AIChE & CEMS

Intro to ChemE

Personal Intro

- Steve Bosomworth
  - Pres. AIChE
  - 4/5 Co-op Student
  - B.E. Chemical Engineering ’19
  - M.E. Systems Engineering ’19
  - Work Experience, UTAS & Infineum

Me: Freshman Year

Itinerary

- ChemE Overview
- Co-Op/Internship
- Undergraduate Research
- Faculty Experience

Intro

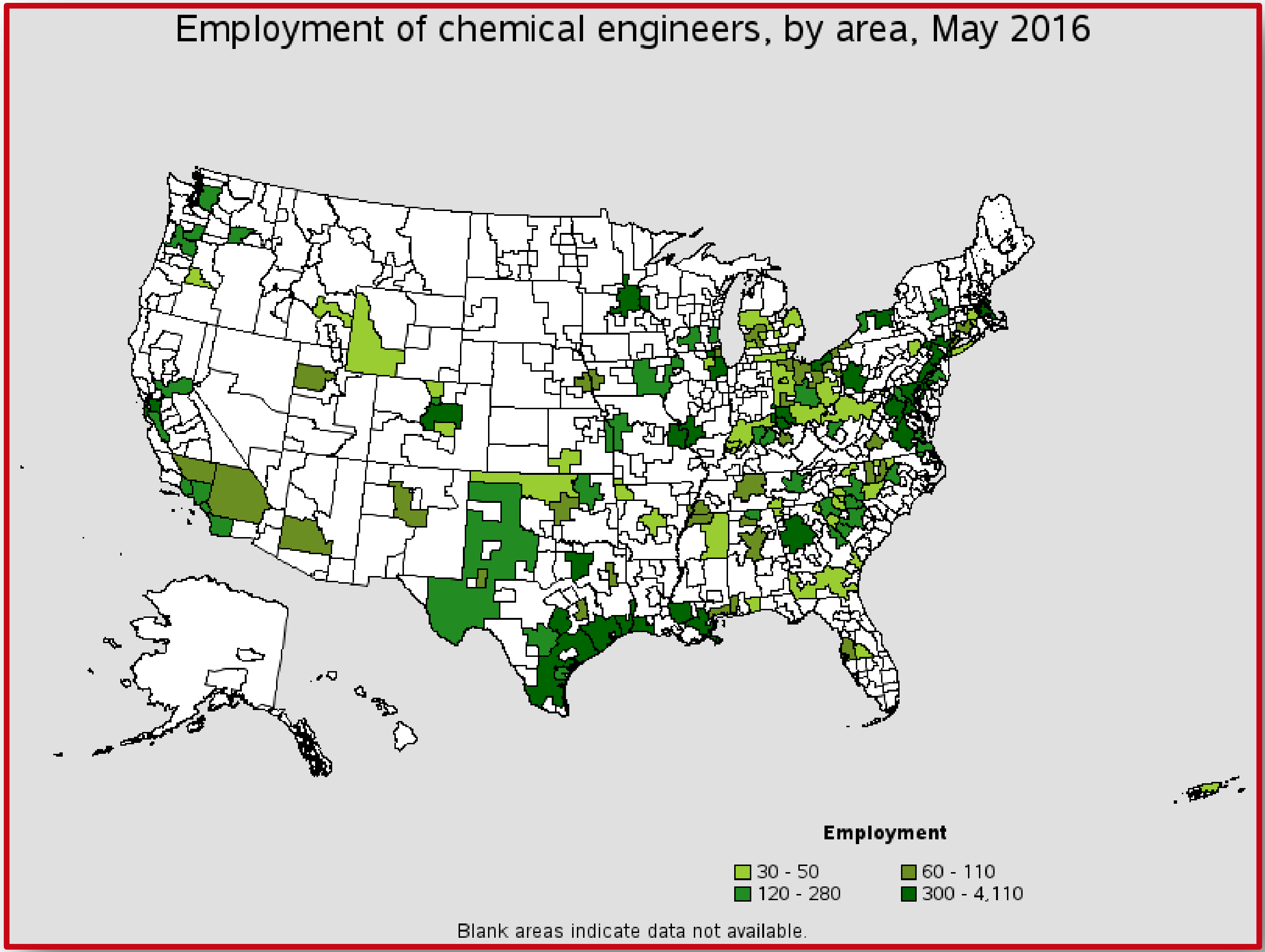
ChemE Overview

Employment

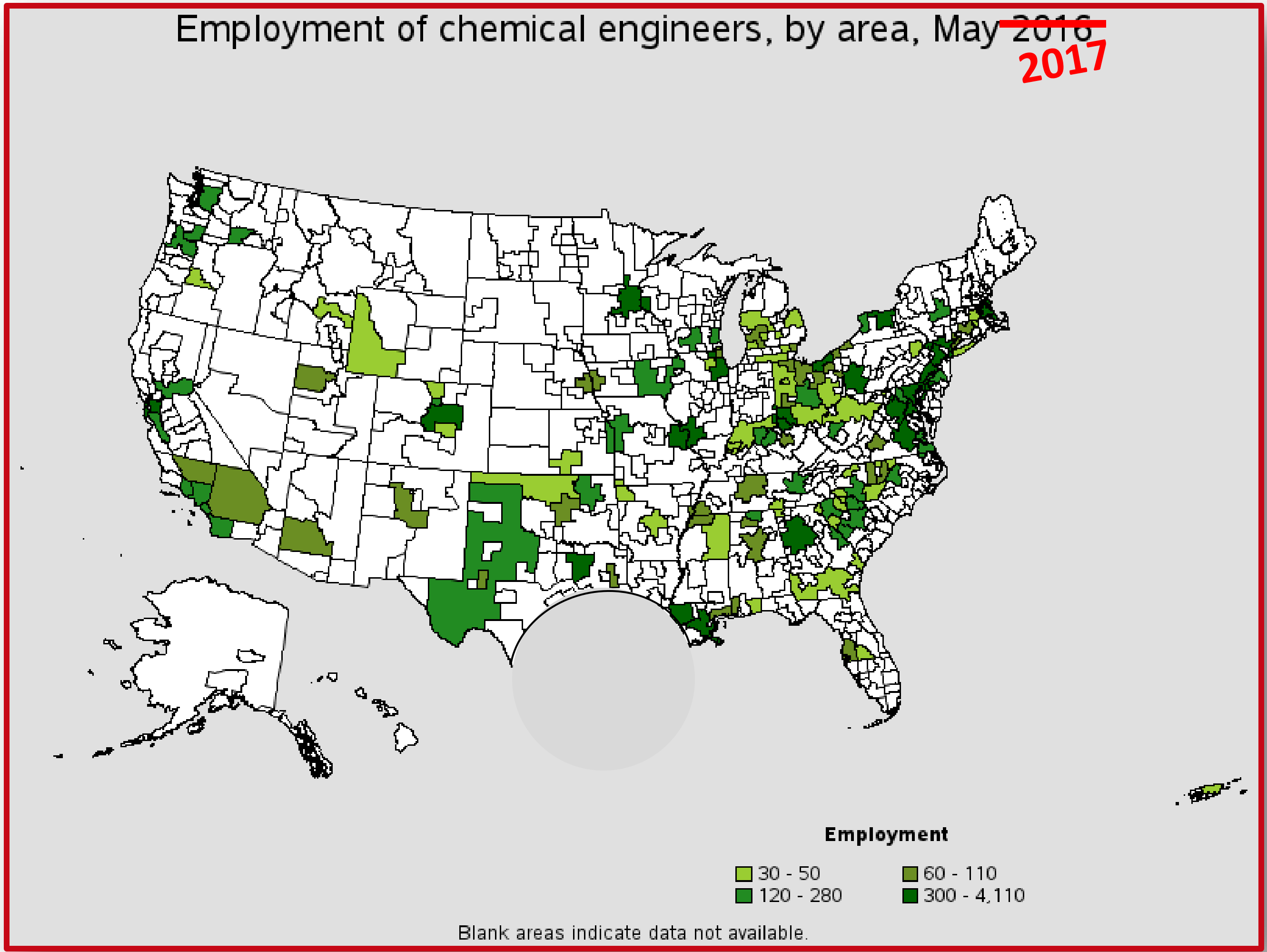
- Total US Workforce: 66,551
- Top US Industries: Industrial Chemicals, Pharmaceuticals, Petroleum
- Top Industries in NJ: Pharmaceuticals, Specialty Chemicals, Flavors & Fragrances



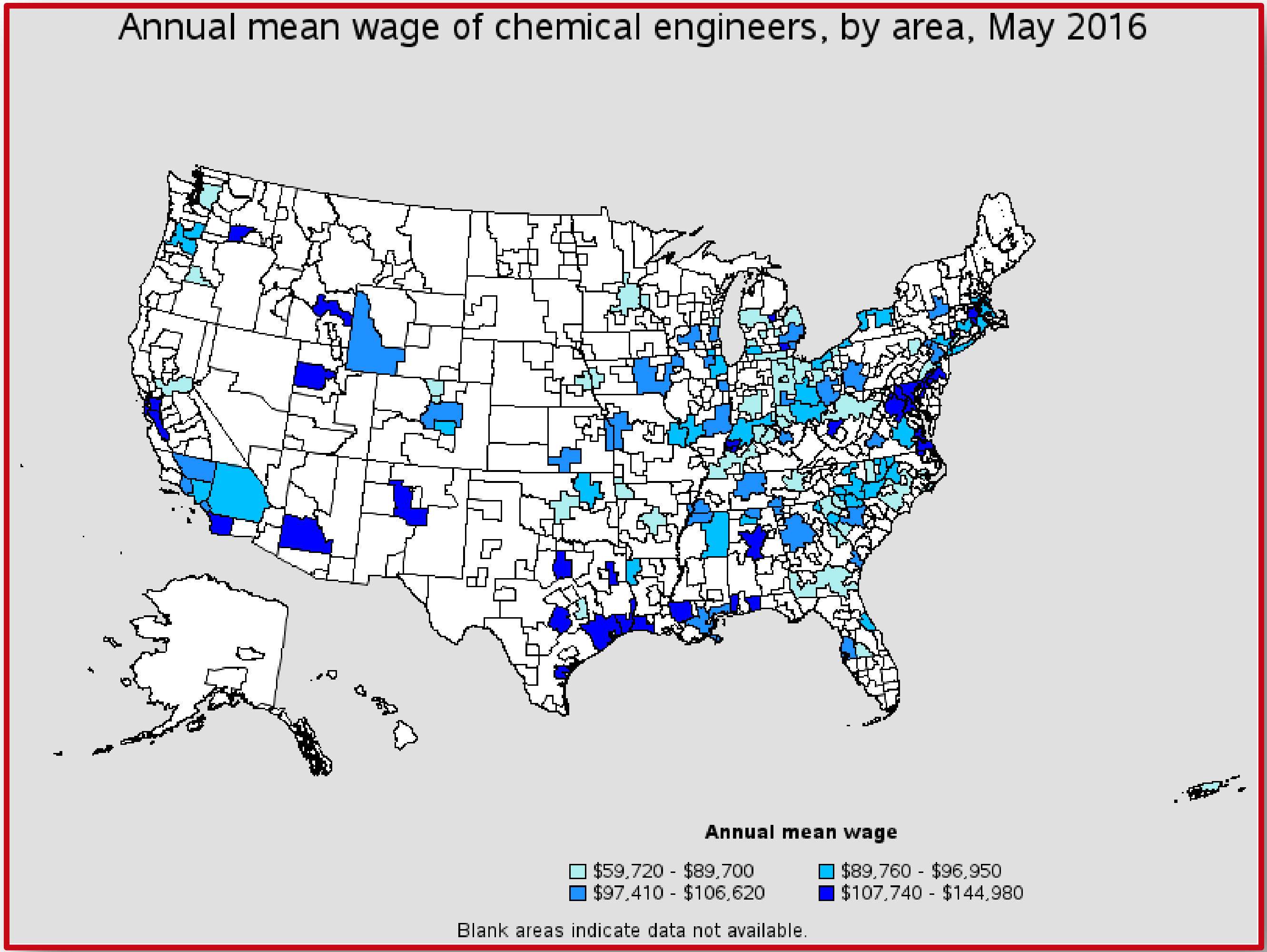
ChemE Geography



ChemE Geography



ChemE *Financial* Geography



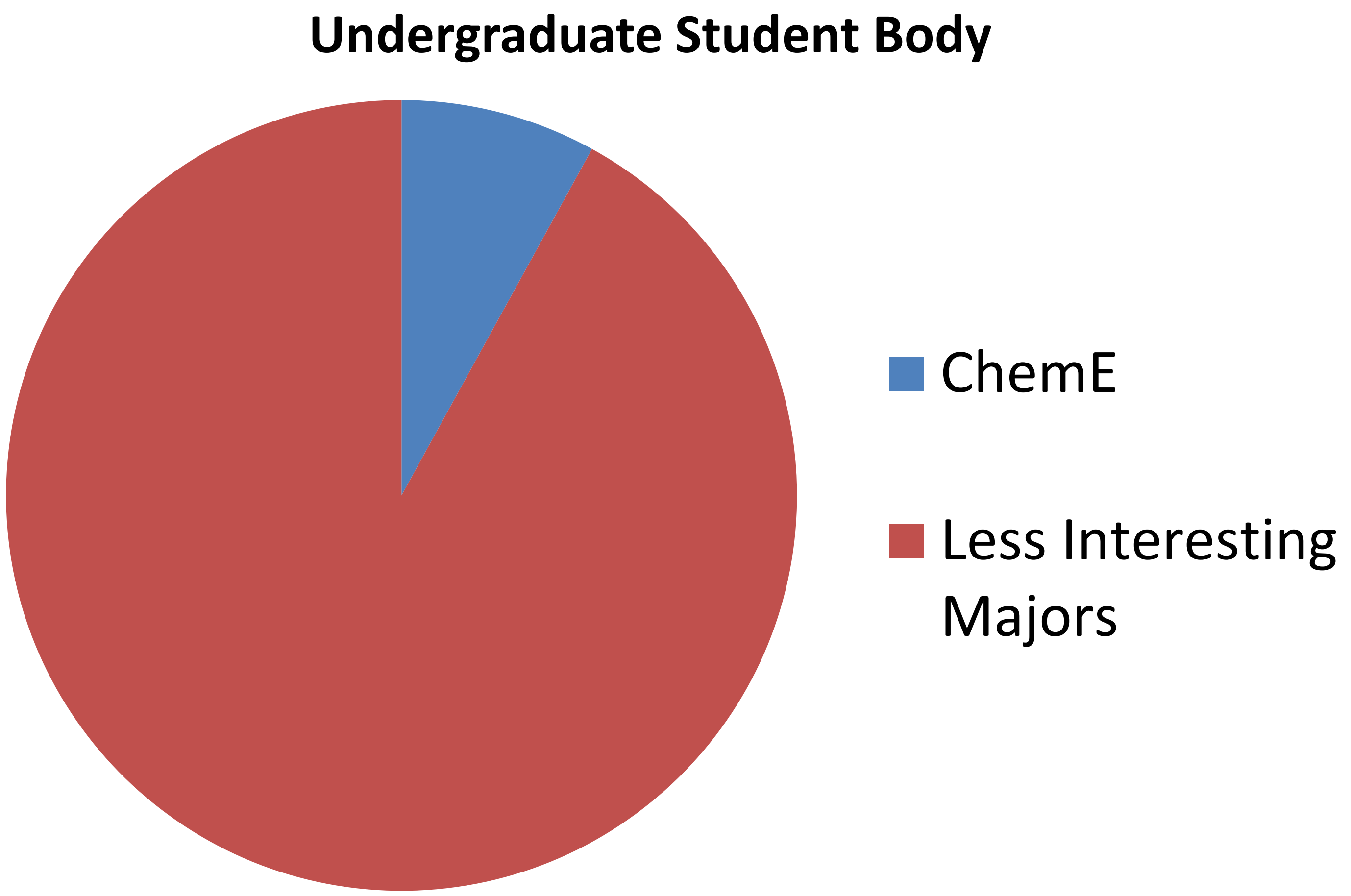
ChemE Outlook

- According to NACE's Winter 2017 *Salary Survey*, Chemical Engineers are projected to be the top-paid engineering major in 2017
- Projected average starting salary: $68,445
- 2016 Mean Annual Salary: $105,420
- 10^{th} Percentile: $60,770
- Employment growing ~2%/yr (>1300 jobs)

ChemE At Stevens

- Current department size
  - Undergraduate students: 230
  - Graduate students: 75 (ChemE and MT)
  - 10 Faculty
- Total undergraduate enrollment: 3,021
  - ~ 8% ChemE

ChemE At Stevens



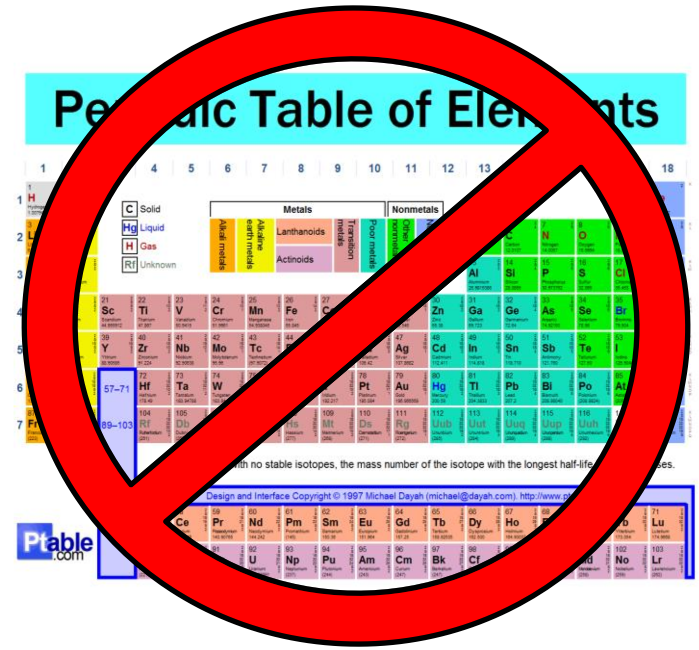
ChemE: The Education

- Raise your hand if this is you:

"Gee I really liked chemistry in high-school! I want to be an engineer! I should be a Chemical Engineer!"

ChemE: The Education

- Chemical Engineering ≠ Chemistry
- Things you WILL learn:
  - – Thermodynamics
  - – Fluid Mechanics
  - – Industrial Reaction and Separation Processes
  - – Process Modeling and Simulation



Curriculum Breakdown

Easy

- The Basics
  - Process Analysis
  - Thermodynamics
  - Fluid Mechanics

Medium

- Processes
  - Separation Operations
  - Heat and Mass Transfer
  - Reactor Design
  - Process Control, Modeling, and Simulation

Hard

- Applications
  - Chemical Engineering Laboratory
  - Engineering Design 6-8

By Graduation

You will be able to…

- Characterize chemical systems
- Design and evaluate chemical processing hardware
- Model and simulate chemical processes using software tools

Other Facets of Education

- Undergraduate research
  - Ability to apply the principles you learn in class to novel research
  - Possibility of publication
- Co-ops/internships
  - Fantastic work experience
  - Develop ‘hard’ and ‘soft’ skills needed to succeed in the workplace

Spotlight

Co-ops/Internships

Personal Intro

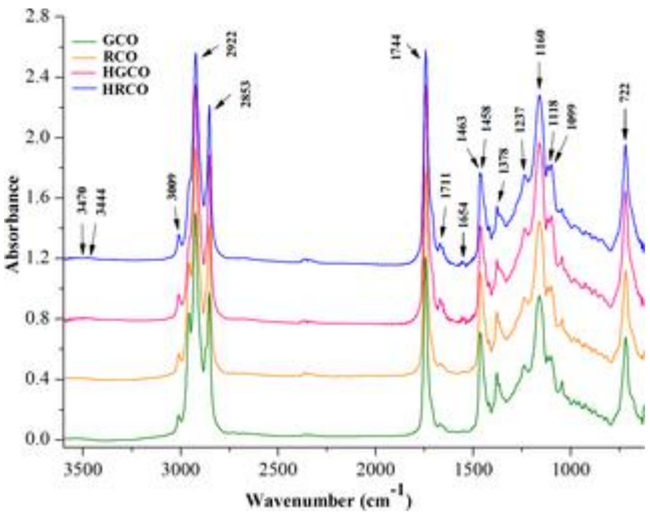
- James Sweeney
  - 4/5 Co-op Student
  - B.E. Chemical Engineering ’19
  - M.E. Systems Engineering ’19
  - Work Experience, Johnson and Johnson & Infineum
  - Research experience on microbial fuel cells (Summer 2015)

J&J Experience

- Consumer R&D Microbiology
- Massive cross-functional exposure
- Conduit between engineering and science

Infineum Experience: Lab Portion

- Analytical tools
  - FTIR, KV, particle counts
- Scale trials
- Developing new methods
- Data analysis



Infineum Experience

- “Classic” chemical engineering
- Process optimization
- Aligning with stakeholders
- Global team member

Key Takeaways

- Dive headlong into company culture
- Imperfect fit ≠ poor experience
- Interview/apply for anything that looks interesting
- Cure for “When am I going to use this in real life?”

Spotlight

Undergraduate Research

Outline

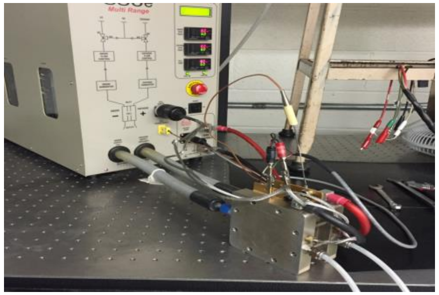
1. My research experiences

2. Introduction to fuel cells/current research

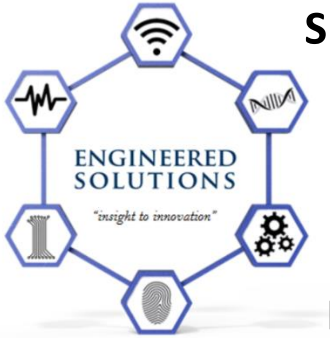
3. Advantages of doing research as an undergraduate

My Research Experience

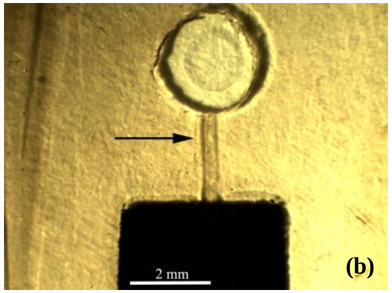
Summer 2015: Start undergraduate research

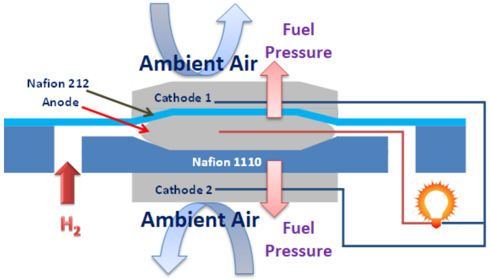


Spring 2016: Co-op J&J Consumer on Engineered Solutions Team



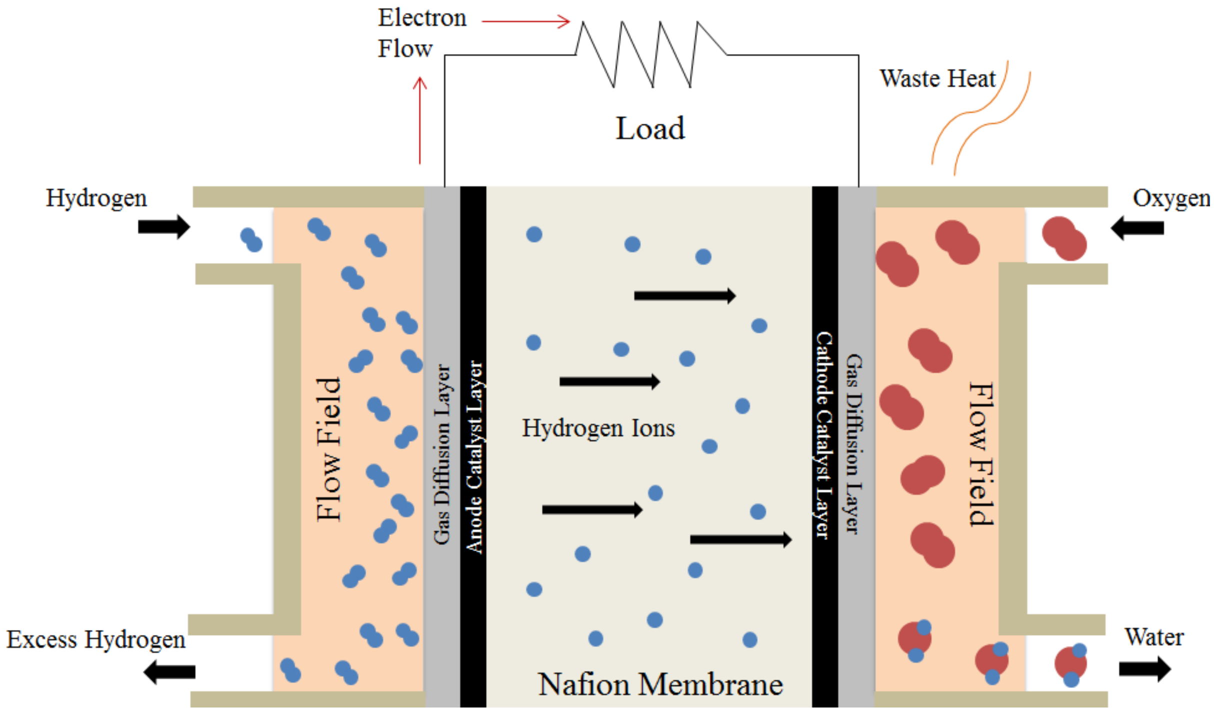
Fall 2016: Start working on thin, flexible, air-breathing fuel cell





PEMFC

Introduction to Proton Exchange Membrane Fuel Cell (PEMFC) Operation



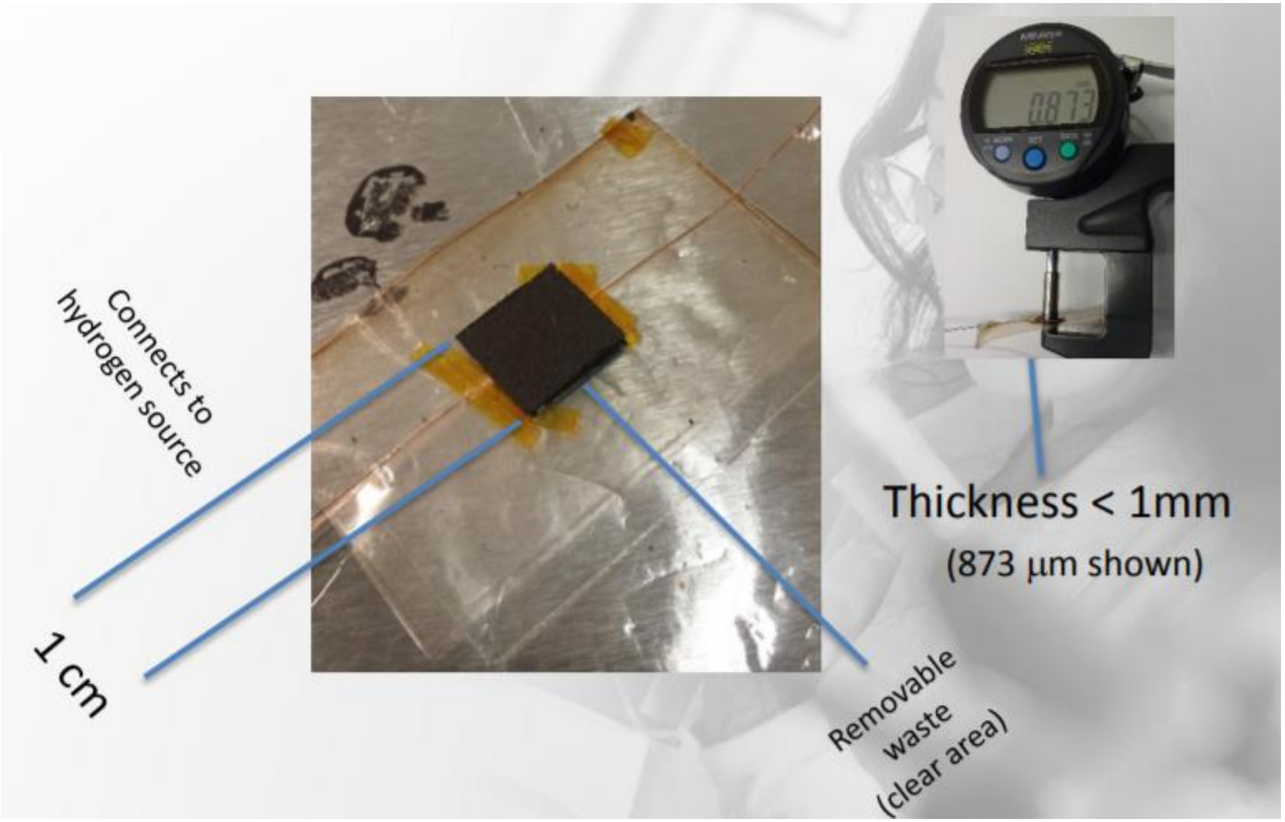
<u>At the Anode:</u> $H_2 \longrightarrow 2H^+ + 2e^-$

<u>At the Cathode:</u> $\frac{1}{2}O_2 + 2H^+ + 2e^- \longrightarrow H_2O$

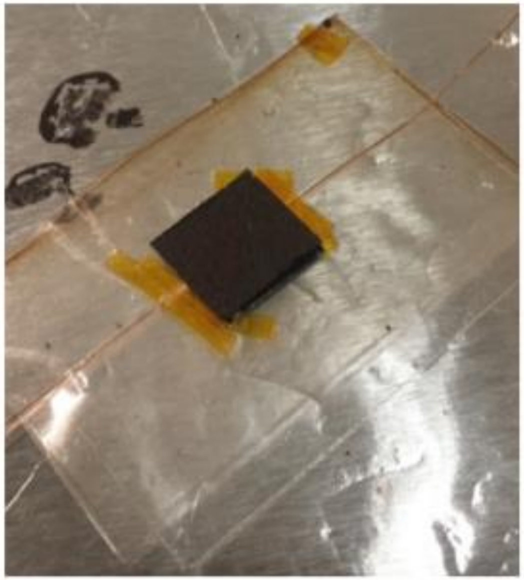
<u>Overall Reaction:</u> $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

Current Research

Current Research: Novel Thin, Flexible, Air-breathing Fuel Cell



Applications of Novel Fuel Cell Design



TFFC: 1.8 W/g

“GLOBALLY THE WORLD's SMALLEST & LIGHTEST FUEL CELLS”

Horizon Ultralight FC – 220W Peak

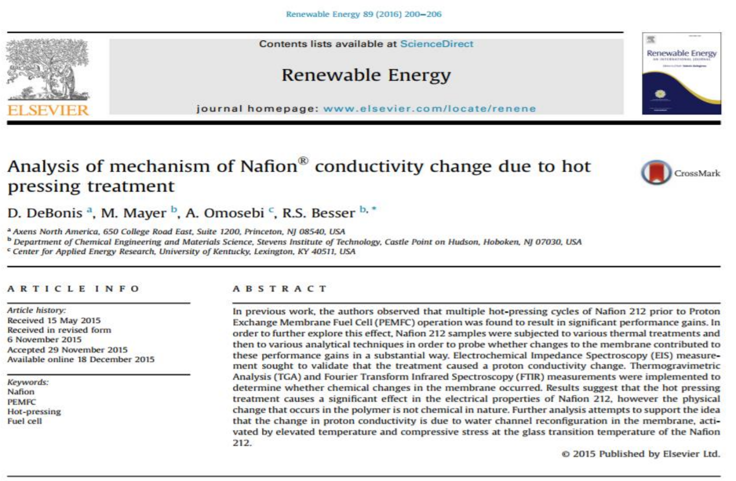
Ultralight FC: 0.34 W/g

- **Capable of increasing flight time of 1 kg Onterra electric RC aircraft by ≈ x5 improvement**

Internship

How do I get my first internship experience?

Benefits of Research



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ELSEVIER

Analysis of mechanism of Nafion® conductivity change due to hot pressing treatment

D. DeBonis [a], M. Mayer [b], A. Omosebi [c], R.S. Besser [b, *]

[a] Axens North America, 650 College Road East, Suite 1200, Princeton, NJ 08540, USA
[b] Department of Chemical Engineering and Materials Science, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ 07030, USA
[c] Center for Applied Energy Research, University of Kentucky, Lexington, KY 40511, USA

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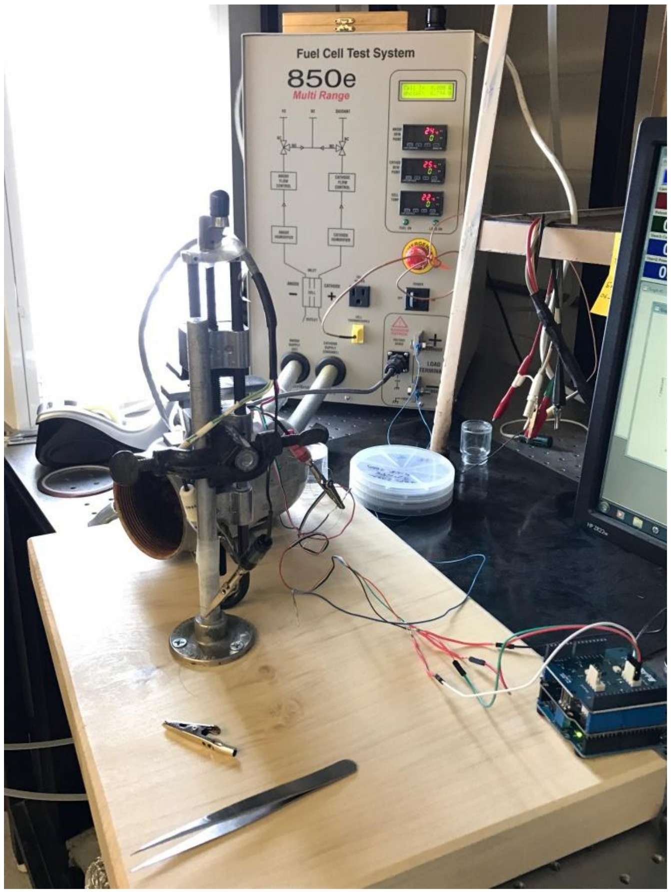
Hot-pressing
Fuel cell

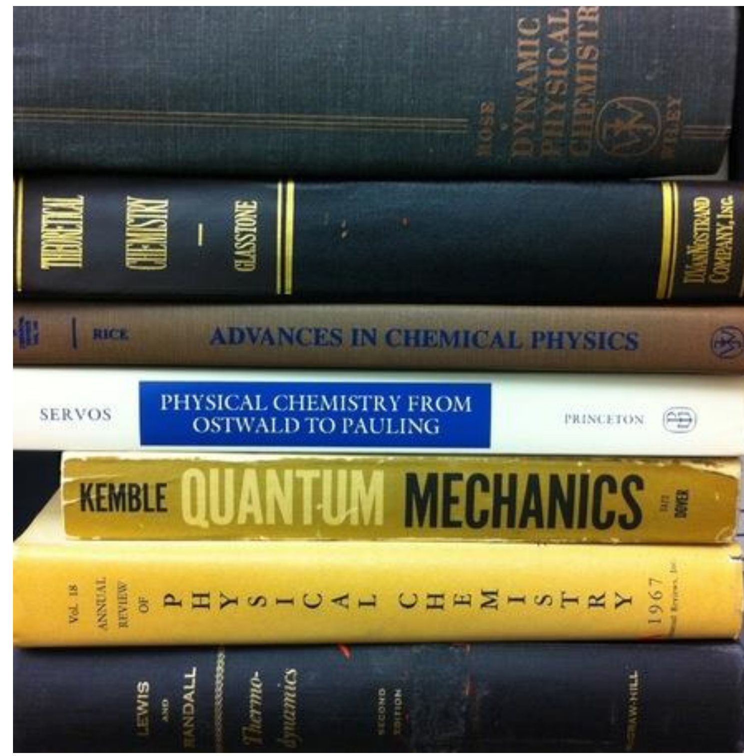
ABSTRACT

In previous work, the authors observed that multiple hot-pressing cycles of Nafion 212 prior to Proton Exchange Membrane Fuel Cell (PEMFC) operation was found to result in significant performance gains. In order to further explore this effect, Nafion 212 samples were subjected to various thermal treatments and then to various analytical techniques in order to probe whether changes to the membrane contributed to these performance gains in a substantial way. Electrochemical Impedance Spectroscopy (EIS) measurement sought to validate that the treatment caused a proton conductivity change. Thermogravimetric Analysis (TGA) and Fourier Transform Infrared Spectroscopy (FTIR) measurements were implemented to determine whether chemical changes in the membrane occurred. Results suggest that the hot pressing treatment causes a significant effect in the electrical properties of Nafion 212, however the physical change that occurs in the polymer is not chemical in nature. Further analysis attempts to support the idea that the change in proton conductivity is due to water channel reconfiguration in the membrane, activated by elevated temperature and compressive stress at the glass transition temperature of the Nafion 212.

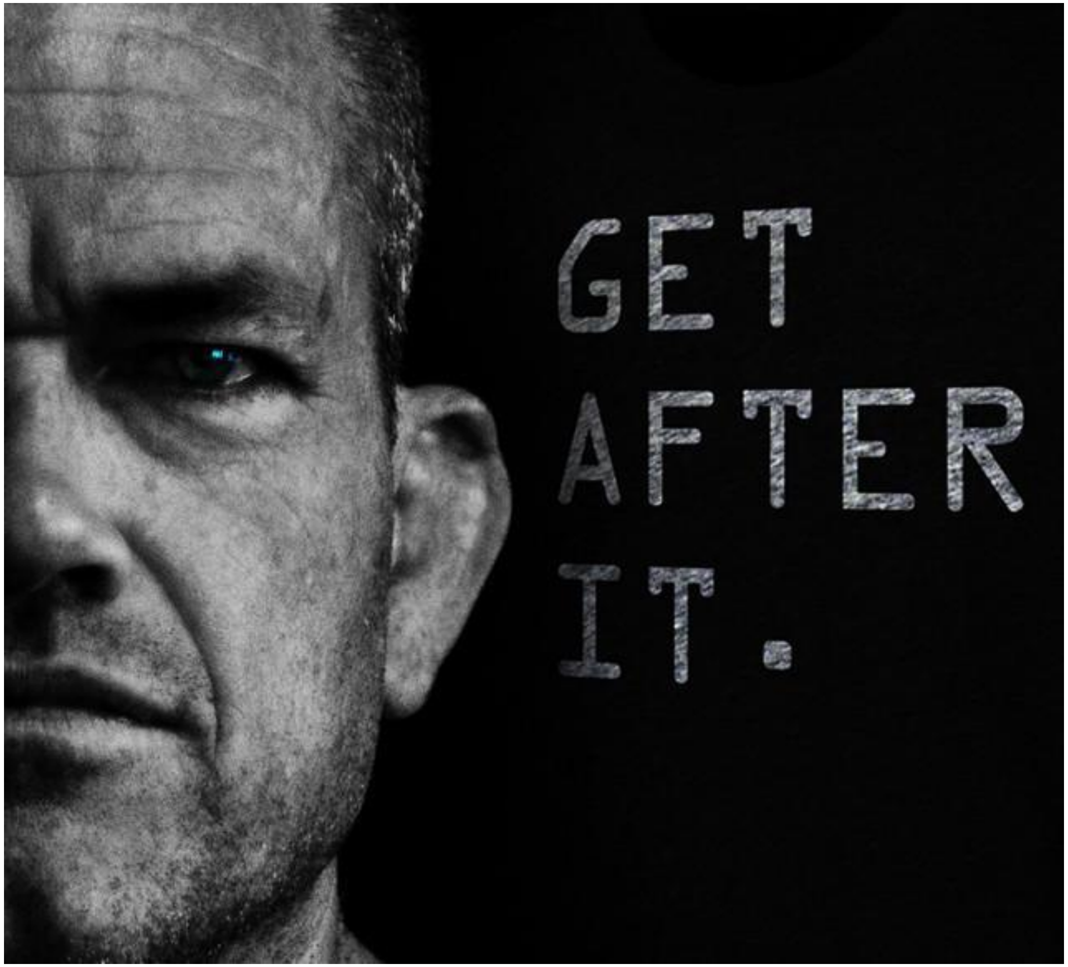
Research vs. Classroom



vs.



When should I get involved?



Acknowledgements

- Lab partners S. Reza Mahmoodi, P.-K. Sun, H. Dai

Spotlight

Faculty Experience

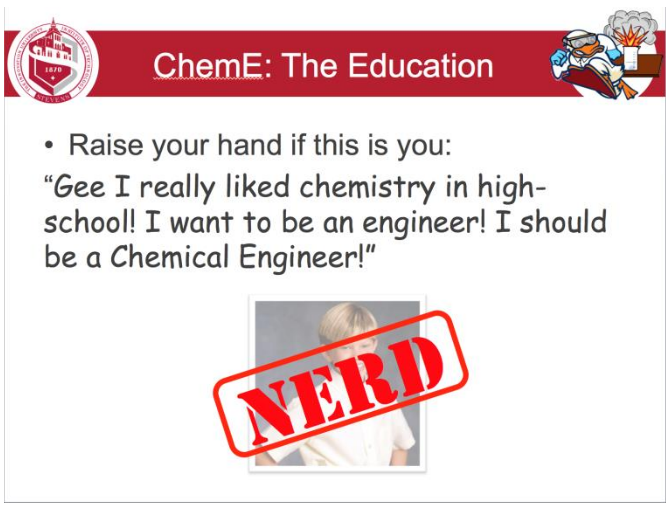
Personal Intro

Stephanie Lee

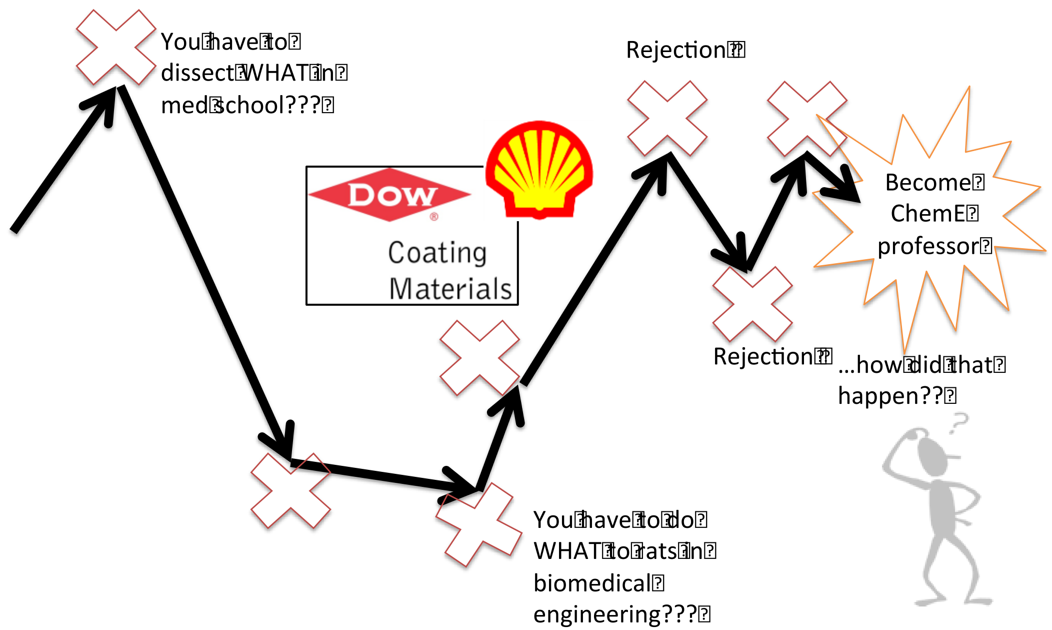
- BS in Chemical Engineering from MIT (2007)
- PhD in Chemical Engineering and Materials Science from Princeton (2012)
- Postdoctoral researcher at NYU (2012-2014)
- Joined Stevens in 2014 as an assistant Professor
- Live in Hoboken with my husband (met on the 1st day of college freshman orientation!) and our 15 month old son, Asher (a.k.a. the cutest baby on the planet)

How did I get here?

- Spoiler alert: I had no idea what career I wanted to pursue until my postdoc at NYU

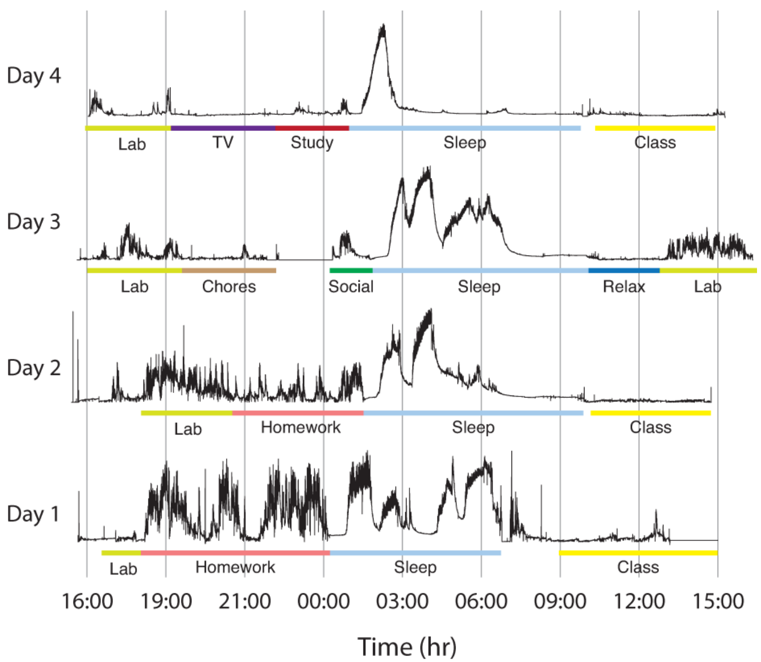


This was me!!

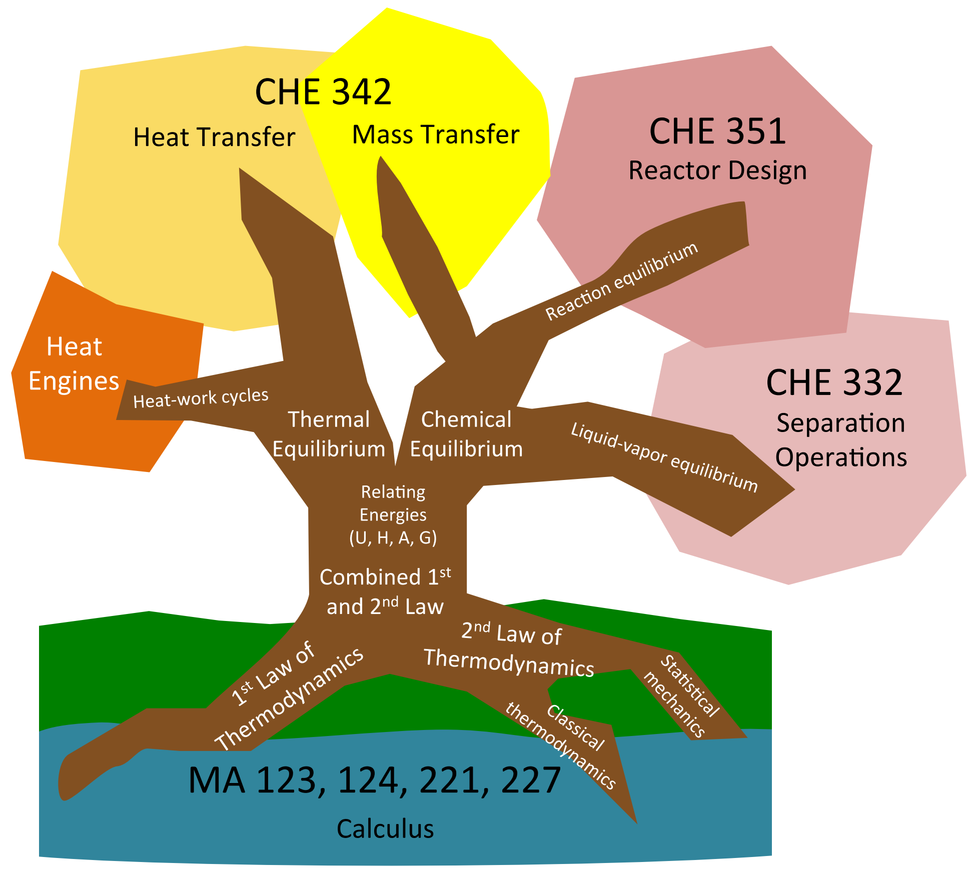


What I do at Stevens

- I "teach" CHE234: Chemical Engineering Thermodynamics and MT665: Soft Matter Physics

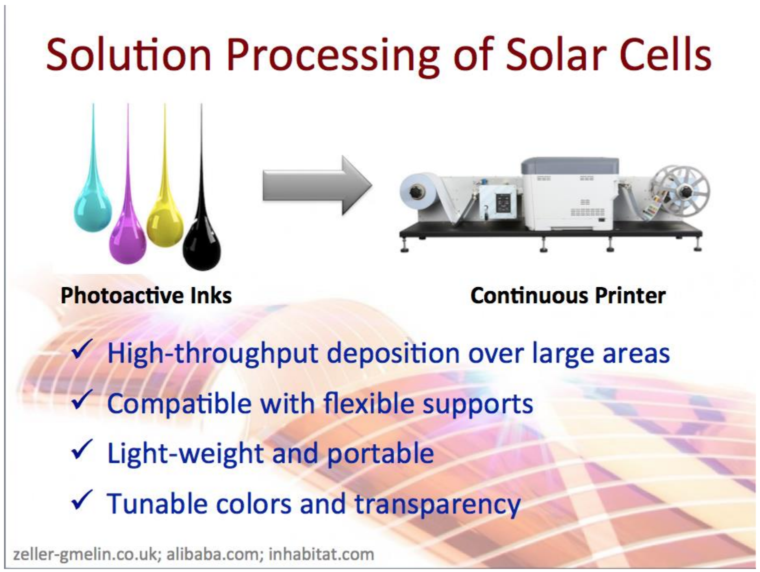


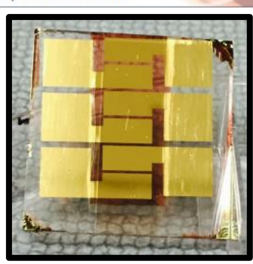
IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 57, NO. 5, MAY 2010



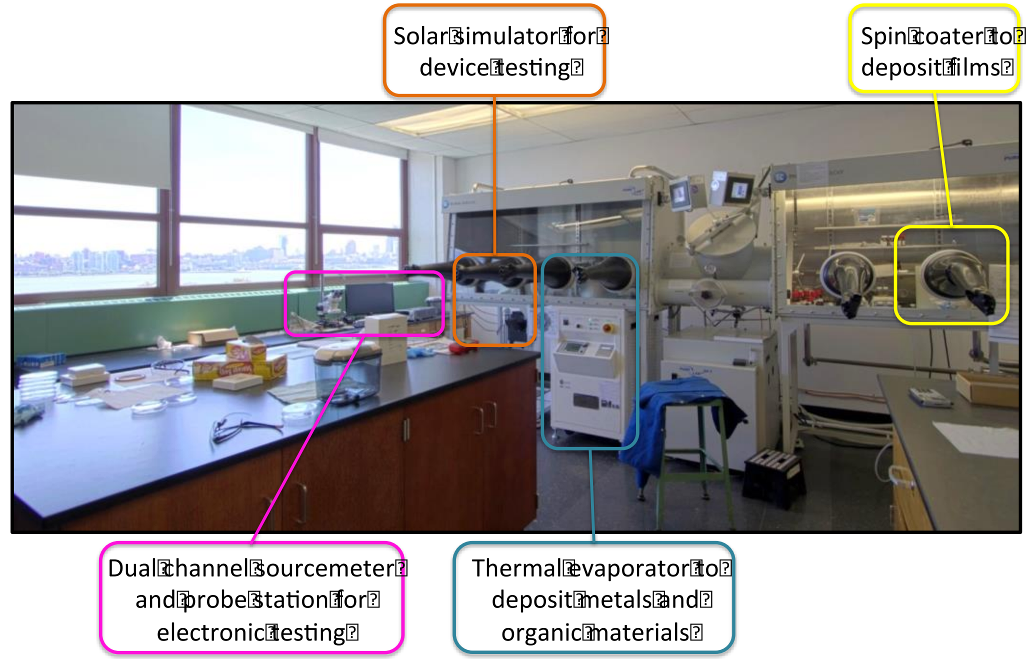
What I do at Stevens

- I direct a research team of graduate and undergraduate students





Hybrid Electronics Laboratory



Research Opportunities for Undergraduates

- Innovation and Entrepreneurship summer research program ($5k stipend)
- Work-study
- Research for credit: CHE498
- Volunteer

CRYSTAL GROWTH & DESIGN
Article
pubs.acs.org/crystal

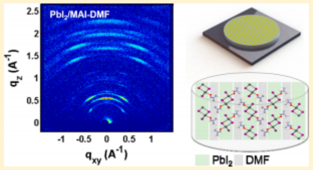
Nanoconfined Crystallization of $MAPbI_3$ to Probe Crystal Evolution and Stability

Sangchul Lee, Joshua Feldman, and Stephanie S. Lee*

Department of Chemical Engineering and Materials Science, Stevens Institute of Technology, Hoboken, New Jersey 07030, United States

Supporting Information

ABSTRACT: The effect of nanoconfinement on the crystallization of methylammonium lead iodide ($MAPbI_3$) was systematically studied using two-dimensional X-ray diffraction (2D XRD). Nanoconfined crystals were prepared by spin coating a cosolution of lead iodide (PbI_2) and methylammonium iodide (MAI) dissolved in *N*,*N*-dimethylformamide or dimethyl sulfoxide onto anodized aluminum oxide (AAO) templates with uniaxially aligned pores ranging from 20–200 nm in diameter. Upon spin coating, a metastable crystalline phase incorporating solvent molecules was observed. Analysis of 2D XRD patterns using refined lattice parameters revealed that these crystals adopt a preferential orientation with alternating sheets of PbI_2 and solvent molecules lying parallel to the long axis of the pores. Upon thermal annealing at temperatures up to 130 °C, the oriented PbI_2/solvent crystals converted to randomly oriented $MAPbI_3$ crystals, with the extent of conversion dependent on the characteristic pore diameter of the AAO template. Nanoconfinement was further observed to affect the stability of $MAPbI_3$ crystals exposed to air. Unconfined $MAPbI_3$ crystals degraded to PbI_2 within a period of 2 weeks of air exposure, accompanied by a significant change in crystal morphology. In contrast, $MAPbI_3$ crystals confined in AAO templates with a characteristic pore size of 100 nm were stable over the same period.



cm CHEMISTRY OF MATERIALS
Article
pubs.acs.org/cm

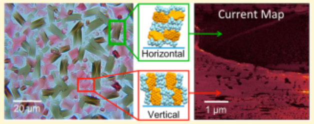
Orientation Control of Solution-Processed Organic Semiconductor Crystals To Improve Out-of-Plane Charge Mobility

Xiaoshen Bai,[†,¶] Kai Zong,[†,¶] Jack Ly,[‡] Jeremy S. Mehta,[§] Megan Hand,[†] Kaitlyn Molnar,[†] Sangchul Lee,[†] Bart Kahr,[#] Jeffrey M. Mativetsky,[§] Alejandro Briseno,[‡] and Stephanie S. Lee*,[†]

[†]Department of Chemical Engineering and Materials Science, Stevens Institute of Technology, Hoboken, New Jersey 07030, United States
[‡]Department of Polymer Science and Engineering, University of Massachusetts Amherst, Amherst, Massachusetts 01003, United States
[§]Department of Physics, Applied Physics and Astronomy, Binghamton University, Binghamton, New York 13902, United States
[#]Department of Chemistry, New York University, New York, New York 10002, United States

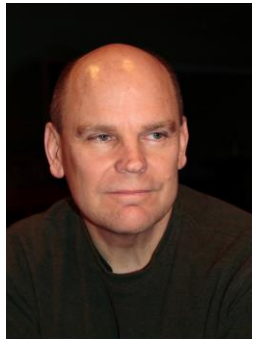
Supporting Information

ABSTRACT: The crystallization of a series of triisopropylsilylethynyl (TIPS)-derivatized acene-based organic semiconductors drop cast from solution onto substrates was investigated as a function of the size of their conjugated cores. When drop cast onto a substrate, the molecules in TIPS-pentacene crystals adopt a "horizontal" orientation, with the long axis of the pentacene core parallel to the substrate surface. For crystals comprising molecules with dibenzopyrene, anthanthrene, and pyranthrene cores, two-dimensional X-ray diffraction patterns revealed the existence of a second population of crystals adopting a "vertical" molecular orientation with the long axis of the acene core perpendicular to the substrate surface. The ratio of the population of TIPS-pyranthrene crystals with molecules adopting horizontal versus vertical orientations was controlled by varying the surface energy of the underlying substrate. These crystals displayed orientation-dependent linear birefringence and linear dichroism, as observed by differential polarizing optical microscopy. Conductive atomic force microscopy (C-AFM) revealed a 42-fold improvement in out-of-plane hole mobility through crystals adopting the vertical molecular orientation compared to those adopting the horizontal molecular orientation.



Research Opportunities

Prof. Akcora
Multi-functional soft materials based on polymers and colloids

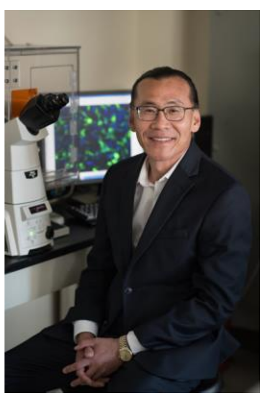


Prof. Besser
Microfluidics, fuel cells, microchemical systems

Prof. Du
Optofluidics, plasmonics, Raman spectroscopy

Prof. Kalyon
Structure and processing of complex fluids, polymer rheology

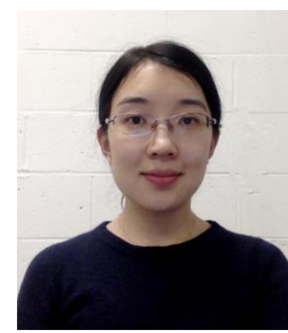
Prof. Lawal
Biofuels, catalysis



Prof. Lee
Microfluidic-based human tissue models, graphene oxide biosensors

Prof. Libera
Transmission electron microscopy, polymeric biomaterials and hydrogels

Prof. Podkolzin
Chemical kinetics and reaction mechanisms on catalytic nanoparticles



Prof. Tian
Photonics, optical fibers for biological sensing

Q/A

FIN

Please remember to sign in