

SUSAN FULLERTON

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EDUCATION

The Pennsylvania State University, University Park, PA USA

Ph.D., Chemical Engineering, August 2009

Dissertation Topic: *Nanoparticle-filled solid polymer electrolytes for rechargeable lithium-ion batteries*

B.S., Chemical Engineering, December 2002 (with distinction)

PROFESSIONAL APPOINTMENTS

University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Assistant Professor

Department of Chemical and Petroleum Engineering

Fall 2015 - present

Department of Electrical and Computer Engineering (by courtesy)

Spring 2017 - present

University of Notre Dame, Notre Dame, Indiana, USA

Research Assistant Professor

Department of Electrical Engineering

Fall 2009 - Fall 2015

Notre Dame Center for Nano Science and Technology (ND*nano*)

PEER-REVIEWED JOURNAL PUBLICATIONS

**Directing author*; †*Undergraduate*

University of Pittsburgh

22. Xu, K.; Lu, H.; Kinder, E.; Seabaugh, A.; **Fullerton-Shirey, S.K.*** “Monolayer Solid State Electrolyte for Electric Double Layer Gating of Graphene Field-Effect Transistor *ACS Nano*, accepted, Impact factor 12 **Contribution:** Directed research and guided manuscript preparation.

21. Crouch, G.; Han, D.; **Fullerton-Shirey, S.K.**; Go, D.*; Bohn, P.* “Addressable Direct-Write Nanoscale Filament Formation and Dissolution by Nanoparticle-Mediated Bipolar Electrochemistry *ACS Nano*, accepted DOI: 10.1021/acsnano.7b01657 Impact factor 12 **Contribution:** Co-developed experimental approach and directed polymer electrolyte effort; manuscript preparation.

20. Park, J.H.; Ravavar, L.; Kwak, I.; **Fullerton-Shirey, S.K.**; Choudhury, P.; Kummel, A.C.* “Growth Mode Transition from Monolayer by Monolayer to Bilayer by Bilayer in Molecularly Flat Titanyl Phthalocyanine Film **2017** *J. Phys. Chem. C* 121, 6721. Impact factor 4.8 **Contribution:** Contributed to TiOPc as seed layer; manuscript preparation.

19. Kahn, A.A.; Vigil, G.D.; Zhang, Y.; **Fullerton-Shirey, S.K.**; Howard, S.S.* “Silica-coated ruthenium-complex nanoprobe for two-photon oxygen microscopy in biological media *Optical Materials Express* **2017** 7, 3. Impact factor 2.6 **Contribution:** Co-developed nanoprobe; manuscript preparation.

18. Wang, W.-H.; Gong, C.; Wang, W.; Kong, F.; Kim, H.; **Fullerton-Shirey, S.K.**; Seabaugh, A.;

Cho, K.* “Energetics of metal ion adsorption on and diffusion through crown ethers: first principles study on two-dimensional electrolyte” *Solid State Ionics* **2017** 301, 176-181. Impact factor 2.1 **Contribution:** Co-contributed original idea for 2D electrolyte; manuscript preparation.

17. Fathipour, S.; Pandey, P.; **Fullerton-Shirey, S.**; Seabaugh, A.* “Electric-double-layer doping of WSe₂ field-effect transistors using polyethylene-oxide cesium perchlorate” *J. Appl. Phys.*, **2016** 120, 234902. Impact factor: 2.2 **Contribution:** Guided polymer electrolyte work and data analysis; manuscript preparation.

16. Lin, Z.; McCreary, A.; Briggs, N.; Subramanian, S.; Zhang, K.; Sun, Y.; Li, X.; Borys, N.; Yuan, H.; **Fullerton-Shirey, S.**; Chernikov, A.; Zhao, H.; McDonnell, S.; Lindenberg, A.; Xiao, K.; LeRoy, B.; Drndic, M.; Hwang, J.; Park, J.; Chhowalla, M.; Schaak, R.; Javey, A.; Hersam, M.; Robinson, J.; Terrones, M. “2D Materials Advances: From Large Scale Synthesis and Controlled Heterostructures to Improved Characterization Techniques, Defects and Applications” *2D Materials*, **2016** 3, 042001. Impact factor: 9.6 **Contribution:** Electrolyte doping of 2D materials (invited review).

15. Park, J.H.; Fathipour, S.; Kwak, I.; Sardashti, K.; Ahles, C.F. Wolf, S.F.; Edmonds, M.; Vishwanath, S.; Xing, H.G.; **Fullerton-Shirey, S.K.**; Seabaugh, A.; Kummel, A.C.* “Atomic Layer Deposition of Al₂O₃ on WSe₂ Functionalized by Titanyl Phthalocyanine” *ACS Nano*, **2016** 10, 6888-6896. Impact factor: 12

Contribution: Contributed to the development of TiOPc as seed layer; manuscript preparation.

14. Park, J.H.; Vishwanath, S.; Liu, X.; Zhou, H.; Eichfeld, S.M.; Fullerton-Shirey, S.K. Robinson, J.A.; Feenstra, R.M.; Furdyna, J.; Jena, D.; Xing, H.G.*; Kummel, A.C.* “Scanning Tunneling Microscopy and Spectroscopy of Air Exposure Effects on Molecular Beam Epitaxy Grown WSe₂ Monolayers and Bilayers” *ACS Nano*, **2016** 10, 4258-4267. Impact factor: 12

Contribution: Chemical models of air oxidation; manuscript preparation.

University of Notre Dame

13. Park, J.H.; Movva, C.P.M.; Chagarov, E.; Sardashti, K.; Chou, H.; Kwak, I.; Hu, K.-T.; **Fullerton-Shirey, S.K.**, Choudhury, P.; Banerjee, S.K.; Kummel, A.C.* “In-Situ Observation of Initial Stage in Dielectric Growth, and Deposition of Ultrahigh Nucleation Density Dielectric on Two-Dimensional Surfaces” *Nano Lett.*, **2015**, 15, 6626-6633. Impact factor: 13.6

Contribution: Solution-casting of monolayers; contributed to manuscript preparation.

12. Lu, H.; Kwak, I.; Park, J.H.; O’Neill, K.; Furuyama, T.; Kobayashi, N.; Seabaugh, A.; Kummel, A.; **Fullerton-Shirey, S.K.*** “Solution-Cast Monolayers of Cobalt Crown Ether Phthalocyanine on Highly Ordered Pyrolytic Graphite” *J. Physical Chemistry C*, **2015**, 119, 21992-22000. Impact factor: 4.8 **Contribution:** Directed research and guided manuscript preparation.

11. Wang, W.-H.; Gong, C.; Wang, W.; **Fullerton-Shirey, S.K.**; Seabaugh, A.; Cho, K*. “First-Principles Study of Crown Ether and Crown Ether-Li Complex Interactions with Graphene” *J. Physical Chemistry C*, **2015**, 119, 20016-20022. Impact factor: 4.8

Contribution: Motivated study by proposing crown ether as potential candidate for ion memory; discussed results and directions; contributed to manuscript preparation.

10. Xu, H.; Kinder, E. W.; Fathipour, S.; Seabaugh, A. C.; **Fullerton-Shirey, S.K.*** “Reconfigurable ion gating of 2H-MoTe₂ field-effect transistors using poly(ethylene oxide)-CsClO₄ solid polymer electrolyte *ACS Nano*, **2015**, 9, 4900-4910. Impact factor: 12

Contribution: Directed research and guided manuscript preparation.

9. Khan, A.A.; **Fullerton-Shirey, S.K.**; Howard, S.S.* “Easily prepared ruthenium-complex nanomille probes for two-photon quantitative imaging of oxygen in aqueous media” *RSC Advances*, **2015**, 5, 291-300. Impact factor: 3.7

Contribution: Developed experimental procedure for probe encapsulation, provided input on data analysis, contributed to manuscript preparation.

8. Schaetzel, D.M.[†]; Li, P.; Chaudhari, N.; Bernstein, G.H.; **Fullerton-Shirey, S.K.*** “Magnetic alignment of gamma (core) - alpha (shell) Fe₂O₃ nanorods in a solid polymer electrolyte for Li-ion batteries” *J. Physical Chemistry C*, **2014**, 118, 18836-18845. 2012 Impact factor: 4.8

Contribution: Conceived of and directed project, designed experiments, aided first author (undergraduate student) with data analysis and manuscript preparation.

7. Elliott, L.C.C.; Jing, B.; Akgun, B.; Zhu, Y.; Bohn, P.W.; **Fullerton-Shirey, S.K.*** “Loading and distribution of a model small molecule drug in poly(N-isopropyl-acrylamide) brushes a neutron reflectometry and AFM study” *Langmuir* **2013**, 29, 3259-3268. 2012 Impact Factor: 4.19

Contribution: Conceived of and directed project, designed experiments, collected and analyzed neutron scattering data, co-wrote manuscript with Elliott.

6. Do, N.S.[†]; Schaetzel, D.M.[†]; Dey, B.; Seabaugh, A.C.; **Fullerton-Shirey, S.K.*** “Influence of Fe₂O₃ nanofiller shape on the conductivity and thermal properties of solid polymer electrolytes: nanorods versus nanospheres” *Journal of Physical Chemistry C* **2012**, 116, 21216-21223.

2012 Impact factor: 4.8

Contribution: Conceived of and directed project, designed experiments, aided first author (Notre Dame undergraduate) with data analysis and manuscript preparation.

Penn State

5. **Fullerton-Shirey, S.K.***; Ganapatibhotla, V.N.R.; Shi, W.; Maranas, J.K. “Influence of humidity and crystallization time on the ionic conductivity of nanoparticle-filled solid polymer electrolytes” *Journal of Polymer Science, Part B: Polymer Physics* **2011**, 49, 1496-1505. 2012 Impact factor: 2.21

4. **Fullerton-Shirey, S.K.**; Maranas, J.K.* “Structure and mobility of PEO/LiClO₄ solid polymer electrolytes filled with Al₂O₃ nanoparticles” *Journal of Physical Chemistry C* **2010**, 114, 9196-9206. 2012 Impact factor: 4.8

3. **Fullerton-Shirey, S.K.**; Maranas, J.K.* “Effect of LiClO₄ on the structure and mobility of PEO-based solid polymer electrolytes” *Macromolecules* **2009**, 42(6), 2142-2156. 2012 Impact factor: 5.5
Cited 52 times as of 10/10/2014 (Source: Web of Science)

2. **Fullerton, S.K.**; Maranas, J.K.* “A molecular dynamics study of the structural dependence of boron oxide nanoparticles on shape” *Nano Letters* **2005**, 5, 363-368. 2005 Impact factor: 9.9

1. **Fullerton, S.K.**[†]; Maranas, J.K.* “A molecular interpretation of vitreous boron oxide dynamics” *Journal of Chemical Physics* **2004**, 121, 8562-8570. 2005 Impact factor: 3.14

Publications in Review or Revision

3. Li, H.-M.; Xu, K.; Bourdon, B.; Lu, H.; Lin, Y.-C.; Robinson, J.; Seabaugh, A.C.; **Fullerton-Shirey, S.K.*** “Electric Double Layer Dynamics in Polyethylene Oxide LiClO₄ on Graphene Transistors” *in review, APL Materials* **Contribution:** Co-directed research and guided manuscript preparation.

2. Jing, B.; Wang, X.; Gao, H.; Zhu, Y. **Fullerton-Shirey, S.K.*** “Hierarchically Branched Polymer

as New Solid Polymer Electrolyte for Rechargeable Lithium-ion Battery” *in review*, *J. Phys. Chem. C*. **Contribution:** Co-directed research and manuscript preparation.

1. Kinder, E.; Fuller, A.[†]; Lin, Y.-C.; Robinson, J.; **Fullerton-Shirey, S.K.***; “Increasing the room-temperature electric double layer retention time in two-dimensional crystal FETs” *in revision*, *ACS Applied Materials and Interfaces*, May 2015. Impact factor 7.1 **Contribution:** Directed research and guided manuscript preparation.

INVITED PUBLICATIONS

Seabaugh, A.; Fathipour, S.; Li, W.; Lu, H.; Park, J.-H.; Kummel, A.C.; Jena, D.; **Fullerton-Shirey, S.K.**; Fay, P. “Steep subthreshold swing tunnel FETs: GaN/InN/GaN and transition metal dichalcogenide channels” 2015, International Electron Devices Meeting (IEDM), *Invited*.

Fullerton-Shirey, S.K.; Maranas, J.K. “Molecular mobility and ion transport in solid polymer electrolytes for lithium batteries”, *NIST Center for Neutron Research 2009 Annual Report* Special Publication 1105, 32-33.

PATENT

Fullerton-Shirey, S.K.; Seabaugh, A.C. “Single transistor random access memory using ion storage in two-dimensional crystals” *Serial No.:* 14/213,310, *Filing Date:* March 14, 2014.

FUNDING

PI or co-PI on awards totaling \$33 M; Amount allocated to the **Fullerton lab: \$2.36 M**

Ongoing Research Support

Title: *A New Approach to Explore the Semiconductor-to-Metal Phase Transition in Two-Dimensional Crystals Using Ionomers*

Investigators: Susan Fullerton (PI), Eric Beckman (co-PI),

Amount: \$496,272 over 3 years

Source: NSF-DMR-EPM

Duration: July 2016 - June 2019

Summary: Demonstrate steep, sub-threshold switching by using a single-ion conductor to induce the semiconductor to metal transition in single-layer MoTe₂.

Title: *Neutron scattering at ORNL to characterize the structure of poly(trimethylene glycol)/water*

Investigators: Susan Fullerton

Amount: \$10,000

Source: ORAU Ralph E. Powe Junior Faculty Enhancement Award

Duration: June 2016 - May 2017

Summary: Use neutrons to measure the molecular structure of a polymer/water system known for its unique thermodynamic properties.

Title: *Holographic Assembly of Reconfigurable Nanoscale Plasmonic and Photonic Elements*

Investigators: Paul Bohn (PI), David Go (co-PI), Greg Timp (co-PI), Ryan Roeder (co-PI), Susan Fullerton (co-PI), Anthony Hoffman (co-PI)

Amount: \$900,000 (Fullerton lab: \$150,000)

Source: DARPA Atoms to Products (A2P)

Duration: May 2015 - April 2018

Summary: Demonstrate electric field-driven filament formation and dissolution between two metallic nanoparticles embedded in a polymer electrolyte; this will ultimately enable metamaterials for which the plasmonic and photonic properties can be dynamically controlled.

Title: *GOALI: A low-voltage nonvolatile single transistor flash memory device based on ion transport in 2D electrolytes*

Investigators: Susan Fullerton (PI), Alan Seabaugh (co-PI)

Amount: \$368,388 over 3 years

Source: NSF-ECCS

Duration: July 2014 - June 2017

Summary: Demonstrate a flash memory based entirely on two-dimensional (2D) materials, including the first demonstration of a 2D electrolyte.

Title: *Center for Low Energy Systems Technology (LEAST)*

Investigators: Alan Seabaugh (PI), Susan Fullerton (co-PI) + 27 co-PIs at 10 other Universities

Amount: \$29,860,355 (Fullerton lab: \$1,150,059)

Source: SRC-DARPA Focus Center Research Program (FCRP)

Duration: January 2013 - October 2017

Summary: Develop ion gating strategies to demonstrate steep subthreshold swing in beyond CMOS transistors, and steep switching for next-generation memory.

Completed Research Support

Title: *New Polymer Electrolyte by Hyperbranched Polymer Assembly for Rechargeable Lithium-Ion Batteries*

Investigators: Y. Elaine Zhu (PI), Susan Fullerton (co-PI), Haifeng Gao (co-PI)

Amount: \$99,808 (Fullerton lab: \$25,000)

Source: U. Notre Dame Sustainable Energy Initiative

Duration: April 2014 - April 2015

Title: *Development of Materials for Improved Secondary Battery Technology*

Investigators: Paul McGinn (PI), Joan Brennecke (co-PI), Susan Fullerton (co-PI), Prashant Kamat (co-PI), Ed Maginn (co-PI), Alan Seabaugh (co-PI)

Source: Department of Defense, U.S. Army, TARDEC

Amount: \$1,386,000 over 3 years (Fullerton lab: \$160,000)

Duration: August 2010 - November 2013

Title: *Start-up funding*

Investigator: Susan Fullerton

Source: Notre Dame Center for NanoScience and Technology

Amount: \$25,000 **Duration:** August 2009

INVITED PRESENTATIONS

22. *TMS 2017 (The Minerals, Metals and Materials Society annual conference)* “Using Ions to Control Transport in Two-dimensional Materials for Electronics” Xu, K.; Liang, J.; Lu, H.; Kinder, E.; Kummel, A.; Seabaugh, A.; Fullerton-Shirey, S.K. February 27th, 2017, San Diego, CA, USA. Oral. *Note:* presentation delivered by postdoc Dr. Ke. Xu because I was 9 months pregnant

21. *The Pennsylvania State University - Department of Materials Science and Engineering; Polymer Physics Seminar Series* “Polymer electrolytes for exploring transport in two-dimensional materials for electronics” Fullerton Shirey, S.K. January 30th, 2017, University Park, PA, USA. Oral.

20. *University of California at Berkeley - Department of Electrical Engineering and Computer Science* “Using ions to control transport in two-dimensional materials for electronics” Fullerton Shirey, S.K. November 16th, 2016, Berkeley, CA, USA. Oral.

19. *Science 2016: Game Changers - University of Pittsburgh* “Using ions to control transport in two-dimensional materials for electronics” **Fullerton Shirey, S.K.** October 20th, 2016, Pittsburgh, PA, USA. Oral.
18. *Tec Talk, Micron Technology, Inc.* “Polymer/semiconductor electric double layers for memory and selectors” **Fullerton Shirey, S.K.** and Alan Seabaugh, September 30th, 2016, Boise, ID. Oral.
17. *CMOS Emerging Technologies Research* “Using ions to control transport in 2D materials for low-power transistors and memory” **Fullerton Shirey, S.K.**, May 27th, 2016, Montreal Canada. Oral.
16. *The Pennsylvania State University, 4th Annual Workshop on 2D materials - Graphene and Beyond: From Atoms to Applications* “Nanoionic two-dimensional memory” **Fullerton Shirey, S.K.** May 10th, 2016, University Park, PA, USA. Oral.
15. *Innovation in Materials, 2016, sponsored by PPG Industries* “Using ions to control transport in two-dimensional materials for electronics” **Fullerton Shirey, S.K.**, May 5, 2016, Pittsburgh, PA, USA. Oral.
14. *Materials Research Society (MRS) Spring Meeting* “2D Electrolytes for the Development of 2D Crystal Memory” **Fullerton Shirey, S.K.**, Xu, K.; Lu, H.; Wang, W.; Kim, H.; Kwak, I.; Cho, K.; Kummel, A.C.; Seabaugh, A. *Session: Novel Materials for End-of-Roadmap Devices in Logic, Power and Memory*, March 30th 2016, Phoenix, AZ, USA. Oral.
13. *University of Pittsburgh - Department of Electrical and Computer Engineering* “Field-controlled ion gating of two-dimensional crystals for logic and memory” **Fullerton Shirey, S.K.** November 4, 2015. Oral.
12. *Carnegie Mellon University - 2D Materials Center* “Ion gating of 2D materials for logic and memory” **Fullerton Shirey, S.K.** September 16, 2015. Oral.
11. *University of California Riverside - Department of Electrical and Computer Engineering* “Engineering ion-electron transport for low-power, two-dimensional electronics” **Fullerton Shirey, S.K.** May 11, 2015. Oral.
10. *US - EU Workshop on 2D Layered Materials and Devices*, Arlington, VA, USA “Nanometer-thick Ion Conductors for 2D Crystal Memory” **Fullerton-Shirey, S.K.**, Lu, H.; Wang, W.; Kim, H.; Kwak, I.; Furuyama, T.; Kobayashi, N.; Cho, K.; Kummel, A., Seabaugh, A.” April 22-24, 2015. Poster. Workshop by invitation only.
9. *West Virginia University - Department of Chemical Engineering* “Engineering ion-electron transport for low-power, two-dimensional electronics” **Fullerton Shirey, S.K.** March 11, 2015. Oral.
8. *University of Pittsburgh - Department of Chemical and Petroleum Engineering* “Engineering ion-electron transport for low-power, two-dimensional electronics” **Fullerton Shirey, S.K.** February 23, 2015. Oral.
7. *University of Minnesota - Materials Research Science and Engineering Center (MRSEC)* “Field-controlled ion gating for low power transistors and graphene memory” **Fullerton Shirey, S.K.** September 26, 2014. Oral.
6. *STARnet Accel eWorkshop* “Field-controlled ion doping of transition metal dichalcogenide FETs and two-dimensional ion-graphene memory” **Fullerton Shirey, S.K.** Available by WebEx to all STARnet researchers. May 7, 2014. Oral.
5. *Institute for Nanoelectronics, Technische Universitat Munchen (TUM)* “Influence of metal oxide nanofillers on the ionic conductivity of solid polymer electrolytes for rechargeable lithium-ion batteries” Do, S.; Schaetzl, D.; Dey, B.; Seabaugh, A.C.; **Fullerton Shirey, S.K.** December 2011.

Munich, Germany. Oral.

4. **American Chemical Society (ACS) Central Regional Meeting** “Conductivity improvement in nanorod-filled solid polymer electrolytes for lithium-ion batteries” Dey, B.; Do, S.; Schaetzl, D.; Seabaugh, A.C.; **Fullerton Shirey, S.K.** *New Advances in Polymer Materials* June 2011. Indianapolis, IN, USA. Oral.

3. **American Conference on Neutron Scattering (ACNS)** “Polymer mobility of nanoparticle-filled Solid Polymer Electrolytes using Neutron Scattering” **Fullerton Shirey, S.K.**; Maranas, J.K. *Neutron Scattering for the Study of Soft Matter Tutorial*, June 2010. Ottawa, ON, Canada. Oral.

2. **2010 National Academies Panel on Neutron Research** “Structure and mobility of PEO-based Solid Polymer Electrolytes” **Fullerton Shirey, S.K.**; Maranas, J.K. *NIST Center for Neutron Research*, March 2010. Gaithersburg, MD, USA. Oral.

1. **NSF Review: Center for High Resolution Neutron Scattering** “Structure and mobility of PEO-based Solid Polymer Electrolytes” **Fullerton Shirey, S.K.**; Maranas, J.K. *NIST Center for Neutron Research*, October 2009. Gaithersburg, MD, USA. Oral.

Non-technical Invited Talk

The Pittsburgh Quantum Institute (PQI): Women in Quantum Science and Engineering Lecture Series “Navigating the work/life balance and using the imposter syndrome to help you excel in your career” **Fullerton Shirey, S.K.**, February 7th, 2017, University of Pittsburgh. Oral.

CONTRIBUTED REFEREED PRESENTATIONS (PRESENTING AUTHOR)

17. **Fullerton Shirey, S.K.**, Xu, K.; Lu, H.; Wang, W.; Kim, H.; Kwak, I.; Cho, K.; Kummel, A.C.; Seabaugh, A. “Electrostatic Double Layer Flash Memory Based on Two-Dimensional Crystals” *2016 AIChE Annual Meeting*, November 14th 2016, San Francisco, CA, USA. Oral.

16. **Fullerton Shirey, S.K.**, Xu, K.; Lu, H.; Wang, W.; Kim, H.; Kwak, I.; Cho, K.; Kummel, A.C.; Seabaugh, A. “Nanoionic 2D crystal memory” *Pittsburgh Quantum Institute (PQI) 2016: Quantum Challenges*, April 20th 2016, Pittsburgh, PA, USA. Oral.

15. **Fullerton-Shirey, S.K.** “Engineering the interplay between ion and electron transport for low-power transistors and memory” *Annual Meeting of the American Institute of Chemical Engineers (AIChE)* November 2015, Salt Lake City, UT, USA. Oral.

14. **Fullerton-Shirey, S.K.**; Lu, H.; Wang, W.; Kim, H.; Kwak, I.; Furuyama, T.; Kobayashi, N.; Cho, K.; Kummel, A.; Seabaugh, A. “Nanometer-thick Ion Conductors for 2D Crystal Memory” *57th Electronic Materials Conference* June 2015, Columbus, OH, USA. Oral.

13. Schaetzl, D.; Li, P.; Bernstein, G.H.; **Fullerton-Shirey, S.K.**; “Magnetic Alignment of Gamma (core)/Alpha (shell) Fe₂O₃ Nanorods in a Solid Polymer Electrolyte” *225th ECS meeting*, May 2014, Orlando, FL, USA. Oral.

12. Schaetzl, D.; Li, P.; Bernstein, G.H.; Seabaugh, A.; **Fullerton Shirey, S.K.** Aligning high-aspect-ratio nanofillers in solid polymer electrolytes for Li-ion batteries *55th Electronic Materials Conference*, June 2013, Notre Dame, IN, USA, Oral.

11. Do, N.S.; Seabaugh, A.; **Fullerton Shirey, S.K.** Influence of nanofiller shape and aspect ratio on the ionic conductivity and thermal properties of solid polymer electrolytes for rechargeable Li-ion batteries *55th Electronic Materials Conference*, June 2013, Notre Dame, IN, USA, Oral.

10. Elliott, L.C.C.; Jing, B.; Akgun, B.; Zhu, Y.; Bohn, P.W.; **Fullerton Shirey, S.K.** “Small molecule drug loading and distribution in poly(N-isopropylacrylamide) brushes and its effect on the lower critical

solution temperature a neutron reflectometry and AFM study *Materials Research Society Fall Meeting*, November 2012, Boston, MA, USA. Oral.

9. Do, N.S.; Schaetzl, D. Dey, B., Seabaugh, A.C., **Fullerton Shirey, S.K.** “Influence of Fe₂O₃ nanofiller shape on the conductivity and thermal properties of solid polymer electrolytes: nanorods versus nanospheres” *Gordon Research Conference - Batteries*, March 2012, Ventura, CA USA. Poster.

8. **Fullerton Shirey, S.K.**; Do, S.; Schaetzl, D.; Dey, B.; Seabaugh, A.C. “Improving conductivity in solid polymer electrolytes using oxide nanorods, *220th ECS Meeting*, October 2011. Boston, MA USA. Oral.

7. **Fullerton Shirey, S.K.**; Maranas, J.K. “The effect of LiClO₄ on the structure and mobility of PEO-based solid polymer electrolytes” *Frank J. Padden Jr. Award Symposium, American Physical Society* - award winner March 2009. Pittsburgh, PA USA. Oral.

6. **Fullerton, S.K.**; Maranas, J.K. “Influence of humidity and crystallization time on the ionic conductivity of nanoparticle-filled solid polymer electrolytes” *American Physical Society*, March 2007. Denver, CO USA. Oral.

5. **Fullerton, S.K.**; Maranas, J.K. “PEO mobility in solid polymer electrolytes as a function of nanoparticle concentration as measured by quasi-elastic neutron scattering” *Gordon Research Conference - Polymer Physics*, July 2006, New London, CT USA. Poster.

4. **Fullerton, S.K.**; Maranas, J.K. “PEO mobility in nanoparticle-filled polymer electrolytes as measured by neutron scattering” *American Physical Society*, March 2006. Baltimore, MD USA. Oral.

3. **Fullerton, S.K.**; Maranas, J.K. “PEO mobility in nanoparticle-filled polymer electrolytes as measured by neutron scattering” *American Institute of Chemical Engineers*, November 2005. Cincinnati, OH USA. Oral.

2. **Fullerton, S.K.**; Maranas, J.K. “Simulations of amorphous nanoparticles: the effect of shape on surface structure and subsequent interactions with the surroundings” *American Physical Society*, March 2005. Los Angeles, CA USA. Oral.

1. **Fullerton, S.K.**; Maranas, J.K. “A molecular interpretation of vitreous boron oxide dynamics” *American Institute of Chemical Engineers*, November 2003. San Francisco, CA USA. Oral.

CONTRIBUTED REFEREED PRESENTATIONS (CO-AUTHOR OR DIRECTING AUTHOR)

30. Kummel, A.; Fathipour, S.; Park, J.H.; Kwak, I.; Sardashti, K. Vishwanath, S.; Xing, H.G.; Fullerton, S.; Seabaugh, A.; Movva, H.; Banerjee, S.K.; Rai, A. “Self Assembled Ordered Phthalocyanine Monolayers on 2D Semiconductors for Subnanometer Dielectric ALD Nucleation” *Pacific Rim Meeting on Electrochemical and Solid-State Science, PRIME 2016*, October 2016, Honolulu, Hawaii, USA.

29. Fathipour, S.; Park, J.H.; Kummel, A.; Fullerton, S.K.; Seabaugh, A.C. “2D Crystal Tunnel Field Effect Transistors” *TECHCON 2016*, September 2016, Austin, TX, USA. Oral and Poster,

28 Seabaugh, A.; Fathipour, S.; Li, H.; Paletti, P.; Kinder, E.; Liu L.; Lu H.; Asghari, M.; Gonzalez, K.; Pandey, P.; Alessandri C.; Remskar, M.; **Fullerton-Shirey, S. K.** “Electric-double-layer field-effect transistors using polyethylene-oxide cesium perchlorate on two-dimensional materials” *Flatlands Beyond Graphene 2016*, July 2016, Bled, Slovenia; Invited.

27. Xu, K.; Lu, H.; Kinder, E.; Kummel, A.; Seabaugh, A.; **Fullerton, S.** “Ion-Doping of Graphene FETs Using a Two-Dimensional Solid-State Electrolyte” *58th Electronic Materials Conference*, June 2016, University of Delaware, Newark, DE, USA. Oral.
26. Fathipour, S.; Paletti, P.; **Fullerton-Shirey, S.**; Seabaugh, A. “Demonstration of electric double layer p-i-n junction in WSe₂” *74th Device Research Conference*, June 2016, University of Delaware, Newark, DE, USA.
25. Li, M.O.; Xiao, S.; Yan, R.; Vishwanath, S.; **Fullerton-Shirey, S.**; Jena, D.; Xing, H.G. “Fermi Level Tunability of A Novel 2D Crystal: Tin Diselenide (SnSe₂)” *74th Device Research Conference*, University of Delaware, June 2016, Newark, DE, USA.
24. Kummel, A.; Park, J.H.; Kwak, I.; Chagarov, E.; Movva, H.; Chou, H.; Banerjee, S.K.; Fathipour, S.; Seabaugh, A.; **Fullerton, S.**; Vishwanath, S.; Xing, H.G.; Choudhury, P. “Phthalocyanine Monolayer Nucleation of Gate Oxide ALD on Single Layer Graphene and TMD Surfaces” *Electrochemical Society Spring Meeting*, June 2016, San Diego, CA, USA, Invited.
23. Fathipour, S.; Li, H.-M.; Remskar, M.; Yeh, L.; Tsai, W.; Chen, E.; Lin, Y.; **Fullerton-Shirey, S.**; Seabaugh, A. “Record high current density and low contact resistance in MoS₂ FETs by ion doping” *2016 Very Large Scale Integration-Technology, Systems and Applications (VLSI-TSA)* April 2016, Hsinchu, Taiwan, Oral.
22. Xu, K.; Chu, T.; Bourdon, B.; Seabaugh, A.; Chen, Z.; **Fullerton-Shirey, S.K.** “Reconfigurable p-n junction formation and bandgap opening in bilayer graphene using polyethylene oxide and CsClO₄ solid polymer electrolyte” *Pittsburgh Quantum Institute (PQI) 2016: Quantum Challenges*, April 2016, Pittsburgh, PA USA. Poster.
21. Kinder, E.W.; Fuller, A.; **Fullerton, S.K.** “Room temperature static doping of 2D crystals using an ion-locking electrolyte” *MRS Spring Meeting*, March 2016, Phoenix, AZ, USA, Oral.
20. Kwak, I.; Park, J.H.; Lu, H.; Sardashti, K.; Ahles, C.F.; Vishwanath, S.; Xing, H.G.; Seabaugh, A.; **Fullerton, S.**; Kummel, A.C. “Functionalization of TMDs for Deposition of ALD NanoScale Dielectrics for FETs with Low SubThreshold Swing” *MRS Spring Meeting*, March 2016, Phoenix, AZ, USA, Poster.
19. Park, J.H.; Kwak, I.; Chagarov, E.; Sardashti, K.; Movva, H.C.P.; Chou, H.; Banerjee, S.K.; Fathipour, S.; **Fullerton-Shirey, S.K.**; Seabaugh, A.; Vishwanath, S.; Xing, H.G.; Choudhury, P.; Kummel, A.C. “Monolayer Organic Films for Nucleation of ALD on Single Layer Graphene and TMD surfaces” *46th IEEE Semiconductor Interface Specialists Conference (SISC)* December 2-5th, 2015, Arlington, VA, USA. Oral.
18. Xu, K.; Chu, T.; Bourdon, B.; Seabaugh, A.; Chen, Z.; **Fullerton-Shirey, S.K.** “Reconfigurable p-n junction formation and bandgap opening in bilayer graphene using polyethylene oxide and CsClO₄ solid polymer electrolyte” *73rd Device Research Conference*, June 2015, Columbus, OH, USA. Poster.
17. Kinder, E. and **Fullerton, S.K.** “Ion-Locking Method for Doping Atomically-Thin Transistors” *11th International Nanotechnology Conference on Communication and Cooperation*, May 2015, Fukouka-city, Fukouka, Japan. Poster.
16. Seabaugh, A., Appenzeller, J., Asbeck, P., Chen, Z., Cho, K.J., Datta, S., Feenstra, R., Fay, P., **Fullerton, S.K.**, Hock, A., Hu, S., Javey, A., Jenna, D., Keller, S., Kim, M., Klimeck, G., Kummel, A., Mayer, T., Narayanan, V., Niemier, M., Robinson, J., Salahuddin, S., Stemmer, S., Van de Walle, C., Vogel, E., Wallace, R., Xing, H. G. “STARnet Center for Low Energy Systems Technology” *11th International Nanotechnology Conference on Communication and Cooperation*, May 2015, Fukouka-city, Fukouka, Japan. Poster.

15. Kinder, E. and **Fullerton, S.K.** “PVA:LiClO₄: a robust, high T_g polymer electrolyte for adjustable ion gating of 2D materials” *American Physical Society*, March 2015, San Antonio, TX, USA. Oral.
14. Li, H.-M.; Bourdon, B.; Lin, Y.-C.; Robinson, J.; Seabaugh A.; **Fullerton, S.** “Dynamics of Ion-Gating 2D Crystals Using a Solid Polymer Electrolyte” *American Physical Society*, March 2015, San Antonio, TX, USA. Oral.
13. Park J.H.; Kwak, I.; Choudhury, P.; Sardashti, K.; Prakash, H.C.; Banerjee, S.; **Fullerton, S.**; Kummel, A.C. “Self Assembled Ordered Phthalocyanine Monolayers on 2D Semiconductors for Subnanometer Dielectrics ALD Nucleation” *Spring MRS meeting*, April 2015, San Francisco, CA. Invited.
12. Li, H.-M.; Bourdon, B.; Lin, Y.-C.; Robinson, J.; Seabaugh, A.; **Fullerton, S.K.** “Temperature dependence of ion transport in solid polymer electrolytes for electrostatic gating of 2D crystals” *The 2nd Muju International Winter School Series (MIWS2-2015)*, January 2015, Muju Deogyusan Resort, Republic of Korea. Poster.
11. Fathipour, S.; Xu, H.; Kinder, E.; **Fullerton-Shirey, S.**; Seabaugh A. “Investigation of aging and restoration of polyethylene-oxide cesium- perchlorate solid polymer electrolyte used for ion doping of a WSe₂ field-effect transistor” *72nd Device Research Conference*, June 2014, Santa Barbara, CA, USA. Poster.
10. Khan, A.A.; Ahmed, T.; Vigil, G.D.; **Fullerton-Shirey, S.K.**; Howard, S.S. “Photophysical properties of novel Ru-complex probes for two-photon dissolved oxygen imaging” *CLEO: 2014*, June 2014, San Jose, CA, USA. Oral.
9. Hwang, W.S.; Fathipour, S.; Seabaugh, A.; Xing, H.; **Fullerton-Shirey, S.K.**; Jena, D. “Two-Dimensional Crystal Semiconductors for Beyond Si Technology” *2014 Collaborative Conference on Materials Research (CCMR)*, June 23-27, 2014, Incheon/Seoul, South Korea. *Invited*.
8. Seabaugh, A.; Lu, H.; Ma, N.; Fathipour, S.; Kinder, E.; Sabnis, S.; Xu, H.; Asghari Heidarlou, M.; Hwang, W.S.; **Fullerton-Shirey, S.**; Jena, D. “Materials Challenges for Steep Subthreshold-Swing Transistors” *2014 Collaborative Conference on Materials Research (CCMR)*, June 23-27, 2014, Incheon/Seoul, South Korea. *Invited*.
7. Xu, H.; Kinder, E.; Fathipour, S.; Seabaugh, A.; **Fullerton-Shirey, S.K.** “Reconfigurable Ion Doping in 2H-MoTe₂ Field-Effect Transistors Using PEO:CsClO₄ Electrolyte” *ISCS 2014 The 41st International Symposium on Compound Semiconductor*, May 2014, Montpellier, France. Oral.
6. Kinder, E.; Lu, H.; Hwang, W.S.; Cho, B.J.; Hong, S.-K.; Seabaugh, A.; **Fullerton-Shirey, S.K.** “Field-Controlled Ion Doping of Graphene” *225th ECS meeting*, May 2014, Orlando, FL, USA. Oral.
5. Kinder, E.; Yan, R.; Xing, H.; **Fullerton-Shirey, S.K.**; “Field-Effect Doping of MoS₂ Using a Solid Polymer Electrolyte” *225th ECS meeting*, May 2014, Orlando, FL, USA. Oral.
4. Kwak, I.; Park J.H.; Movva, H.C P., Kinder, E.; Lu, H.; Akinwande, D.; Seabaugh, A.; **Fullerton, S.**; Banerjee, S.; Kummel A.; “Graphene Transfer Using Sacrificial PIB Layer onto 1nm Al₂O₃/TiOPc/Graphene Gate Stacks” *Spring MRS meeting*, April 21-25, 2014, San Francisco, CA. Poster.
3. Wang, W.; Gong, C.; **Fullerton, S.**; Seabaugh, A. “First Principles Study on Crown Ether and Crown Ether-Li Complex Interactions with Graphene” *Spring MRS meeting*, April 21-25, 2014, San Francisco, CA. Oral.
2. Lu, H.; Kinder, E.; Vahala, J.; Hwang, W.S.; Gong, C.; Cho, K.; Hong, S.K.; Cho, B.J.; **Fullerton-Shirey, S.**; Seabaugh, A. “Low-Voltage Nonvolatile Graphene Memory Based on Ion Transport” *INC 9*, May 2013, Berlin, Germany, Poster.

1. Khan, A.A.; DeLeon, E.R.; Ahmed, T.; **Fullerton-Shirey, S.K.**; Olson, K.R.; Howard, S.S. "Chemical Probes for Two-Photon Bioimaging Based on Surfactant Nanomicelles and Ormosil PEB-BLEs *CLEO: 2013*, June 2013, San Jose, CA, USA. Poster.

FELLOWSHIPS AND AWARDS

The Ralph E. Powe Junior Faculty Enhancement award, ORAU (\$10,000)	2016
The Frank J. Padden Jr. Award for " <i>Excellence in Polymer Physics Research</i> " The American Physical Society	2009
General Electric - First Year Faculty for the Future Fellowship in Engineering (\$10,000)	2007
Outstanding Research Presentation: The Larry Duda Award for Outstanding Graduate Student Performance in Chemical Engineering, sponsored by Arkema, Inc. (\$3000)	2006
Outstanding Teaching Assistant Award: The Walter R. and Aura Lee Supina Graduate Fellowship in Chemical Engineering (\$2000)	2004
National Science Foundation Graduate Research Fellowship	2004-2007
The Arthur and Elizabeth Rose Memorial Graduate Fellowship in Chemical Engineering (\$5000)	2003
Marie Underhill Noll Graduate Fellowship in Engineering (\$2500)	2003
General Electric - Faculty for the Future Fellowship in Engineering (\$5000)	2003
Paul Morrow Endowed Scholarship in Engineering (\$4000)	1998
James H. Lum Scholarship in Engineering (\$4000)	1998
Travel Award to the Eighth International Conference on Quasi-Elastic Neutron Scattering Bloomington Convention Center, Bloomington, IN USA	June 14-17, 2006
Travel Award to the Spallation Neutron Source - High Flux Isotope Reactor Users Meeting Oak Ridge National Laboratory, Oak Ridge, TN USA	October 11-13, 2005
Travel Award to Methods and Applications of Neutron Spectroscopy NIST Center for Neutron Research, Gaithersburg, MD USA	June 20-24, 2005

PERSONNEL SUPERVISED

Current group members: 4 PhD, 2 Undergrads, 1 Postdoc

Erich Kinder

January 2013 - present

PhD candidate, University of Notre Dame, EE

Project: "2D Nanoionic Memory"

Support: SRC/DARPA (LEAST)

Award: 3rd place prize of \$225 at the IEEE mini-symposium on Electron Devices and Photonics, Notre Dame, IN. January 2015

Award: \$3,000 NSF Travel Award to the 11th International Nanotechnology Conference on Communication and Cooperation, Hilton Sea Hawk, Fukuoka-city, Fukuoka, Japan *May 11-13, 2015*.

Ke Xu

August 2014 - present

Visiting Research Assistant Professor, University of Pittsburgh, ChE

Project: “Ion gating for low voltage electronic devices.”
Support: SRC/DARPA (LEAST)

Jierui (Jerry) Liang *October 2015 - present*
PhD Student, University of Pittsburgh, ChE
Project: “Nanoionic 2D crystal memory”
Support: NSF-ECCS/GOALI **Award:** Grand prize: \$1,000 travel award and iPad; PQI, Science 2016 poster session

Zhongmou Chao *October 2015 - present*
PhD Student, University of Pittsburgh, ChE
Project: “Electrolytes for Reconfigurable Nanoscale Plasmonic and Photonic Elements”
Support: DARPA Atoms to Products

Yunze (Lindsey) Tian *January 2017 - present*
PhD student, University of Pittsburgh, ChE
Project: “A new approach to explore the semiconductor-to-metal transition in MoTe₂”
Support: NSF-DMR-EPM

Matei Jordache *January 2017 - present*
Undergraduate, University of Pittsburgh, ChE
Project: “AFM Characterization of exfoliated MoS₂ and monolayer electrolyte”
Support: NSF-DMR-ECCS REU supplement

Brian Radka *January 2017 - present*
Undergraduate, University of Pittsburgh, ChE
Project: “Filament formation/dissolution kinetics in a polymer/ionic liquid film ”
Support: Start-up

Former group members

Ziwei Guo *November 2015 - present*
Masters student University of Pittsburgh, ChE
Project: “Electrolyte gating of organic field-effect transistors”
Support: N/A

Hao Lu (co-advised with Alan Seabaugh, EE) *July 2014 - October 2016*
Graduate Student, University of Notre Dame, EE
PhD Dissertation: “Development of Nanometer Ion Conductor for 2D-Crystal Memory and Universal Tunnel Transistor SPICE Model.” Defense date: 10/3/16
Support: SRC/DARPA (LEAST), NSF-ECCS/GOALI

Blaec Toncini *January 2016- present*
Undergraduate student, University of Pittsburgh, ChE
Project: “Development of Processes for Cleaning Resist from 2D Crystal Surfaces”
Support: NSF-ECCS/GOALI REU (summer 2016)

Rachel Buck *May 2016- August 2016*
Undergraduate student, University of Minnesota Duluth, ChE
Project: “Physical Characterization of Electrolytes for Reconfigurable Nanoscale Elements”
Support: NSF REU site; U. of Pittsburgh, Chem. Eng. (summer 2016)

Sandhya Vasudevan *June 2014 - May 2016*
University of Notre Dame, EE
MS Thesis: “The effect of nanoparticle shape on conductivity in solid polymer electrolytes.” Defense date: 5/19/16

Edward Hunkler, NSF REU *May 2015 - August 2015*
Undergraduate Student, University of Notre Dame, EE
“CO₂ cleaning of 2D crystal surfaces”

Ashley Fuller *May 2015 - August 2015*
Undergraduate Student,
St. Mary’s College and University of Notre Dame, Chem/ChE
“PVA-based electrolytes for ionic gating”

Katie O’Neill *May 2014 - August 2014*
Undergraduate student, Trinity College, Dublin, Ireland
“Characterizing 2D electrolytes for ion-graphene memory.”

Huamin Li (co-Advised with Alan Seabaugh, EE) *May 2014 - March 2015*
Postdoctoral Scholar, University of Notre Dame, EE
“Time and temperature-dependent ion-gating of graphene FETs”

Benxin Jing, Ph.D (co-advised with Elaine Zhu, ChE) *April 2014 - April 2015*
Postdoctoral Scholar, University of Notre Dame, Chemical Engineering
“New Polymer Electrolyte by Hyperbranched Polymer Assembly for Rechargeable Li-ion batteries.”

Huilong Xu, Ph.D. *August 2013 - August 2014*
Visiting Research Assistant Professor, University of Notre Dame, EE
“Electrostatic doping of 2D materials for memory and TFETs”

Buchanan Bourdon *May 2013 - December 2014*
Undergraduate student, University of Notre Dame, EE
“Modeling ion-electron transport in 2D materials”

Kiersten Lieurance *September 2013 - January 2014*
Marian High School, Mishawaka
“Electrical Characterization of PEO:LiClO₄ as a Function of Humidity”

Samuel Leung (co-advised with Alan Seabaugh, EE) *May 2012 - August 2012*
Undergraduate, University of Notre Dame, ChE
“Ion Transport in a Solid Polymer Electrolyte Between 2-D Graphene Surfaces

Josh Vahala (co-advised with Alan Seabaugh, EE) *May 2012 - December 2013*
Undergraduate, University of Notre Dame, EE
“Electrical characterization of ion transport in planar graphene/PEO:LiClO₄/graphene structures”

Nhu Suong Do *Spring 2011 - Spring 2013*
Undergraduate, University of Notre Dame & Saint Mary’s College, EE & Math
“Effect of nano-filler shape on the conductivity of solid polymer electrolytes (SPEs) for rechargeable lithium-ion batteries”

Dean Schaetzl *Spring 2011 - Summer 2013*

Undergraduate, Purdue University South Bend, EET

“Aligning conductive pathways in solid polymer electrolytes for lithium-ion batteries”

Barnali Dey (co-advised with Alan Seabaugh, EE)

May 2011 - August 2011

Graduate Student, University of Notre Dame, EE

“Charge transport study of solid polymer electrolytes for lithium ion batteries”

Melissa Cunningham

Fall 2011 - Spring 2011

Marian High School, Mishawaka

“New materials for flexible batteries”

3rd Place in EE category at the 2011 Northern Indiana Regional Science and Engineering Fair

Sarah Schubert

May 2010 - August 2010

“Preparing a solid-state quantum-dot sensitized rainbow solar cell with polymer nanoparticles”

Undergraduate, University of Notre Dame, Chem.

PROFESSIONAL AFFILIATIONS

American Chemical Society [ACS]

American Institute of Chemical Engineers [AIChE]

American Physical Society [APS]

Electrochemical Society [ECS]

Institute of Electrical and Electronics Engineers [IEEE]

Materials Research Society [MRS]

Neutron Scattering Society of America [NSSA]

PROFESSIONAL SERVICE

Journal and Proposal Reviewer

ACS Applied Materials and Interfaces (1), ACS Nano (2), Applied Physics Letters (2), Beamtime Proposals at the NIST Center for Neutron Research (NCNR) (10) Chemistry of Materials (1), IEEE Transactions on Electron Devices (1), Ionics (1), Langmuir (1), Nano Research (1), Nano Letters (1), Nanoscale (1), Nature Communications (1) Materials Science and Engineering B (1) Materials Science in Semiconductor Processing (4), Membranes (1), The Journal of Physical Chemistry (2), The Journal of Physical Chemistry Letters (7), The Journal of Polymer Science B (1),

Federal Review Panels and Invited Meeting Participant

NSF Panel Review (March 2015, March 2016)

NSF-Sponsored US-EU Workshop on 2D Materials and Devices, Arlington, VA (April 2015)

Invited Organizer 2015, 2016, 2017: *Electronic Materials Conference* Topics: Electrochemical Energy Storage and Conversion and Materials for Memory Devices

Session Chair

- 2015 Electronic Materials Conference, Session K: Materials for Memory and Computation, Ohio State University, Columbus, OH, June 24, 2015

- 2016 Electronic Materials Conference, Session AA: Impact of Surface Interactions on 2D Devices, University of Delaware, Newark, DE, June 23, 2016

- 2017 Electronic Materials Conference, Session S: BN, BP, TMD and Novel 2D Materials, University of Notre Dame, Notre Dame, IN, June 29, 2017

General Arrangements Chair

- 2018 Annual meeting of the the American Institute of Chemical Engineers (AIChE), Pittsburgh, PA

University Service

- Goldwater selection committee, Fall 2015
- Graduate admissions Chemical Engineering Fall 2015 - present
- Faculty search committee Chemical Engineering 2016/2017
- Poster judge for Pittsburgh Quantum Institute (PQI) 2016: Quantum Challenges, April 2016
- Co-coordinator of Chemical and Petroleum Engineering seminar series 2016-2017
- Thesis committees at Pitt: Victor Manrique (ChE, MS, Pitt, 2016), Amey More (ChE, PhD, Pitt), Quing Guo (Physics, PhD, Pitt), Jiaqi Zhao (ChE, PhD, Pitt)