 2013. Effect of abomasal lactate infusion on phosphorus absorption in lactating dairy cows. *J. Dairy Sci.* 96:4586-4591.

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9. Duncan, S.E., and H.H. Chang. 2012. Implications of light energy on food quality and packaging selection. *Adv. Food Nutr. Research* 67:25-66.
10. Omur-Ozbek, P., A. Dietrich, S. Duncan, and Y. Lee. 2012. Role of lipid oxidation, chelating agents, and antioxidants in metal flavor development in the oral cavity. *J. Agric. Food Chem.* 60(9):2274-2280.

SYNERGISTIC ACTIVITIES

1. **Education:** *Ph.D. Training:* Co-Director (2014-present) and Co-Principal Investigator, Virginia Tech Water INTERface Interdisciplinary Graduate Education Program (IGEP; 2011-present, 21 graduate students (17 PhD)); Director and Principal Investigator for the NSF Macromolecular Interfaces with Life Sciences (MILES) IGERT (2004-2011; 35 PhD IGERT students plus 4 affiliated PhD IGERT students and 20 SURP students. *Curriculum Development and Instruction:* Developed 4 multidisciplinary MILES courses and a graduate certificate program approved through the university. Assisted in curriculum development for Water INTERface IGEP graduate certificate, courses and served as co-instructor in the Water INTERface IGEP Water for Health seminar course (2011, 2013, 2015). Co-Principal Investigator, REU Site: Materials Innovation at the Intersection of Food-Energy-Water Systems (MII FEWS), NSF (2016-2019; 12 undergraduate students to date)
2. **Outreach:** *K-12:* MILES IGERT contributor to the Mentoring Academic Growth in the Community (MAGIC) outreach program with the Science Museum of Western Virginia (2005-10); coordinated activities and hosted middle school students in the Department of Food Science and Technology (2007-09), with demonstrations pertaining to sensory quality and analytical measurements; mentored a home schooled 9th grader for regional science fair (2012). *Industry:* Provide technical expertise to the dairy, food & beverage, and packaging industries related to sensory evaluation, quality, and packaging through contractual grants and independent interactions. *Professional Service:* Member, Board of Directors of the American Dairy Science Association (2011-14), Vice President (2014-15), President (2015-16).
3. **Research:** Recognized expert in sensory evaluation of food (beverage)-packaging interactions and oxidation-based, including photo-induced, reactions in biological fluids, beverages and foods; expertise in sensory evaluation of metallic flavor pertaining to water, foods and health; consumer insights pertaining to food, water, packaging.

Julia M Gohlke

Asst. Professor, Environmental Health
Department of Population Health Sciences
205 Duck Pond Drive MC 0395
Virginia Tech
Blacksburg, VA 24061-0395; jgohlke@vt.edu

Professional Preparation

University of Michigan	Biology	B.S.	1997
University of Washington	Environmental Health/Public Hlth	M.S.	2001
University of Washington	Toxicology/ Env Health	PhD	2004
NIEHS/NIH	Biostats/Bioinformatics/Env Hlth	Post-doc	2009

Appointments

Assistant Professor	Virginia Tech, Dept. Population Hlth Sci	2015 to present
Assistant Professor	Univ of Alabama at Birmingham, Dept Env Hlth Sci	2010 - 2015
AAAS Fellow	U.S. Department of State, Washington DC	2009 - 2010
Temporary Advisor	World Health Organization, Switzerland	2008

Products

Dr. Gohlke has authored 40 peer-reviewed scientific publications and 10 book chapters/technical reports.

Five Products most closely related:

1. Bernhard, MC, MB Evans, ST Kent, E Johnson, SL Threadgill, SB Tyson, SM Becker, JM Gohlke (2013). Identifying environmental health priorities in underserved populations: a study of rural versus urban communities. *Public Health* 127 (11): 994-1004.
2. Gohlke JM, D Doke, M Tiple, M Leader, T Fitzgerald. (2011). A review of seafood safety after the Deepwater Horizon blowout. *Environ Health Perspect.* 119(8): 1062-9
3. Fitzgerald, TP, JM Gohlke. (2014). Contaminant levels in Gulf of Mexico reef fish after the Deepwater Horizon oil spill as measured by a fishermen-led testing program. *Environ Sci and Technol.* 48(3): 1993-2000.
4. Sathiakumar N, M Tiple, A Turner-Henson, L Chen, M Leader, J Gohlke. (2017). Post-Deepwater Horizon blowout seafood consumption patterns and community-specific levels of concern for selected chemicals among children in Mobile County, Alabama. *Int. J. Hyg. Environ. Health* 220 (1): 1-7
5. Bernhard, MC, ST Kent, MA Sloan, MB Evans, McClure LA, JM Gohlke. (2015). Measuring personal heat exposure in an urban and rural environment. *Environmental Research* 137: 410-418.

Five Other Recent Significant Products:

1. Porter, T, ST Kent, W Su, HM Beck, JM Gohlke. (2014). Birth outcomes in neighborhoods surrounding coke production and steel making facilities in Alabama, USA. *Environmental Health* 13: 85.

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2. Kent ST, McClure LA, Zaitchik BF, Smith TT, & JM Gohlke. (2014). Heat Waves and Health Outcomes in Alabama (USA): The Importance of Heat Wave Definition. *Environ Health Perspect.* 122(2): 151-8
3. Schwartz TS, P Pearson, J Dawson, DB Allison, JM Gohlke. (2016). Effects of fluctuating temperature and food availability on reproduction and lifespan. *Experimental Gerontology* 86: 62-72.
4. Crider, KG, EH Maples, JM Gohlke. (2014). Incorporating occupational risk in heat stress vulnerability mapping. *Journal of Environmental Health* 77(1): 16-22.
5. Chan MP, RS Weinhold, R Thomas, JM Gohlke, CJ Portier. (2015). Environmental predictors of U.S. mortality patterns on a national basis. *PLoS One* 10(12): e0137832

Synergistic Activities

1. Outreach: Several of our CDC and NIH funded research projects take a community-engaged approach, working with organizations in underserved communities in Birmingham and Black Belt counties in Alabama and Tazewell Cty, Virginia. We have established advisory boards made up of community and local government members, as well as academic representation to determine research goals.
2. Education: I have taught a graduate level environmental health and human health risk assessment for 6 years exploring the intersection between human health sciences (toxicology), epidemiology, environmental policy and economics.
3. International Activities: Developed and put on a lessons learned workshop from the Deepwater Horizon oil spill to build capacity in Ghana, a country that has begun deepwater oil drilling. Mentored a Fulbright PhD student from Ghana.
4. Service: Grant reviewer for NIH Climate Change and Health Panel, NASA Health and Air Quality Applied Sciences, NIOSH Centers for Agricultural Health and Safety, EPA STAR Graduate Fellowship Program, Human Health Risk Assessment Public Health Panel, NSF Graduate Research Fellowship Program, NSF Geography and Spatial Sciences Program, Army Corps of Engineers Engineer Research and Development. Served as Editorial Board Member for *Reproductive Toxicology* and *Journal of Health and Pollution*.

Collaborators

Virginia Tech: Linsey Marr, Susan Marmagas, Leigh-Anne Krometis, Korine Kolivras, Molly Richardson, Samarth Swarup, Dawen Xie, Jim Bohland, Emily Satterwhite

University of Alabama at Birmingham: Mary B Evans, David B Allison, Claudiu Lungu, Stephen A Watts

Johns Hopkins University: Benjamin F Zaitchik, Tiffany Smith, Anna Scott

Drexel University: Leslie A McClure

Auburn University: Tonia S Schwartz

Texas Tech University: John A Dawson

Graduate and Postdoctoral Advisors: Christopher J Portier, retired, previous at NIEHS and CDC and Elaine M Faustman, University of Washington

Graduate Student and Post-doc Advisees: Post-docs: Shia Kent, Tonia S Schwartz, Yuhao Wu, Molly Richardson PhD students: Molly C Bernhard, Dzigbodi Doke MS students: Jordan E Roberts, Sherri Hudson

VALISA E. HEDRICK

Assistant Professor, Human Nutrition, Foods and Exercise
295 West Campus Drive
Virginia Tech
Blacksburg, VA 24061; vhedrick@vt.edu

PROFESSIONAL PREPARATION

Virginia Tech

Human Nutrition and Dietetics
Registered Dietitian Nutritionist
Clinical Human Nutrition
Behavioral Human Nutrition

BS 2006
RDN 2007
PhD 2011
Post-doc 2011-2014

APPOINTMENTS

- Assistant Professor, Human Nutrition, Foods, and Exercise, Virginia Tech, 2014-present

PRODUCTS: Dr. Hedrick has published 21 products in the peer-reviewed literature.

FIVE MOST CLOSELY RELATED *= student advisee

- **Hedrick VE**, Savla J, Comber DL, Flack KD, Estabrooks PA, Nsiah-Kumi PA, Ortmeier S, and Davy BM. Development of a Brief Questionnaire to Assess Habitual Beverage Intake (BEVQ-15): Sugar-Sweetened Beverages and Total Beverage Energy Intake. *J Acad Nutr Diet*. 2012;112:840-849.
- **Hedrick VE**, Davy BM, Duffey K. Is Beverage Consumption Related to Specific Dietary Pattern Intakes? *Current Nutrition Reports*. 2015;4(1):72-81, DOI: 10.1007/s13668-014-0109-z.
- **Hedrick VE**, Davy BM, Myers EA*, You W, Zoellner JM. Changes in the Healthy Beverage Index in Response to an Intervention Targeting a Reduction in Sugar-Sweetened Beverage Consumption as Compared to an Intervention Targeting Improvements in Physical Activity: Results from the Talking Health Trial. *Nutrients*, 2015 (7), 101168-10178.
- Hooper LP*, Myers EM*, Zoellner JM, Davy BM, **Hedrick VE**. The Impact of Health Literacy Status on the Validity and Sensitivity of an Interactive Multimedia Beverage Intake Questionnaire. *Nutrients*. 2016;9(1).
- **Hedrick VE**, Davy BM, You W, Porter KJ, Estabrooks PA, Zoellner JM. Dietary quality changes in response to a sugar-sweetened beverage reduction intervention. Results from the Talking Health randomized controlled clinical trial. *The American Journal of Clinical Nutrition*. 2017;105(4):824-833.

5 OTHER SIGNIFICANT RELEVANT PRODUCTS

- **Hedrick VE**, Comber DL, Ferguson K, Estabrooks PA, Savla JS, Dietrich AM, Serrano EL, and Davy BM. A Rapid Beverage Intake Questionnaire Can Detect Changes in Beverage Intake. *Eating Behav*. 2013;14:90-94.
- **Hedrick VE**, Dietrich AM, Estabrooks PA, Savla JS, Serrano EL, and Davy BM. Dietary Biomarkers: Advances, Limitations and Future Directions. *Nutrition Journal*. 2012, 11:109. (Epub ahead of print) DOI: 10.1186/1475-2891-11-109.
- Zoellner JM, **Hedrick VE**, You W, Chen Y, Davy BM, Porter KJ, Bailey A, Lane H, Alexander R, and Estabrooks PE. Effects of a Behavioral and Health Literacy Intervention to Reduce Sugar-sweetened Beverages: A Randomized-controlled Trial. *Int J Behav Nutr Phys Act*. 2016. doi: 10.1186/s12966-016-0362-1.
- **Hedrick VE**, Zoellner JM, Jahren AH, Woodford NA, Bostic J, Davy BM. A dual carbon and nitrogen stable isotope ratio model is not superior to a single carbon stable isotope ratio model for

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predicting added sugar intake in Southwest Virginian adults. *The Journal of Nutrition*. 2015, Jun;145(6):1362-9.

- **Hedrick VE**, Davy BD, Wilburn GA, Jahren AH, Zoellner JM. Evaluation of a Novel Biomarker of Added Sugar Intake ($\delta^{13}\text{C}$) Compared to Self-Reported Added Sugar Intake and the Healthy Eating Index in a Community-Based, Rural U.S. Sample. *Public Health Nutrition*. 2015, 23:1-8.

SYNERGISTIC ACTIVITIES:

- Co-Instructor of Virginia Tech's Water INTERface seminar course (2016), an Interdisciplinary Graduate Education Program that integrates students and faculty in the departments of Human Nutrition, Food, and Exercise; Civil and Environmental Engineering; and Food Science and Technology. Guest lecturer for the Water INTERface Interdisciplinary Research Course (2017).
- Executive Committee Member, Research Dietetics Practice Group, Academy of Nutrition and Dietetics (2016-present).
- Reviewer:
 - United States Department of Agriculture's Economic Research Service
 - Center for Disease Control, Preventing Chronic Disease
 - Nutrition Journal
 - Public Health Nutrition
 - Nutrients
 - British Journal of Nutrition
- Invited presentations
 - "Artificial Sweeteners: Sweet Poison or Sweet Success?" Invited speaker, 2015 Nutrition Assistants' Multi-State Conference, Roanoke, VA. May 6, 2015.
 - "Beverages: Effects on Calorie Intake, Body Weight Regulation, and Cardio-metabolic Health". Invited speaker, Virginia Academy of Nutrition and Dietetics 2017 Annual Meeting. Co-presented with Brenda Davy. Blacksburg, VA March 28, 2017.

COLLABORATORS AND CO-AUTHORS

Virginia Tech

Brenda Davy
Wen You
Elena Serrano
Andrea Dietrich
Tina Savla
Kiyah Duffey
Richard Winett
Andrew Neilson
Osman Balci
Susan Duncan

External Collaborators

Jamie Zoellner, University of Virginia
Jennie Hill, Gretchen Swanson Center
Tanya Halliday, University of Colorado
Paul Estabrooks, University of Nebraska
A. Hope Jahren, University of Oslo
Hollie Raynor, University of Tennessee
Yvonne Chen, University of Kansas
Susan Swithers, Purdue University
Karina Lora, University of Connecticut

GRADUATE ADVISEES

Erin M. Passaro, MS (2016) Dietetic Intern with the Medical University of South Carolina
Molly C. Bremer (expected MS 2017) Future: Dietetic Intern with the University of Virginia
Erica L. Hess (expected MS 2017) Future: Dietetic Intern with the Medical University of SC
Emily A. Myers (expected PhD 2018)
Natalie A. Kruzliakova (expected PhD 2018)
Anna G. Fausnacht, MPH (expected PhD 2020)

Zhen He, Ph.D.

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Engineering
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Professional Preparation

Tongji University	Environmental Engineering	B.S., 2000
Technical University of Denmark	Environmental Engineering	M.S., 2003
Washington University in St. Louis	Environmental Engineering	Ph.D., 2007

Appointments

- 2013 – present Associate Professor, Department of Civil and Environmental Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA
- 2009 – 2013 Assistant Professor, Department of Civil Engineering and Mechanics, University of Wisconsin – Milwaukee, Milwaukee, WI
- 2007 – 2009 Postdoctoral Research Associate, University of Southern California, Los Angeles, CA

Five Relevant Products

- Zou, S., Qin, M., Morean, Y., and He, Z. (2017) Nutrient-energy-water recovery from synthetic sidestream centrate using a microbial electrolysis cell - forward osmosis hybrid system. *Journal of Cleaner Production*. Vol 154, pp 16-25.
- Luo, S. and He, Z. (2016) Ni-coated carbon fiber as an alternative cathode electrode material to improve cost efficiency of microbial fuel cells. *Electrochimica Acta*. Vol 222, pp 338-346.
- Qin, M., Abu-Reesh, I.M. and He, Z. (2016) Effects of current generation and electrolyte pH on reverse salt flux across thin film composite membrane in osmotic microbial fuel cells. *Water Research*. Vol 105, pp 583-590.
- Yuan, H., Hou, Y., Wen, Z., Guo, X., Chen, J. and He, Z. (2015) Porous carbon nanosheets co-doped with nitrogen and sulfur for oxygen reduction reaction in microbial fuel cells. *ACS Applied Materials & Interfaces*. Vol 7, pp 18672-18678.
- Zhang, B., Wen, Z., Ci, S., Mao, S., Chen, J. and He, Z. (2014) Synthesizing nitrogen-doped activated carbon and probing its active sites for oxygen reduction reaction in microbial fuel cells. *ACS Applied Materials & Interfaces*. Vol 6, pp 7464-7470.

Other Significant Products

- Yuan, H., Abu-Reesh, I. and He, Z. (2016) Mathematical modeling assisted investigation of forward osmosis as pretreatment for microbial desalination cells to achieve continuous water desalination and wastewater treatment. *Journal of Membrane Science*. Vol 502, pp 116-123.
- Lu, Y. and He, Z. (2015) Mitigation of salinity buildup and recovery of wasted salts in a hybrid osmotic membrane bioreactor - electrodialysis system. *Environmental Science & Technology*. Vol 49, pp 10529-10535.
- Qin, M. and He, Z. (2014) Self-supplied ammonium bicarbonate draw solute for achieving wastewater treatment and recovery in a microbial electrolysis cell - forward osmosis coupled system. *Environmental Science & Technology Letters*. Vol 1, pp 437-441.
- Li, W.W, Yu, H. Q. and He, Z. (2014) Towards sustainable wastewater treatment by using microbial fuel cells-centered technologies. *Energy & Environmental Science*. Vol 7, pp 911-924.
- Zhang, B. and He, Z. (2013) Improving water desalination by hydraulically coupling an osmotic microbial fuel cell with a microbial desalination cell. *Journal of Membrane Science*. Vol 441, pp 18-24.

Synergistic Activities:

Major Courses Developed/Taught

Introduction to Environmental Engineering (UG), Freshwater Engineering (G), Environmental Biofuel and Resource Recovery (G), Hazardous Waste Management (UG/G), Bioelectrochemical Systems for Environmental Engineering (G)

Professional Affiliations, Honorary Societies, and other Honors

Vice Chair of Research and Innovation Committee, Water Environment Federation, Association of Environmental Engineering and Science Professors, International Water Association, American Association for the Advancement of Science

Reviewing

Manuscript reviewer for more than 35 journals (> 400 manuscripts)

Proposal reviewer for NSF Energy for Sustainability, NSF PIRE, NSF Environmental Sustainability, USDA SBIR, Research Foundation Flanders, HongKong ITSP

Editorial Activities

Associate Editor, *Water Environment Research*

Appendix I: Biosketches

Ryan D. Stewart, Ph.D., E.I.T.
Assistant Professor
Crop and Soil Environmental Sciences
Virginia Tech, Blacksburg, VA 24061
Email: ryan.stewart@vt.edu
Phone: (540) 231-0253

Fax: (540) 231-3431

a. Professional Preparation

California Polytechnic State U.	Mechanical Engineering	B.S. 2002
Oregon State University	Water Resources Engineering	M.S. 2010
Oregon State University	Water Resources Engineering	Ph.D. 2013
Oregon State University	Post Doctoral Scholar	2013

b. Appointments

Since 2014 Assistant Professor, Virginia Tech

c. Products

Five relevant publications

1. **Stewart, R. D.,** Z. Liu, D. E. Rupp, C. W. Higgins and J. S. Selker. 2015. A new instrument to measure plot-scale runoff. *Geoscientific Instrumentation, Methods and Data Systems*. 4: 57-64. doi:10.5194/gi-4-57-2015.
2. **Stewart, R. D.,** M. R. Abou Najm, D. E. Rupp, John W. Lane, Hamil C. Uribe, Jose Luis Arumí, and J. S. Selker. 2014. Hillslope runoff thresholds in shrink-swell clay soils. *Hydrological Processes*. doi:10.1002/hyp.10165.
3. **Stewart, R. D.,** D. E. Rupp, M. R. Abou Najm, and J. S. Selker. 2013. Modeling effect of initial soil moisture on sorptivity and infiltration. *Water Resources Research*. doi:10.1002/wrcr.20508.
4. **Stewart, R. D.,** M. R. Abou Najm, D. E. Rupp, and J. S. Selker. 2012. An image-based method for determining bulk density and the soil shrinkage curve. *Soil Science Society of America Journal*. 76(4):1 217-1221. doi: 10.2136/sssaj2011.0276n.
5. **Stewart, R. D.,** M. R. Abou Najm, D. E. Rupp, and J. S. Selker. 2012. Measurement tool for dynamics of soil cracks. *Vadose Zone Journal*. 11(2). doi:10.2136/vzj2011.0048.

Five other publications of significance

1. **Stewart, R. D.,** M. R. Abou Najm, D. E. Rupp, and J. S. Selker. 2016. Modeling multi-domain hydraulic properties of shrink-swell soils. *Water Resources Research*. 52: doi:10.1002/2016WR019336.
2. **Stewart, R. D.,** M. R. Abou Najm, D. E. Rupp, and J. S. Selker. 2016. A Unified Model for Soil Shrinkage, Subsidence, and Cracking. *Vadose Zone Journal*. 15(3): 1-15. doi: 10.2136/vzj2015.11.0146.
3. **Stewart, R. D.,** D. Moreno, C. T. Gregory and J. S. Selker. 2016. Evaluation of infiltration discharge as a strategy to meet effluent temperature limits. *Journal of Sustainable Water in the Built Environment*. doi: 10.1061/JSWBAY.0000818.
4. **Stewart, R. D.,** D. Moreno, and J. S. Selker. 2014. Quantification and scaling of infiltration from a constructed infiltration wetland. *Journal of Hydrologic Engineering*. 04015007. doi:10.1061/(ASCE) HE.1943-5584.0001164.

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5. **Stewart, R. D.**, R. W. Hut, D. E. Rupp, H. Gupta, and J. S. Selker. 2012. A resonating rainfall and evaporation recorder. *Water Resources Research*. 48(8): W08601. doi: 10.1029/2011WR011529.

d. Synergistic Activities

1. Convener/Co-Convener: “Applying Soil Physics to Soil Health,” Soil Science Society of America Annual Meeting (2017); “Soil Physics and Hydrology Division Student Competition,” Soil Science Society of America Annual Meeting (2017); “Understanding Hydrogeophysical States and Fluxes: Connecting Point Scale Information with Remote Sensing,” American Geophysical Union Fall Meeting (2015).
2. Reviewer: Panel Member, National Science Foundation, Engineering Directorate, CBET Division (2016; 2017); Panel Member, National Science Foundation, Geosciences Directorate, Graduate Research Fellowship Program (2015); Journal Reviewer (34 total in 19 different journals).
3. Committee Member: S483 Don and Betty Kirkham Soil Physics Award, Soil Science Society of America Soil Physics and Hydrology Division (2016-present); Virginia Tech, College of Agriculture and Life Sciences, Graduate Education Committee for the proposed School of Plant and Environmental Sciences (2015-2016); Virginia Tech, Crop & Soil Environmental Sciences Dept., Graduate Seminar Committee (2014-present)
4. Member: Multi-State Project W3188: Environmental Soil Physics (2014-present)

Appendix I: Biosketches

Kang Xia

Professor in Environmental Chemistry
Department of Crop & Soil Environmental Sciences
Virginia Tech

1880 Pratt Dr., Virginia Tech Cooperative Research Center, Blacksburg, VA 24061

Phone: (540)231-9323

Fax: (540)231-3431

Email: kxia@vt.edu

a. Professional Preparation

Beijing Agricultural University	Soil Chemistry	B.S.	1989
Louisiana State University	Soil Chemistry	M.S.	1993
University of Wisconsin-Madison	Soil Chemistry	Ph.D.	1997
University of Wisconsin-Madison	Environmental Chemistry		1997-1998
	(Postdoctoral Associate)		

b. Appointments

2016 to present	Professor, Dept. Crop & Soil Environ. Sci., Virginia Tech
2011 to 2016	Associate Professor, Dept. Crop & Soil Environ. Sci., Virginia Tech
2006 to 2011	Director for Research Division and Industrial and Agricultural Services Division, Mississippi State Chemical Laboratory
2010 to 2011	Associate Professor, Dept. of Chemistry, Mississippi State University
2006 to 2010	Assistant Professor, Dept. of Chemistry, Mississippi State University
2002 to 2005	Assistant Professor, University of Georgia
1998 to 2001	Assistant Professor, Kansas State University
1997 to 1998	Postdoctoral Researcher, University of Wisconsin-Madison

c. Publications

[out of 52 peer-reviewed journal publications and book chapters]

5 most related:

1. Chen, C. Q., and K. Xia. 2017. Fate of Land Applied Emerging Organic Contaminants in Waste Materials. Current Pollution Reports. Curr. Pollution Rep. 3:38-54.
2. Ray, P*, C.Q. Chen, K. F. Knowlton, A. Pruden, and K. Xia. 2017. Fate and effect of antibiotics in beef and dairy manure during static and turned composting. J. Environ. Qual. 46:45-54.
3. Kulesza, S. B., R. O. Maguire, K. Xia, J. Cushman, K. F. Knowlton, and P. Ray. 2016. Impact of manure injection on pirlimycin transport in surface runoff. J. Environ. Qual. 45:511–518.
4. Chao Q., D. Troya, C. Shang, S. Hildreth, R. Helm, and K. Xia. 2015. Surface Catalyzed Oxidative Oligomerization of 17 β -estradiol by Fe³⁺-Saturated Montmorillonite. Environ. Sci. Technol. 49:956–964.
5. Ray, P., K.F. Knowlton, C. Shang, and K. Xia. 2014. Method development and validation: solid phase extraction (SPE)-ultra performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS) quantification of pirlimycin in bovine feces and urine. J AOAC International. 97:1730-1736.

5 other significant publications:

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6. Ray, P., K.F. Knowlton, C. Shang, and **K. Xia**. 2014. Development and validation of a UPLC-MS/MS method to monitor cephalixin excretion in dairy cows following intramammary infusion. *PLOS ONE*. 9:1-12.
7. Gunatilake, S. R., J. W. Kwon, T. E. Mlsna, and **K. Xia**. 2014. A novel approach to determine estrogenic hormones in swine lagoon wastewater using QuEChERS method combined with solid phase extraction, and LC/MS/MS analysis. *Anal. Methods*. 6:9267 – 9275.
8. Fahrenfeld, N., K. Knowlton, L. A. Krometis, W. C. Hession, **K. Xia**, E. Lipscomb, K. Libuit, B. L. Green, A. Pruden. 2014. Effect of Manure Application on Abundance of Antibiotic Resistance Genes and their Attenuation Rates in Soil: Field-Scale Mass Balance Approach. *Environ. Sci. Technol.* 48:2643–2650.
9. Keith A. Maruya, D. E. Vidal-Dorsch, S. M. Bay, J. W. Kwon, **K. Xia**, and K. L. Armbrust. 2012. Organic contaminants of emerging concern in sediments and flatfish collected near outfalls discharging treated wastewater effluent to the Southern California Bight. *Environ. Toxicol. Chem.* 31:2683–2688.
10. **Xia, K.**, G. Hagood, C. Childers, J. Atkins, B. Rogers, L. Ware, K. Armbrust, J. Jewell, D. Diaz, N. Gatian, and H. Folmer. 2012. Polycyclic Aromatic Hydrocarbons (PAHs) in Mississippi Seafood from Areas Affected by the Deepwater Horizon Oil Spill. *Environ. Sci. Technol.* 46 (10):5310–5318.

d. Synergistic Activities

Major advisor for graduate students in environmental chemistry; Panel member of the USDA Soil Process Program; Reviewer of approximately 20 papers and proposals every year; Associate Editor for *Journal of Environmental Quality*. Conduct interdisciplinary research to investigate mineral surface reactivity and soil organic C and N dynamics using synchrotron-based spectroscopic techniques, to study the environmental fate of emerging contaminants in animal waste and biosolids-affected soil and water environment, and to develop chromatographic analytical methods for detecting trace level organic contaminants.

Appendix I: Biosketches

Timothy E. Long

Department of Chemistry, Virginia Tech, Blacksburg, VA 24061

540-231-2480; telong@vt.edu

A. Professional Preparation

St. Bonaventure University
Virginia Tech

Chemistry
Chemistry

B.S., 1983
Ph.D., 1987

B. Appointments

2014 Director, Macromolecules Innovation Institute
2011 Associate Dean for Research and International Outreach, College of Science
2009 Associate Director Interdisciplinary Research and Education, Fralin Institute, Virginia Tech
2003 Professor of Chemistry, Virginia Tech
2001 Associate Professor of Chemistry, Virginia Tech
1999 Assistant Professor of Chemistry, Virginia Tech
1993 Principal Research Chemist, Eastman Chemical Company, Kingsport, TN
1993 Senior Research Chemist, Eastman Kodak Company, Kingsport, TN
1991 Advanced Technical Program Researcher (ATP, sponsored by NIST)
1990 Senior Research Scientist, Eastman Kodak Company, Rochester, NY
1987 Advanced Research Scientist, Eastman Kodak Company, Rochester, NY

C. Publications

(i) Publications Related to the Proposed Project

1. Pekkanen, A. M.; Zawaski, C.; Stevenson Jr., A. T.; Dickerman, R.; Whittington, A. R.; Williams, C. B.; Long, T. E., Poly(ether ester) Ionomers as Water-Soluble Polymers for Material Extrusion Additive Manufacturing Processes. *ACS Applied Materials and Interfaces*, **2017**, 10.1021/acsami.7b01777
2. Long, T. E., Toward Recyclable Thermosets. *Science* **2014**, 344(6185), 706-707.
3. Nelson, A.; Pekkanen, A.; Forsythe, N.; Herlihy, J.; Zhang, M.; Long, T., Synthesis of Water Soluble Imidazolium Polyesters as Potential Non-viral Gene Delivery Vehicles. *Biomacromolecules* **2017**, 18(1), 68-76.
4. Long, T.E., Reaction: Benign by Design Demands Innovation. *Chem* **2017**, 2(1), 7-8.
5. Zhang, K.; Nelson, A. M.; Talley, S. J.; Chen, M.; Margaretta, E.; Hudson, A. G.; Moore, R. B.; Long, T. E., Non-isocyanate poly(amide-hydroxyurethane)s from sustainable resources. *Green Chemistry* **2016**, 18, 4667-4681.

(ii) Other Significant Publications

1. Schultz, A.R.; Chen, M.; Fahs, G.B.; Moore, R.B.; Long, T.E., Living anionic polymerization of 4-diphenylphosphino styrene for ABC triblock copolymers. *Polymer International* **2017**, 66 (1), 52-58
2. Schreiner, C.; Bridge, A.T.; Hunley, M.T.; Long, T.E.; Green, M.D., Segmented imidazolium ionenes: Solution rheology, thermomechanical properties, and electrospinning. *Polymer* **2017**, 114, 257-265.
3. Aduba, D.C. Jr.; Margaretta, E.; Marnot, A.E.C.; Chartrain, N.A.; Valentine K.; Surbey, W.R.; Feller, K.D.; Whittington, A.R.; Long, T.E.; Williams, C.B., 3D printed acid-cleavable hydrogels using vat photopolymerization. *Applied Physics Reviews - 3D Bioprinting: Physical and Chemical Processes*; AIP Publishing; Winston-Salem, NC; May 2-3, **2017**.
4. Chartrain, N.A.; Vratsanos, M.; Han, D.T.; Sirrine, J.M.; Pekkanen, A.; Long, T.E.; Whittington, A.R.; Williams, C.B., Microstereolithography of tissue scaffolds using a biodegradable

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photocurable polyester. *Proceedings of the 27th Annual International Solid Freeform Fabrication Symposium* **2016**, 1732-1748.

5. Long, T. E., Elabd, Y. A., Yuan, J., Ionic liquids in polymer design. *Macromolecular Rapid Communications* **2016**, 37(14), 1105-1105.
6. Zhang, K.; Fahs, G. B.; Drummey, K. J.; Moore, R. B.; Long, T. E., Doubly-Charged Ionomers with Enhanced Microphase-Separation. *Macromolecules* **2016**, 49(18), 6965-6972.
7. McDaniel D.K.; Jo A.; Ringel-Scaia V.M.; Coutermarsh-Ott S.; Rothschild D.E.; Powell M.; Zhang R.; Long T.E.; Oestreich K.; Riffle J.S., TIPS pentacene loaded PEO-PDLLA core-shell nanoparticles have similar cellular uptake dynamics in M1 and M2 macrophages and in corresponding in vivo microenvironments. *Nanomedicine: Nanotechnology, Biology and Medicine*. **2016**, 13(3), 1255-1266.
8. Zimmermann, K. A.; Inglefield, D. L., Jr.; Zhang, J.; Dorn, H. C.; Long, T. E.; Rylander, C. G.; Rylander, M. N., Single-walled carbon nanohorns decorated with semiconductor quantum dots to evaluate intracellular transport. *Journal of Nanoparticle Research* **2014** 16(1), 2078-2096.

D. Synergistic Activities

PI of \$350k NSF REU *Materials Innovation at the Intersection of Food-Energy-Water Systems* with 13 faculty from 7 departments at Virginia Tech; PI or Co-PI of \$3.4M funds in 2016 for polymer synthesis research projects, including 3D printing, additive manufacturing, and materials characterization; Participated in an intensive collaborative research exchange with Waseda U., Tokyo, Japan and San Sebastian, Spain (since 2004) as part of a university initiative to establish international research & student exchange programs. Appointed as Director of the Macromolecules Innovation Institute at Virginia Tech in 2014 with responsibilities for interdisciplinary research & education in polymer sciences across the campus.

E. Collaborations

(i) Recent Collaborators and Co-Editors (w/affiliations, alphabetical, coeditors/chairs)

R. Allen (IBM), S. Armentrout (EMN), A. Beuhler (Elevance), F. Beyer (ARL), G. Brown, (AFRL), C. Bunyard (Kimberly Clark Corp), K. Caster (ARO), T. Chen (ExxonMobil), R. Colby (Penn State), D. Cotsakis (Carlisle), C. Dejesus (Henkel), J. Elabd (Drexel U.), K. Haider (Bayer Material Science), R. Jensen (ARL), D. Kiserow (ARO), J. Messman (Honeywell), H. Nishide (Waseda U.), R. Odle (SABIC), J. Orlicki (ARL), A. Rawlett (ARL), A. Schneller (BASF), J. Snyder (ARL), B. Voit (IPF Dresden), C. Willis (Kraton), K. Winey, (UPenn), E. Yilgor, I. Yilgor (Koc U), Q. Zhang (Penn State).

(ii) Graduate Advisors and Postdoctoral Sponsors

PhD Advisor: Prof. James McGrath, Virginia Tech.

(iii) Thesis Advisor and Postgraduate-Scholar Sponsor: (Current students, VT) Joe Dennis, Justin Sirrine, Mingtao Chen, Ryan Mondschein, Allison Pekkanen, Katherine Valentine, Kevin Drummey, Philip Scott, Emily Wilts, Tyler White, Clay Arrington, Josh Wolfgang. **(Recent former students, VT)** Alison Schultz (Owens Corning), Evan Margaretta (Sun Chemical) Keren Zhang, (Dow), Ashley Nelson (HARL), Chainika Jangu (3M), David Inglefield (Eastman Chemical), Sean Hemp (Michelin), Daniel Buckwalter (Owens Corning), Eveline van der Aa (unemployed), Matthew Hunley (DuPont), Mana Tamami (Lubrizol), Steven June (3M), Shijing Cheng (3M), Matthew Green (Arizona State U.), Tianyu Wu (Bausch & Lomb), Renlong Gao (PPG), Michael Allen (Adhesives Research), Nancy Zhang (IBM Almaden). **(Recent Post-graduate scholars)** Daisuke Yamamoto (Toray), Makito Yokoe (Toray), Asem Abdulahad (Jefferson College of Health Science), Zhiyang Zhang (VT), Sachin Bobade (EMD), Nicholas Moon (Milliken), Maruti Hegde (VT), Jana Herzberger (VT).

(iv) Total Students and Postdocs: 82

Appendix I: Biosketches

LUKE E. K. ACHENIE

Professor, Department of Chemical Engineering, Virginia Tech
Tel: (540) 231-4257 • Fax: (540) 231-5022 • Email: achenie@vt.edu

A. PROFESSIONAL PREPARATION

Massachusetts Institute of Technology, Cambridge, MA, Chemical Engineering, B.S., 1981
Northwestern University, Evanston, IL, Engineering Science, M.S., 1982
Carnegie Mellon University, Pittsburgh, PA, Applied Mathematics, M. A. M., 1984
Carnegie Mellon University, Pittsburgh, PA, Chemical Engineering, Ph.D., 1988

B. APPOINTMENTS

1/14 – Present	Virginia Tech, Professor of Health Sciences.
1/12 – 1/13	Program Director, NSF/CBET /PRE
8/07 – Present	Virginia Tech, Professor of Chemical Engineering.
8/04 – 8/07	University of Connecticut, Professor
9/97 – 8/04	University of Connecticut, Associate Professor
9/91 – 8/97	University of Connecticut, Assistant Professor
8/88 – 7/91	Shell Development Company, Associate Research Engineer

C. PRODUCTS [FIVE PRODUCTS MOST CLOSELY RELATED TO THE PROPOSED PROJECT OUT OF OVER 160]

1. Rachael McCarthy, Luke E.K. Achenie, (2017), "Agent-Based Modeling – Proof of Concept Application to Membrane Separation and Hydrogen Storage in a MOF", (In press, Comp. Chem Eng.)
2. Luke E. K. Achenie, Yousef Sharifi, Dong-Gyu Lee. Tools For Chemical Product Design, 1st Edition, From Consumer Products to Biomedicine, Edited by Mariano Martín, Mario R. Eden and Nishanth G. Chemmangattuvalappil, Chapter 4. Multi-Scale Approaches to Computer Aided Product Design, Elsevier Publishers – (October, 6, 2016). – Print Book ISBN :9780444636836
3. Ma, Xianfeng; Li, Zheng; Achenie, Luke; Xin, Hongliang "Machine-Learning-Augmented Chemisorption Model for CO₂ Electroreduction Catalyst Screening", J. Phys. Chem. Lett., 6, 3528–3533, 2015 (extensive coverage on electronic news outlets for example "Designfax weekly eMagazine", "World of Chemicals", "ECN Magazine", "Newswise", etc.)
4. Yang, Q. and Achenie, L.E.K. "Comparing Penetrants Transport in Composite Poly (4-methyl-2-pentyne) and Nanoparticles of Cristobalite Silica and Faujasite Silica through Molecular Dynamics Simulation," *Ind. Eng. Chem. Res.*, 2013, 52 (19), 6462–6469, 2013 DOI: 10.1021/ie400524k
5. Zhenxing Wang, Luke E.K. Achenie, Sheima Jativ Khatib and S. Ted Oyama, "Simulation study of carbon dioxide and methane gas permeation in hybrid organic-inorganic membrane," *Journal of Membrane Science.*, 387/388, 30–39, 2012.

D. PRODUCTS [FIVE OTHER SIGNIFICANT PRODUCTS]

1. Yang, Q. and Achenie, L.E.K. "Development of a force field for artemisinin and molecular dynamics simulation of the dissolution of artemisinin in different solvents," *Journal of Theoretical and Computational Chemistry*, 2013, 12 (5), 1350038, 2013 DOI: 10.1142/S0219633613500387
2. Sharifi, Y. and Achenie, L.E.K., "Using Density Functional Theory to Postulate a Mechanism for Zinc Sulfide Formation in a CVD Reactor," *Journal of Crystal Growth*, 307, 440–447, 2007.
3. Yang, Q. and Achenie, L.E.K. "Molecular Dynamics Simulation of Penetrants Transport in Composite Poly(4-methyl-2-pentyne) and Silica Nanoparticles," *J. Phys. Chem. C*, 116, 7409–7415, 2012.
4. Stanescu, I. and Achenie, L.E.K., "A Theoretical Study of Solvent Effects on Kolbe-Schmitt Reaction Kinetics," *Chemical Engineering Science*, 61, 6199– 6212, 2006.

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5. Stanescu, I., Gupta, R. and Achenie, L.E.K., "An in-silico study of solvent effects on the Kolbe-Schmitt reaction using a DFT method," *Molecular Simulation*, **32**, 279-290, 2006.

E. SYNERGISTIC ACTIVITIES

1. I am the current 2017 Chair of the IC (International Committee), a committee within the American Institute of Chemical Engineering (AIChE). The committee helps with the globalization efforts of the AIChE.
2. I was the 2015 Chair of MPPG, a committee within the American Chemical Society (ACS). The committee decides on the themes for ACS Meetings. For example in the Spring (San Diego) meeting, the theme is "Computers in Chemistry" – I proposed and supported this theme four years ago and it was adopted for Spring 2016.
3. Sustainable Manufacturing Roadmap Development Workshop in Arlington, VA, Aug. 20, 2015.
4. GSAS-Qatar Global Conference (invited speaker on molecular modeling), Doha, Qatar, July 2012.
5. "Green chemical processes: solvents and catalysts" (invited talk), Second Chemical Sciences and Society Symposium (CS3) on "Sustainable Materials," September 2010, Gerard Cross, London, England.

F. COLLABORATORS & OTHER AFFILIATIONS (past 48 months)

Ranga Pitchumani (Virginia Tech); Chris Roy (Virginia Tech); Ted Oyama (Tokyo University/Virginia Tech); Foster Agblevor (Utah State University); Yon Woo Lee (Virginia Tech); Angela Scarpa (Virginia Tech).

(2). GRADUATE STUDENTS

PhD Maryam Moarefian (Virginia Tech, Current), Jamelle Simmons (Virginia Tech, Current), Chris Christie (Virginia Tech), Quan Yang (Post Doc in China), Naresh Pavurala (USDA post-doc), Zhenxing Wang (postdoc at Prof. Brian Laird's Lab, Chemistry Dept. University of Kansas), Andres Fernando Barrios Gonzales (Associate Professor, Univ. de Los Andes, Columbia); Rishi Gupta (Senior Research Scientist, Abbvie, Chicago IL); Shaoduan Ou (Assistant Professor, School of Energy and Power Engineering, Central South University, Changsha Hunan, China); Arunprakash Thirugnanam (Assistant Professor, Univ. of Colorado, Denver, CO.); Ozlem Yilmaz (Research Scientist); Yousef Sharifi; Ivan Datskov (Research Engineer, OSISOFT 777 Davis Street, Suite 250, San Leandro, CA 94577); Manish Sinha (Staff Research Engineer, General Motors, Rochester, NY); Yiping Wang (Research Engineer, Infineon, 6179 Pond Grass Rd Mechanicsville, VA 23111); Sanjeev Garg (Professor, IIT/Kanpur), Michael Butkus (Professor, joint with Dominic Grasso), H.K. Oh (joint with Norman Garrick).

MS Chris Christie (Virginia Tech), Quan Yang (Virginia Tech), Naresh Pavurala (Virginia Tech), Nuttapol Lerkkasemsan (Virginia Tech); Christina Geras (UTC Power); Charles Acquah (PhD candidate, UConn); Ozlem Yilmaz (Research Scientist); Yousef Sharifi; Amrit Prasad; Ioana Stanescu; Nick Antonopoulos (UTC Fuel Cells, East Windsor, CT); Shaoduan Ou (PhD candidate, UConn); Arunprakash Thirugnanam (USEPA,NRC), Cincinnati, OH); Mohammad Hussein (Texas Tech), Ivan Datskov (Research Engineer, OSISOFT 777 Davis Street, Suite 250, San Leandro, CA 94577); Sanjeev Garg (Assistant Professor, IIT/Kanpur), Yan Wan, Scott Ferrigno, Pennangaram Devika, Amit Duvedi, Nachiket Churi, Bhupen Wankarkar, Anand Karalapakkam, Vinod Kalikiri, Sandhya Paladugu, Michael Rouns, (Engineer, Pfizer, Groton, CT.), Jaeyong Myung.

Sanket A. Deshmukh

Department of Chemical Engineering, Virginia Tech

Professional Preparation

University of Pune, India	Chemistry	B.S. 2002
University of Pune, India	Polymer Science	M.S. 2004
University College Dublin, Ireland	Chemical & Bioprocess Engineering	Ph.D. 2009
Argonne National Laboratory, USA	Center for Nanoscale Materials	Postdoc, 2010-2015
North Carolina State University, USA	Materials Science and Engineering	Postdoc, 2015-2016

Appointments

2016-Present	Assistant Professor, Department of Chemical Engineering, Virginia Tech, Blacksburg, VA
2015-2016	Postdoc, Materials Science and Engineering Department, North Carolina State University, Raleigh, NC
2010-2015	Postdoc/Visiting Scientist, Center for Nanoscale Materials, Argonne National Laboratory, IL
2004-2006	Project Assistant II, National Chemical Laboratory, Pune, India

Related Publications

1. Z. Jiang, J. He, S. A. Deshmukh, P. Kanjanaboos, G. Kamath, Y. Wang, S.K.R.S. Sankaranarayanan, J. Wang, H. M. Jaeger, X. M. Lin, "Subnanometre ligand-shell asymmetry leads to janus-like nanoparticle membranes", *Nature Materials* 14 (2015) 912 – 917, DOI: [10.1038/nmat4321](https://doi.org/10.1038/nmat4321)
2. S. A. Deshmukh, L. A. Solomon, G. Kamath, H. C. Fry, S.K.R.S. Sankaranarayanan, "Water ordering controls the dynamic equilibrium of micelle–fibre formation in self-assembly of peptide amphiphiles", *Nature Communications* 7 (2016), 12367, DOI: [10.1038/ncomms12367](https://doi.org/10.1038/ncomms12367)
3. D. Berman[#], S. A. Deshmukh[#], S. K.R.S. Sankaranarayanan, A. Erdemir, and A. Sumant, "Macroscale superlubricity enabled by graphene nanoscroll formation", *Science* 348 (2015) 1118 – 1122, DOI: [10.1126/science.1262024](https://doi.org/10.1126/science.1262024) (# Shared first author)
4. D. Berman, S. A. Deshmukh, S. K.R.S. Sankaranarayanan, A. Erdemir, and A. Sumant, "Extraordinary macroscale wear resistance of one atom thick graphene layer", *Advanced Functional Materials*, 24 (2014) 6640 – 6646, DOI: [10.1002/adfm.201401755](https://doi.org/10.1002/adfm.201401755)
5. S. A. Deshmukh, S. K.R.S. Sankaranarayanan, K. J. Suthar, and D. C. Mancini, "Role of Solvation Dynamics and Local Ordering of Water in Inducing Conformational Transitions in Poly(N-isopropylacrylamide) Oligomers Through the LCST", *Journal of Physical Chemistry B* 116 (2012) 2651 - 2663, DOI: [10.1021/jp210788u](https://doi.org/10.1021/jp210788u)

Other Significant Publications

1. D Berman, SA Deshmukh, B Narayanan, SKRS Sankaranarayanan, Z. Yan, A. A. Balandin, A. Zinovev, D. Rosenmann, A. V. Sumant, "Metal-induced rapid transformation of diamond into single and multilayer graphene on wafer scale" *Nature communications*, 7 (2016), 12099, DOI: [10.1038/ncomms12099](https://doi.org/10.1038/ncomms12099)
2. S. A. Deshmukh, G. Kamath, B. Narayanan, V. G. Pol, J. Wen, D. J. Miller, and S. K.R.S. Sankaranarayanan, "Nanoscale origin and evolution of kinetically induced defects in carbon spheres", *Carbon*, 96 (2016), 647 – 660, DOI: [10.1016/j.carbon.2015.09.109](https://doi.org/10.1016/j.carbon.2015.09.109)
3. S. A. Deshmukh, S. K.R.S. Sankaranarayanan and D. C. Mancini, "Non-equilibrium effects Evidenced by vibrational spectra during coil-to-globule transition in Poly(N-isopropylacrylamide) subjected to ultrafast heating-cooling cycle", *Soft Matter* 10 (2014) 1462-1480, DOI: [10.1039/c3sm51750k](https://doi.org/10.1039/c3sm51750k)

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4. S. A. Deshmukh, Z. Li, K. J. Suthar, S. K.R.S. Sankaranarayanan and D. C. Mancini, "Atomistic Insights into Solvation Dynamics and Conformational Transformation in Thermo-Sensitive and Non-Thermo-Sensitive Oligomers", *Polymer* 54 (2013) 210 – 222, [DOI: 10.1016/j.polymer.2012.11.009](https://doi.org/10.1016/j.polymer.2012.11.009)
5. S. A. Deshmukh, S. K.R.S. Sankaranarayanan, and D. C. Mancini, "Vibrational Spectra of Proximal Water in a Thermo-Sensitive Polymer Undergoing Conformational Transition Across Lower Critical Solution Temperature", *Journal of Physical Chemistry B* 116 (2012) 5501 - 5515, [DOI: 10.1021/jp211831x](https://doi.org/10.1021/jp211831x)

Synergistic Activities

1. Organizer of workshops for users of computing facilities at the Argonne National Laboratory,
2. Reviewer of funding agencies: ACS Petroleum Research Funds
3. Panelist at various review meeting organized by DOE's Office of Basic Energy Science.
4. Reviewer of Journals: Industrial & Engineering Chemistry Research, Nano, Proceedings of the 2011 MRS Fall Meeting, Journal of Physical Chemistry B, Nature Communications, Nanoscale, and Macromolecules

Collaborators and Co-editors

Katsuiko Ariga (NIMS); Gary Baker (University of Missouri–Columbia); Alexander Balandin (UC-Riverside); Ganesh Balasubramanian (Iowa State University); Diana Berman (University of North Texas); Daniel Bowron (Rutherford Appleton Laboratory); Darryl Butt (Boise State University); Samantha Callear (Rutherford Appleton Laboratory); Jesse Clark (SLAC National Accelerator Laboratory); Larry Curtiss (Argonne National Laboratory); Richard Cutler (Boise State University); William David (Rutherford Appleton Laboratory); Ari Erdemir (Argonne National Laboratory); Nicola Ferrier (Argonne National Laboratory); H. Christopher Fry (Argonne National Laboratory); Stephen Gray (Argonne National Laboratory); Benjamin Hanson (North Carolina State University); Ross Harder (Argonne National Laboratory); Jinbo He (University of Chicago); Phay Ho (Argonne National Laboratory); Joshua Huefner (Boise State University); Heinrich Jaeger (University of Chicago); Qian Jiang (Tianjin Polytechnic University); Zhang Jiang (Argonne National Laboratory); Ganesh Kamath (InterX Inc.); Pongsakorn Kanjanaboos (University of Chicago); Jong Woo Kim (UC-San Diego); Kah Chun Lau (Argonne National Laboratory); Yuelin Li (Argonne National Laboratory); Zheng Li (Argonne National Laboratory); Chi-Kai Lin (Argonne National Laboratory); Xiao-Min Lin (Argonne National Laboratory); Derrick Mancini (Illinois Institute of Technology); Stephen Martin (Virginia Tech); Evan Maxey (Argonne National Laboratory); Dean Miller (Argonne National Laboratory); Amanda Morris (Virginia Tech); Paul Mulvaney (University of Melbourne); Badri Narayanan (Argonne National Laboratory); Riley Parrish (Boise State University); Melissa A Pasquinelli (North Carolina State University); Vilas Pol (Purdue University); Shriram Ramanathan (Harvard University); Daniel Rosenmann (Argonne National Laboratory); Subramanian Sankaranarayanan (Argonne National Laboratory); Kiran Sasikumar (Argonne National Laboratory); Mehdi Shakourian-Fard (University of Missouri–Columbia); Oleg Shpyrko (UC-San Diego);

Graduate Advisor and Post-doctoral Sponsor

Doctoral: Prof. Damian A. Mooney, Chemical and Bioprocess Engineering, University College Dublin, Ireland;

Postdoctoral: 1. Prof. Yaroslava Yingling, Materials Science and Engineering Department, North Carolina State University, Raleigh, NC

2. Dr. Subramanian Sankaranarayanan, Center for Nanoscale Materials, Argonne National Laboratory

Current Funding

1. Virginia Tech Start-up Funds
2. ICTAS Diversity and Inclusion Seed Grant (\$ 10,000).

Appendix I: Biosketches

ANDREA M. DIETRICH

Professor, Civil and Environmental Engineering
Adjunct Professor, Food Science and Technology
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413 Durham Hall
Virginia Tech
Blacksburg, VA 24061; andread@vt.edu

PROFESSIONAL PREPARATION

Boston College	Chemistry and Biology (dual major)	B.S. 1977
Drexel University	Environmental Sciences and Engineering	M.S. 1981
Univ. of North Carolina at Chapel Hill	Environmental Sciences and Engineering	Ph.D. 1987

APPOINTMENTS

- Professor, Department of Civil and Environmental Engineering, Virginia Tech, 2005-present
- Adjunct Professor, Food, Science, and Technology, Virginia Tech, 2012-present
- Associate Professor, Department of Civil Engineering, Virginia Tech, 1995-2005
- Assistant Professor, Department of Civil Engineering, Virginia Tech, 1988-1994

PRODUCTS: Dr. Dietrich has published 136 products in the peer-reviewed literature.

FIVE MOST CLOSELY RELATED *= student researcher

1. Ahart, M.*, Gallagher, D.L., Scardina, P., Dietrich A.M. Industrial spills and water distribution: MCHM sorption and desorption in polymer pipes and linings. *J. Environmental Engineering*; 10.1061/(ASCE)EE.1943-7870.0001116, 142(1), 04016045.1-9., 2016.
2. Ma, X.*, Deng, J., Feng, J., Shanaiah, N., Smiley, E., Dietrich, A.M. Identification and characterization of phenylacetonitrile as a nitrogenous disinfection byproduct derived from chlorination of phenylalanine in drinking water. *Water Research*. doi:10.1016/j.watres.2016.06.029, 102, 202-210, 2016.
3. Dietrich, A.M., Whelton, A.J., Gallagher, D.L. *Chemical Permeation/Desorption in New and Chlorine Aged Polyethylene Pipes*, Project 4138, Water Research Foundation, Denver, CO; 131p, 2010.
4. Mitroka, S., Smiley, T.D.*, Tanko, J.M., Dietrich, A.M. Reaction mechanism for the oxidation and degradation of high density polyethylene in chlorinated water. *Polymer Degradation and Stability*. doi:10.1016/j.polymdegradstab.2013.03.020, 98:1369-1377; 2013.
5. Tang, J.* D.L. Gallagher, A.M. Dietrich. Predicting permeation of organic contaminants into polyethylenes. *ASCE Journal of Environmental Engineering*. 10.1061/(ASCE)EE.1943-7870.0000644, 139(2):205-212; 2013.

5 OTHER SIGNIFICANT RELEVANT PRODUCTS

1. Weidhaas, J.; Dietrich, A.M.; DeYonker, N.; Dupont, R. R.; Foreman, W.; Gallagher, D.; Gallagher, J.; Whelton, A.; Alexander, W. Enabling science support during incident response for better decision making. *Journal of Environmental Quality*; 45(5):1490-1500, 2016.
2. Dietrich, A.M., Thomas, A.*, Zhao, Y.*, Smiley, E., Shanaiah, N., Ahart, M., Charbonnet, K.A., DeYonker, N.J., Alexander, W.A., Gallagher, D.L. Partitioning, aqueous solubility, and dipole moment data for cis- and trans-(4-methylcyclohexyl)methanol, principal contaminants of the West Virginia chemical spill. *Environmental Science and Technology Letters*. DOI: 10.1021/acs.estlett.5b00061, 2: 123-127 2015.

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3. Dietrich A.M., Burlingame, G.A. Critical review and rethinking of USEPA secondary standards for maintaining consumer acceptability of organoleptic quality of drinking water. *Environmental Sciences and Technology*. DOI: 10.1021/es504403t, 49(2):708-720, 2015.
4. Sain, A.E.*, Dietrich A.M., Smiley, E., Gallagher, D.L. Assessing human exposure and odor detection during showering with crude 4-(methylcyclohexyl)methanol (MCHM) contaminated drinking water. *Science of the Total Environment*. doi:10.1016/j.scitotenv.2015.08.050, 538, 298-305; 2015.
5. Mirlohi, S.*, A.M. Dietrich, S.E. Duncan. Age-associated variation in sensory perception of iron in drinking water and the potential for overexposure in the human population. *Environmental Science and Technology*, 45(15):6575-83, 2011.

SYNERGISTIC ACTIVITIES:

1. Education: Teaching Excellence Award, from Civil and Environmental Engineering Alumni Association. Co-Director of Virginia Tech's Water INTERface, an Interdisciplinary Graduate Education Program that integrates students and faculty in the departments of Civil and Environmental Engineering, Food Science and Technology, Human Nutrition, Food, and Exercise.
2. Outreach: *Public Schools*: Visit public school children to talk about various topics in science and engineering. Regular volunteer for Virginia Tech summer camp and recruitment events for 6-12 students. *Professional Outreach*: American Water Works Association: Member since 1979 and Chair of Taste and Odor Committee 2005-2008. Chair of International Water Association's Specialty Group for Tastes, Odours, and Algal Toxins in Drinking Water Sources and Aquaculture, 2012-present.
3. International Activities: Co-Organizer or program Committee member of International Water Association's Specialty Group for Tastes, Odours, and Algal Toxins in Drinking Water Resources and Aquaculture. Paris, France, 1998; Barcelona, Spain, 2002; Cornwall, Ontario, 2005; Korea, 2008; Scotland, 2011; Taiwan 2013; Sydney, Australia 2017.
4. Professional Development: Selected to receive Fellowships: 1) American Association for the Advancement of Science: Environmental Science & Engineering Fellow; 2) NASA Visiting Scientist Fellow; 3) AAAS Science, Technology and Policy Fellow.
5. Invited presentations and keynote addresses:
 - Dietrich, A.M. Occurrence and detection of taste and odour compounds and algal toxins; 11th International Water Association Symposium on Tastes, Odours and Algal Toxins in Water: Occurrence and Control; 14th - 16th February 2017, Sydney, Australia. (Themed Speaker).
 - Dietrich, A.M. Unthinkable and Undrinkable: Chemical Spills in Water. The 11th IWA-TOAT Workshop – Causes and Occurrences of Tastes, Odours, Algal Toxins in Water. October 29-November 01, 2015, Xiamen, China. Plenary Presentation.
 - Dietrich, A.M. Chemistry and qualities of good tasting drinking water. The 10th IWA Symposium on Off-Flavours in the Aquatic Environment, October 27-November 01, 2013, National Cheng Kung University, Tainan, Taiwan. Keynote.
 - Dietrich, A.M. Invited Speaker: Improving Water Quality and Consumer Satisfaction using Guidance from the SMCLs. National webinar for Water Research Foundation, Denver, CO., 2014.
 - Dietrich, A.M. Water Sources and Chemical Quality Considerations for Animal Production and Food Processing, 2014 American Dairy Science Association (ADSA-ASAS-CSAS Joint Annual Meeting), July 20-24, 2014, Kansas City, KS. Invited Multidisciplinary and International Leadership Keynote (MILK) Symposium Speaker.

Kevin J. Edgar

Department of Sustainable Biomaterials, Virginia Tech, Blacksburg, VA 24061

Phone 540.231.0674; e-mail kjedgar@vt.edu

A. Professional Preparation

Bucknell University	Chemistry	B.S.	1975
Duke University	Organic Chemistry	Ph.D.	1979

B. Appointments

2007-present	Professor of Biomaterials, Virginia Tech
2008-present	Adjunct Professor of Chemistry, Virginia Tech
1979-2007	Positions including Technology Fellow; Technology Director - Eastman Drug Delivery Systems; Lab Head, Cellulose Esters Research Lab; R&D Scientist, Eastman Chemical Company

C. Publications

(i) Five publications most relevant to the proposed project

1. Liu, S.; Liu, J.; Esker, A.R.; Edgar, K.J. "An Efficient, Regioselective Pathway to Cationic and Zwitterionic N-Heterocyclic Cellulose Ionomers" *Biomacromolecules* **2016**, *17*, 503-513.
2. Liu, S.; Edgar, K.J. Water-soluble co-polyelectrolytes by selective modification of cellulose esters *Carbohydr. Polym.*, **2017**, *162*, 1-9.
3. Meng, X.; Choudhury, S.R.; Edgar, K.J. "Multifunctional cellulose esters by olefin cross-metathesis and thiol-Michael addition", *Polym. Chem.* **2016**, *7*, 3848-3856.
4. Meng, X.; Matson, J.B.; Edgar, K.J. "Olefin cross-metathesis, a mild, modular approach to functionalized cellulose esters", *Polym. Chem.*, **2014**, *5*, 7021-7033.
5. Mosquera-Giraldo, L.I.; Borca, C.; Meng, X.; Edgar, K.J.; Slipchenko, L.; Taylor, L.S. "Mechanistic Design of Chemically Diverse Polymers with Applications in Oral Drug Delivery" *Biomacromolecules* **2016**, *17*, 3659-3671.

(ii) Five other significant publications

1. Dong, Y., Mosquera-Giraldo, L.I.; Taylor, L.S.; Edgar, K.J. "Amphiphilic Cellulose Ethers Designed for Amorphous Solid Dispersion via Olefin Cross-Metathesis" *Biomacromolecules* **2016**, *17*, 454-465.
2. Liu, H.; Ilevbare, G.; Cherniawski, B.P.; Ritchie, E.T.; Taylor, L.S.; Edgar, K.J. Synthesis and structure-property evaluation of cellulose ω -carboxyesters for amorphous solid dispersions" *Carbohydr. Polym.*, **2014**, *100*, 116-125.
3. Zhang, R.; Liu, S.; Edgar, K.J. Regioselective synthesis of cationic 6-deoxy-6-(*N,N,N*-trialkylammonio)curdlan derivatives *Carbohydr. Polym.* **2016**, *136*, 474-484.
4. Dong, Y.; Mosquera-Giraldo, L.I.; Troutman, J.; Skogstad, B.; Taylor, L.S.; Edgar, K.J. "Amphiphilic hydroxyalkyl cellulose derivatives for amorphous solid dispersion prepared by olefin cross-metathesis", *Polym. Chem.* **2016**, *7*, 4953-4963.
5. Codera, V.; Edgar, K.J.; Faijes, M.; Planas, A. "Functionalized Celluloses with Regular Substitution Pattern by Glycosynthase-Catalyzed Polymerization" *Biomacromolecules* **2016**, *17*, 1272-1279.

D. Synergistic activities

1. *Associate Editor* of journals *Cellulose* (2009-present) and *Carbohydrate Polymers* (2012-present).

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2. **Editor** of two American Chemical Society (ACS) Symposium Series books (*Cellulose Solvents*, **2010**, No. 1033; *Polysaccharide Materials: Performance by Design*, **2009**, No. 1017).
3. **Recent Awards: 2016 Anselme Payen award** from ACS Cellulose & Renewable Materials Div. (CELL); Fellow of ACS (inaugural class) 2009; Fellow of ACS CELL 2010.
4. **Contributions to Professional Societies, ACS: CELL:** Councilor 2008-present (overall have been ACS Councilor for 20 years); Program Chair, 2000-2002; Chair 2003-2004, Immediate Past Chair 2005-2006. **ACS National Governance:** Elected member, Nominations & Elections Committee, 2010-2012; Chair, National ACS Divisional Activities Committee (DAC), 2007-2009; Member, Board Committee on Planning, 2007-2009.
5. **Gordon Conference on Chemistry of Polysaccharides:** Conceived, wrote proposal which was approved by the Gordon Conferences. First conference was at Mt. Holyoke College, Massachusetts, July, 2001. This Gordon Conference was a unique concept where the meeting (every 2 years) rotated between sites in North America, Europe, and Asia, to serve the geographically diverse Polysaccharide Chemistry community.

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John J. Jack Lesko

Associate Dean for Research & Graduate Studies, College of Engineering
Professor, Biomedical Engineering and Mechanics (formerly Engineering Science and Mechanics)
Virginia Polytechnic Institute and State University
Blacksburg, VA, 24061, jlesko@vt.edu

Professional Preparation

University of Maryland	College Park, Maryland	Mechanical Engineering	B.S., 1987
Virginia Polytechnic Institute and State University	Blacksburg, Virginia	Engineering Mechanics	M.S., 1991
Virginia Polytechnic Institute Mechanics and State University	Blacksburg, Virginia	Engineering	Ph.D., 1994

APPOINTMENTS

Virginia Tech, Blacksburg, Virginia

Associate Dean for Research & Graduate Studies, College of Engineering, 2011 - Present
Professor, 2006 – Present,
Associate Professor, August 2000 - 2006
Assistant Professor, Engineering Science & Mechanics Department, August 1995 - 2000
Research Associate/Visiting Assistant Professor, Engineering Science & Mechanics Department, August 1994 – August 1995
Senior Graduate & Graduate Research Assistant, Engineering Science & Mechanics Department, January 1989 - August 1994

David Taylor Research Center, Carderock, Maryland

Structural Test Engineer, GS 11.2, June 1987 to August 1989

Publications

Five Publications Most Closely Related to Proposed Project:

1. H. Oyama, J.J. Lesko, & J.P. Wightman, "Inter-diffusion at the Interface Between Poly(vinylpyrrolidone) and Epoxy," *Journal of Polymer Science*, Vol. 35, 1997, pp. 331-346.
2. K. N. E. Verghese, R. E. Jensen, J. J. Lesko, & T. C. Ward, "Effects of Molecular Relaxation Behavior on Sized Carbon Fiber/Vinyl Ester Matrix Composite Properties," *Polymer*, Vol. 42, No. 4, 2000, pp. 1633-1645.
3. D. Liu, M. A. Hickner, S. W. Case, and J. J. Lesko, "Relaxation of proton conductivity and stress in proton exchange membranes under strain," *Journal of Engineering Materials and Technology, Transactions of the ASME*, Vol. 128, No. 4, October, 2006, pp. 503-508.
4. S. E. Boyd, J. V. Bausano, S. W. Case, and J. J. Lesko, "Compression creep rupture behavior of a glass/vinyl ester composite subject to isothermal and one-sided heat flux conditions," *Composites Part A: Applied Science and Manufacturing*, Vol. 38, Issue 6, June 2007, pp. 1462-1472.
5. A. Shaver, J. D. Moon, D. Savacool, W. Zhang, G. Narang, G. Miller, B. Vondrasek, J.J. Lesko, B. D. Freeman, J.S. Riffle, J. E. McGrath, "Poly(2,6-dimethyl-1,4-phenylene oxide) blends with a Poly(arylene ether ketone) for gas separation membranes," *Polymer*, Available online 17 February 2017,

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FIVE OTHER SIGNIFICANT PUBLICATIONS:

1. V. S. Sokolinsky, H. F. von Bremen, J. J. Lesko, and S. R. Nutt, "Higher-order Free Vibrations of Sandwich Beams with a Locally Damaged Core," *International Journal of Solids and Structures*, 41, July 2004, pp. 6529-6547.
2. M. D. Hayes and J. J. Lesko, "Failure Analysis of a Hybrid Composite Structural Beam," *Composites Part A: Applied Science and Manufacturing*, v 38, n 3, March, 2007, pp. 691-698.
3. N. L. Post, S. W. Case, J. J. Lesko, "Modeling the variable amplitude fatigue of composite materials: A review and evaluation of the state of the art for spectrum loading," *International Journal of Fatigue*, Volume 30, Issue 12, December 2008.
4. S. W. Boyd, J. V. Bausano, S. W. Case, J. J. Lesko, "Mechanistic Approach to Structural Fire Modeling of Composites," *Fire Technology*, 47(4), 941-983, 2011.
5. B. Lutz, C. Hixson, M. Paretti, A. Epstein, and J. Lesko, "Mentoring and Facilitation in Entrepreneurship Education: Beliefs and Practices," *Journal of Engineering Entrepreneurship*, Vol. 6, Issue 1, 2015.

Synergistic Activities

- **Board Seats: GEM National Consortium** - Executive Committee, VP for University Strategy, August 2013 – Present. & the **Commonwealth Center for Advanced Manufacturing** – Board of Directors, August 2013 - Present, Appointed by Virginia Tech's President's Office.
- Collaborative development, installation and repair with FRP girders of the 40-foot-span **Dickey Creek Bridge** in Sugargrove, Virginia, September 2001 and rehabilitation utilizing an FRP bridge deck system **Hawthorne Street Bridge**, Covington, Virginia, November 2007.
- **WEPAN Webinar on Self-Efficacy**, Co-developed with Drs. Amelink & Beier (Rice University) and delivered by Women in Engineering ProActive Networks.
- **NSF I-Corps Mid-Atlantic Regional Node**, Served as Co-PI and trained national instructor for the National training program for NSF I-Corps Teams, operated in coordination with the University of Maryland, George Washington University, and Johns Hopkins University.
- **Co-Founder and Principal of PowerHub Systems**, PowerHub (formerly VPT Energy Systems) designs and manufactures distributed battery energy storage and power processing hardware for smart grid applications. PowerHub Systems was recently (February 2016) sold to an undisclosed utility facing company.

Appendix II: Tables and Figures

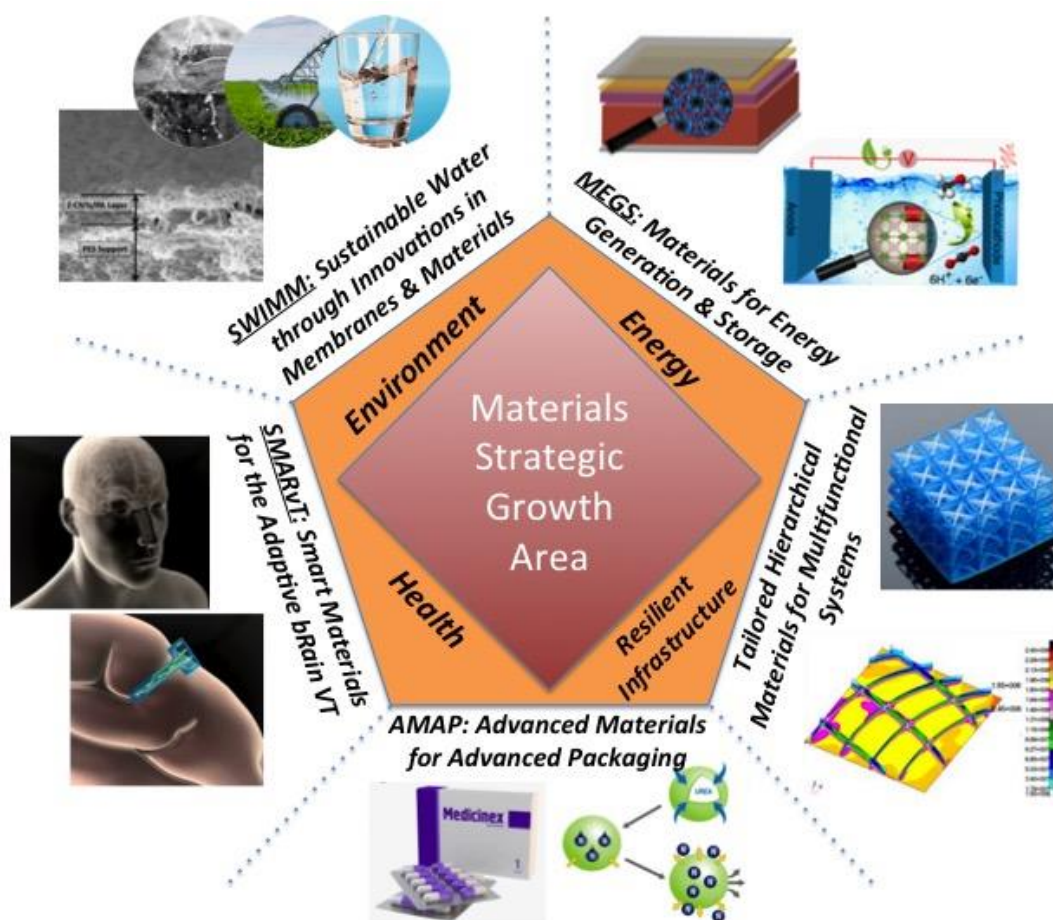


Figure 1: Materials SGA Overview

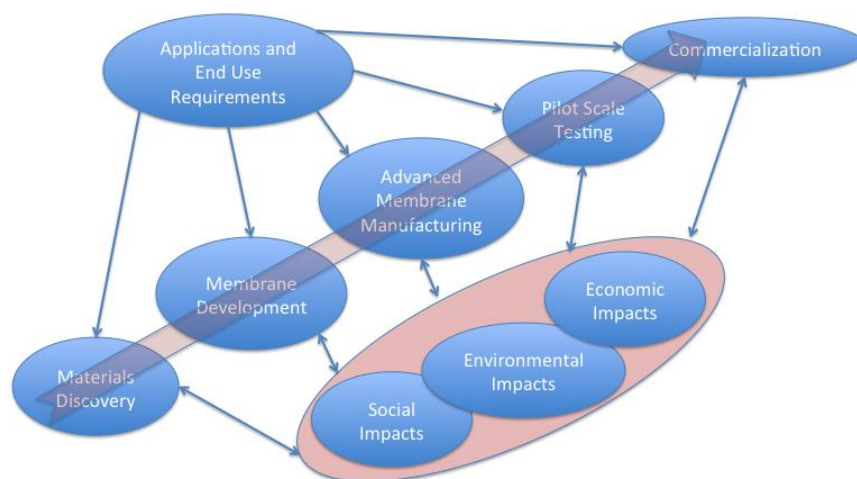


Figure 2: Sustainable Water through Innovations in Membranes & Materials - SWIMM



Figure 3: Research Team Contributions

Table 1: Milestones and Deliverables

Milestone	Deliverable	Timeline
SWIMM Workshop	Detailed report on current VT efforts and plans to interact with destination areas and other Materials SGA research pillars.	Summer 2017
New Faculty Hire	Faculty Search in the area of Advanced Manufacturing of Membranes resulting in a new faculty hire	Spring 2018
Pilot-Scale Facility	Planning and design for a combined membrane manufacturing and pilot-scale testing facility in collaboration with the new faculty hire.	Spring 2019
Center Proposal	Preparation and submission of a Center-level interdisciplinary proposal in Water Purification Membrane Materials	Fall 2020

Table 2: Team and Current Collaborations

Faculty	Department	College	Collaborations
Klaus Moeltner	Agricultural & Applied Economics	CALS	He
Brian Badgley	Crop & Soil Environmental Sciences	CALS	Dietrich, He, Stewart, Xia
Kang Xia	Crop & Soil Environmental Sciences	CALS	Stewart, Badgley, Vikesland
Ryan Stewart	Crop & Soil Environmental Sciences	CALS	Long, Morris, Dietrich, Badgley, Xia
Susan Duncan	Food Science and Technology	CALS	Dietrich, Long, Hedrick, He, Edwards, Riffle
Valisa Hedrick	Human Nutrition, Foods, and Exercise	CALS	Dietrich, He
Kevin Edgar	Sustainable Biomaterials	CNRE	Martin, Moore, Long, Riffle, Baird, Foster, Cheng
David Dillard	Biomedical Engineering & Mechanics	COE	Baird, Long
Jack Lesko	Biomedical Engineering & Mechanics	COE	Riffle, Long
Donald Baird	Chemical Engineering	COE	Long, Moore, Riffle (Chemistry); Foster (MSE); Edgar (SusBio); Dillard (BEAM); Martin (CHE) - MII
Luke Achenie	Chemical Engineering	COE	Deshmukh
Sanket Deshmukh	Chemical Engineering	COE	Martin, Morris
Stephen Martin	Chemical Engineering	COE	Baird, Deshmukh, (CHE); Moore (Chemistry); Foster (MSE); Edgar (SusBio) - MII
Andrea Dietrich	Civil & Environmental Engineering	COE	Badgley, Duncan, Gohlke, He, Hedrick, Lesko, Martin, Morris, Stewart
Jason He	Civil & Environmental Engineering	COE	Morris, Badgley, Long, Dietrich, Moeltner
Marc Edwards	Civil & Environmental Engineering	COE	Vikesland, Duncan
Peter Vikesland	Civil & Environmental Engineering	COE	Edwards, Xia, He
Johan Foster	Materials Science & Engineering	COE	Martin, Baird - MII
Amanda Morris	Chemistry	COS	He, Martin
Judy Riffle	Chemistry	COS	Baird, Long, Moore, Lesko
Robert Moore	Chemistry	COS	Martin, Long, Baird, Riffle
Tim Long	Chemistry	COS	Moore (Chemistry)- MII
Shengfeng Cheng	Physics	COS	MI
Julia M. Gohlke	Population Health Sciences	Vet Med	Dietrich

Appendix III: Provisional Job Ad

Tenure Track Faculty Position
Global Systems Science Destination Area
Virginia Tech

The Global Systems Science (GSS) Destination Area at Virginia Tech seeks outstanding candidates for a tenure-track faculty opening at the rank of Associate or Full Professor. The Sustainable Water through Innovation in Membranes & Materials program (SWIMM) is an interdisciplinary research effort aimed at improving access to clean water through the development of novel materials and devices for water treatment and purification. The successful candidate should have significant experience and national recognition in the areas of advanced manufacturing and fabrication of membranes, as well as the scale-up of membrane devices and systems. The candidate is expected to take a lead role in the creation of a new membrane processing and scale-up facility on campus, and will serve as a key point of contact between other SWIMM and GSS faculty, industrial partners, and government sponsors. Applicants should have a Ph.D. in Chemical Engineering, Materials Science, or a related field, a record of excellence in research, and a commitment to teaching and working with a diverse population of undergraduate and graduate students.