
Biomolecular Engineering
Materials and Interfaces
Undergraduate Research Opportunities
Department of Chemical & Biomolecular Engineering
Environmental Engineering
Energy Applications

Research for Pay:
The EXCEL Scholars Program

- Lafayette's EXCEL Scholars Program enables high-performing students to **assist faculty members with their scholarship**. The purpose of the EXCEL Program is to **encourage collaboration in learning between faculty and students**. The work of the student must, therefore, be research-oriented and not administrative in its primary emphasis. EXCEL Scholars may work part-time during the academic year or full-time during the Summer and the Interim Session.

- Participation in the EXCEL Program is an honor reserved for those students who have achieved distinction in their academic program at Lafayette. To be eligible as an EXCEL Scholar, students should have completed their first year at Lafayette and should maintain a cumulative GPA of 3.25.

http://researchsupport.lafayette.edu/research-by-students/

Research for Pay:
Clare Booth Luce Scholars Program

- "Since it's inception in 1989, the Clare Boothe Luce Program has been one of the most significant sources of support for women seeking to study or teach science, engineering, and mathematics."

- Participation in the CBL Program is an honor reserved for those **female** students who have achieved distinction in **engineering** at Lafayette. To be eligible as a CBL Scholar, students should have completed their first year at Lafayette, be a US Citizen, and should maintain a cumulative GPA of 3.25.

- Students submit a written application to **engineering@lafayette.edu**
  - Personal Statement (what, how, who, why)
  - Recommendation from any Faculty Member

Research for Credit: CHE 392/293: Independent Research

- Independent Research in Chemical Engineering serves to provide students with a **high quality *hands-on* student-faculty research experience** for a range of technical topics. Before registering, a research proposal must be submitted to a faculty member who serves as the adviser and to the Scholarship Committee for approval. Each student is required to submit a course Portfolio for course credit.

- Course Hours:
  - One hour per week meeting with Instructor (minimum)
  - Ten hours per week course work (minimum)

- CHE 392/393 satisfies a free elective in chemical engineering.

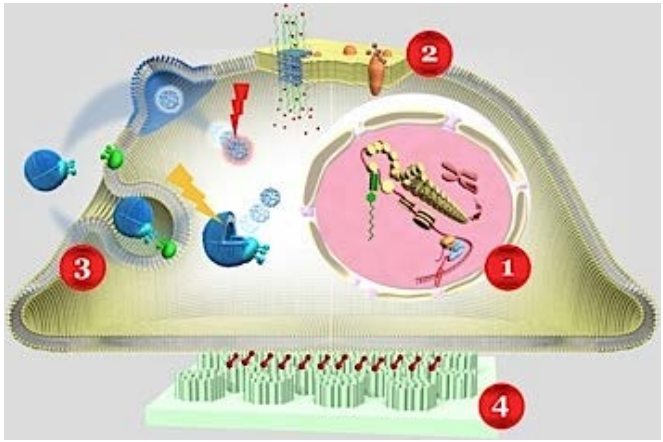
Research for Credit and Honors: CHE 495/496 Honors Thesis

- An Honors Thesis in Chemical Engineering serves to provide outstanding students with a **high quality student-faculty research experience during the senior year**. Candidates for honors must have and must maintain a cumulative GPA of 3.00 and ChBE Departmental GPA of 3.20. The specific research topic of the Honors Thesis should be discussed well in advance of the senior year with the Instructor.

- Course Hours:
  - One hour per week meeting with Instructor (minimum)
  - Ten hours per week course work (minimum)

- CHE 496 satisfies a chemical engineering elective.

Engineering the cell-surface interaction

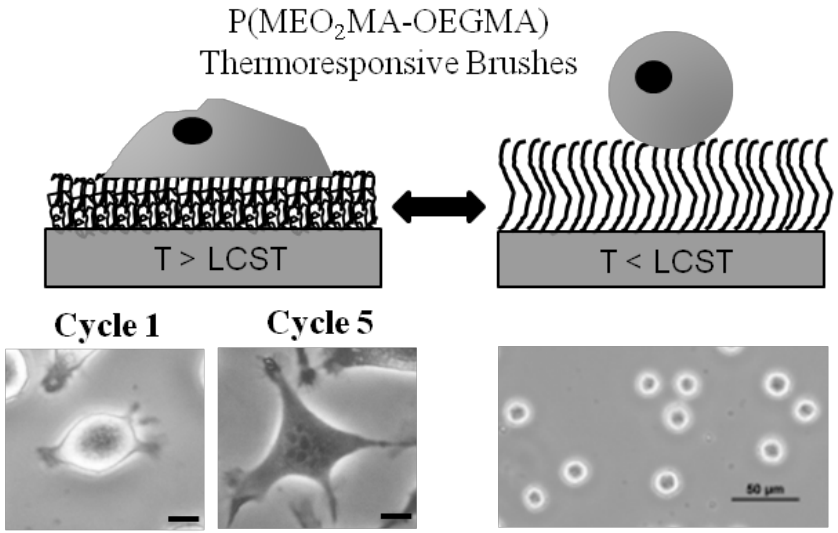


DNA → RNA → PROTEIN

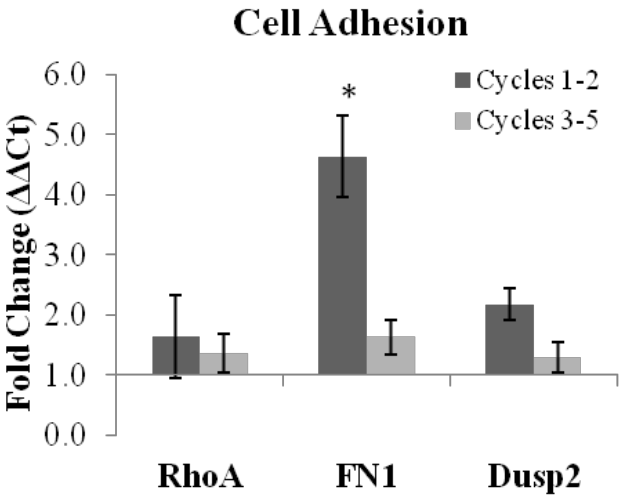
- ***Overarching principle:*** *Manipulate biomaterial properties, (bulk: modulus; surface: chemistry, topography), to selectively control the cell-material interaction.*

- For the relevant cell type, evaluate the following parameters on the biomaterial:
  - Cell morphology: microscopy, image analysis (spreading, circularity)
  - Cell adhesion: microscopy, immunofluorescence, adhesion assays
  - Cell differentiation: gene and protein expression, soluble signaling
  - Cell proliferation: DNA quantification
  - Cell-vitality: live/dead quantification using ViCell

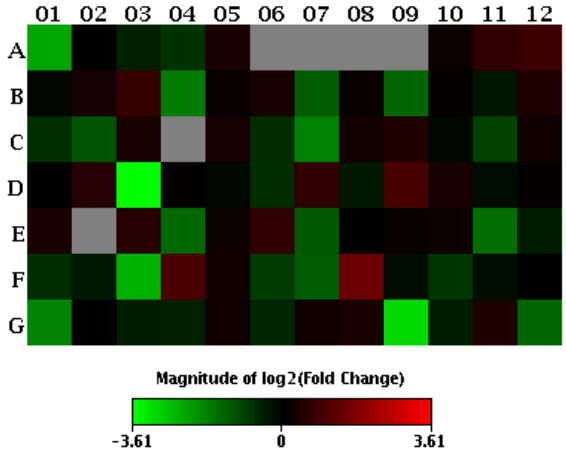
Thermoresponsive Polymer Brush Fabrication and Cell Culture



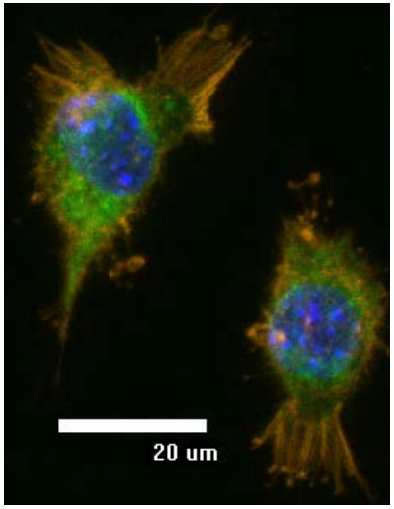
Gene Expression by Real-time RT-PCR



Mechanistic Cell Adhesion Analysis using mRNA Microarrays



Cell Morphology by Confocal Microscopy



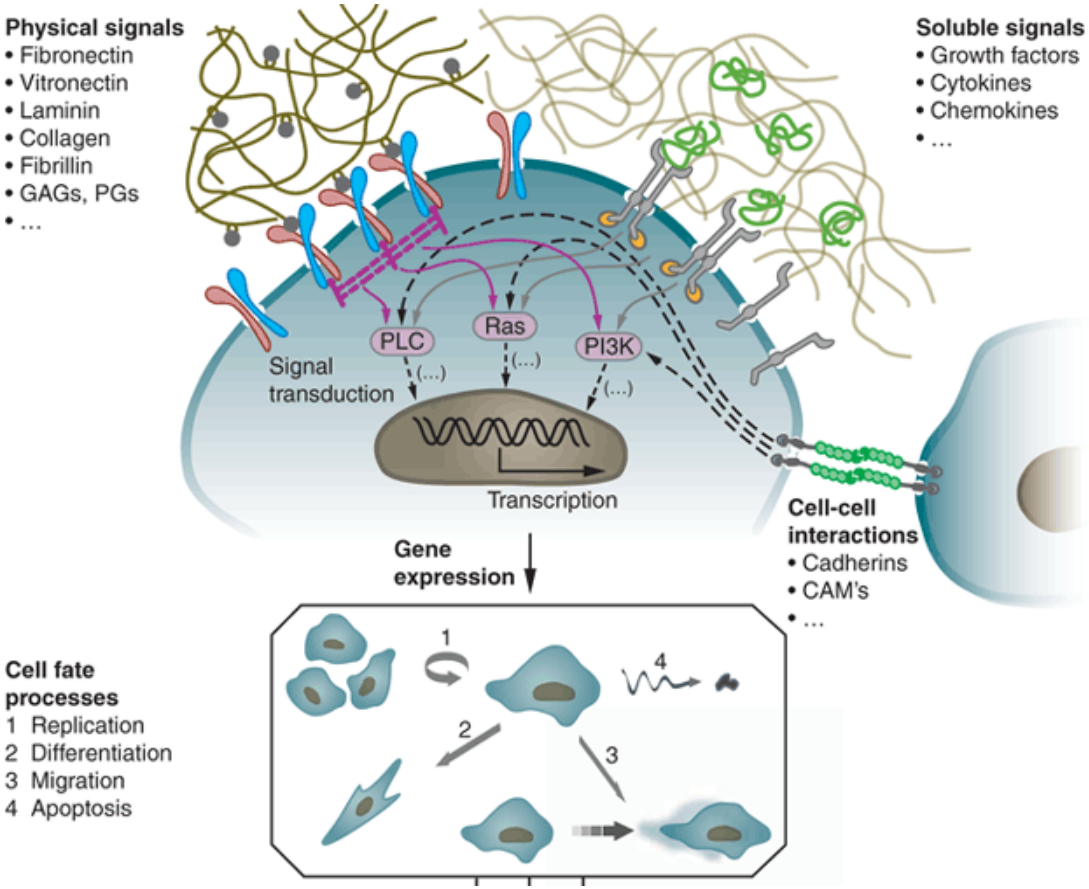
What skills will I learn?

- Sterile cell culture
- Real-time RT-PCR
- Microscopy (phase contrast, confocal)
- Polymer fabrication (nanofibers, microspheres, 2D films)
- UV-vis spectrophotometry

What positions are open?

- Summer 2016
  - EXCEL Scholars
  - Clare Booth Luce (female engineers)
- AY16/17 by discussion

Investigation of protein expression and cell function in biomolecular engineering applications



INPUT TO CELL

GENE EXPRESSION

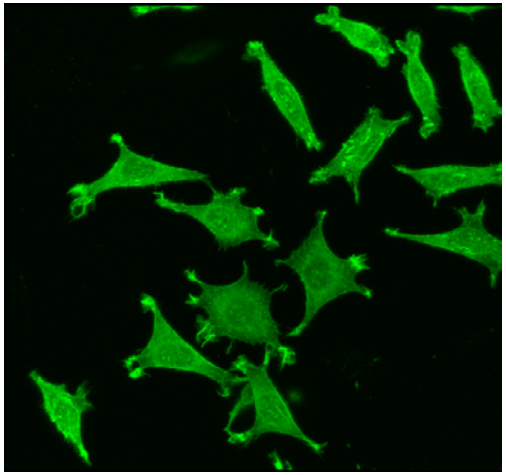
PROTEIN EXPRESSION

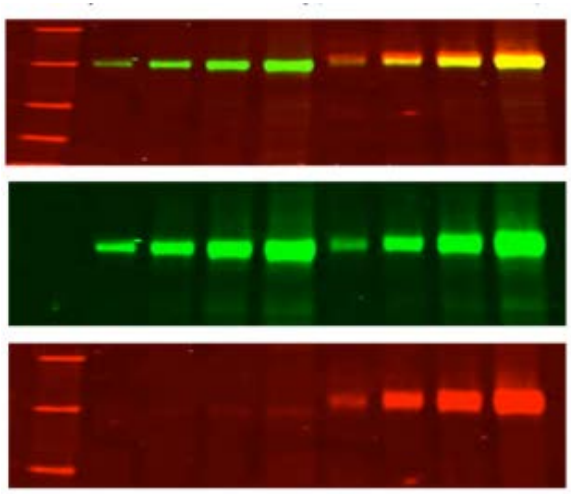
CELLULAR RESPONSE

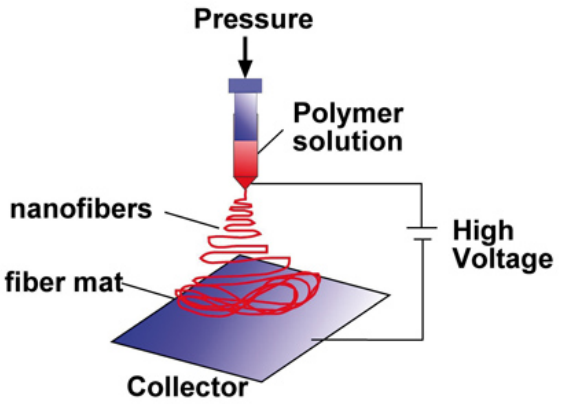
Central question: How does the regulation of cell protein expression affect cell function and inform the engineering of better materials?

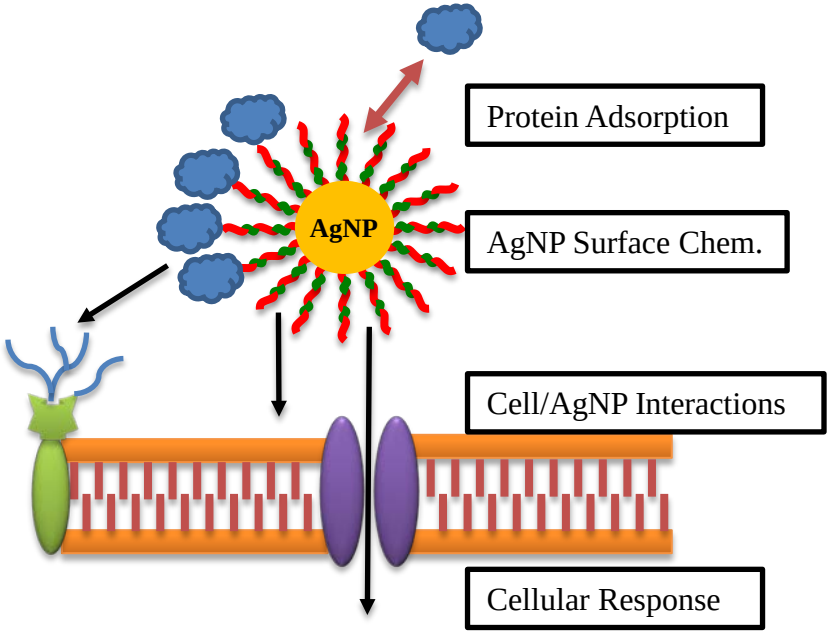
Cellular and Proteomic Responses to Engineered Materials

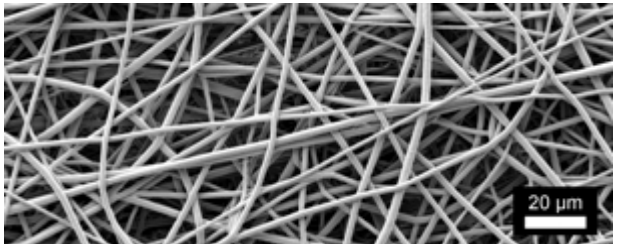
Cell/Biomaterial Interactions

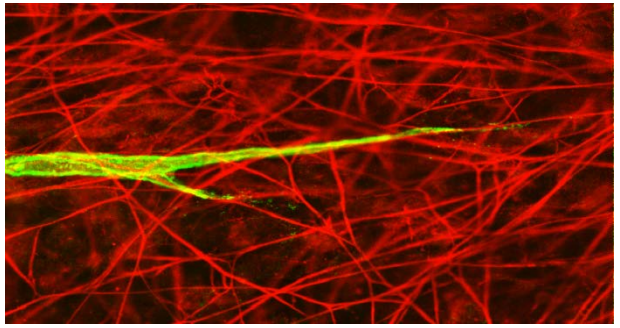












Experimental skills:

- Sterile cell culture
- Immunohistochemistry
- Confocal microscopy
- Protein electrophoresis and western blot
- Fluorescence spectroscopy
- In vitro cell function assays

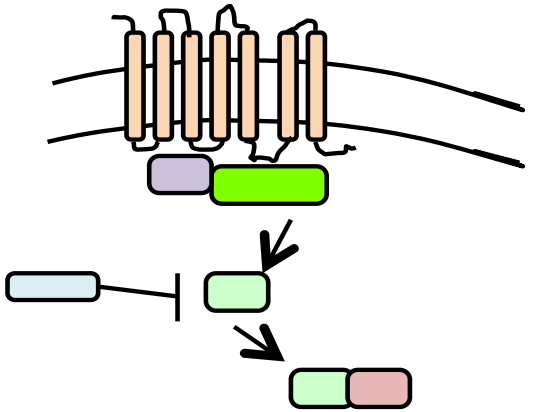
Availability:

- Honors Thesis: AY 2016-2017 (Juniors)
- EXCEL/CBL: AY 2016-2017 (Soph/Juniors)

Doolan

Protein-Protein Interactions

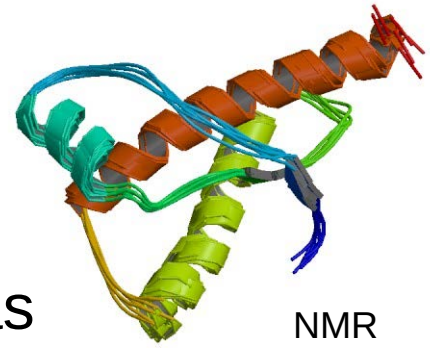
- Cell Adhesion
- Metabolic Regulation
- Antibody Therapeutics
- Neurodegenerative Disease



Neurodegenerative Diseases

Alzheimer's, Parkinson's, Huntington's, CJD

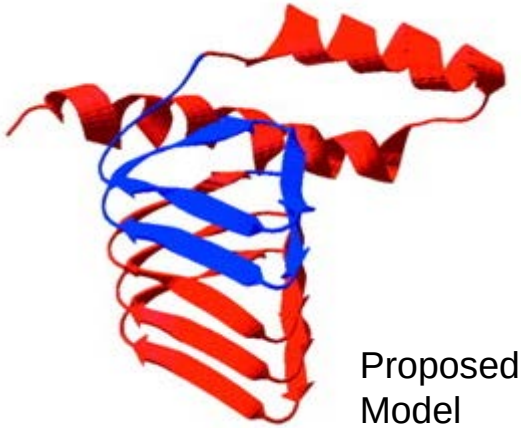
Disease conformation acts as template for converting native form to disease form



NMR

PrP^{C}

James *et al. PNAS* (1997)



Proposed Model

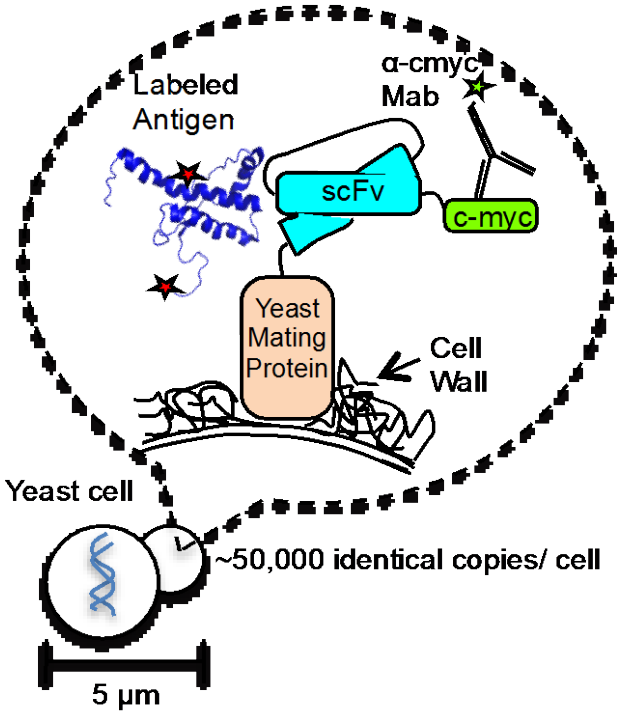
PrP^{Sc}

Wille *et al. PNAS* (2002)

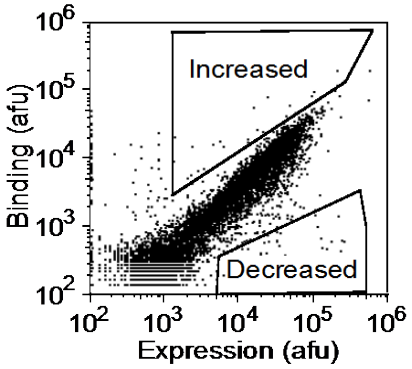
Doolan

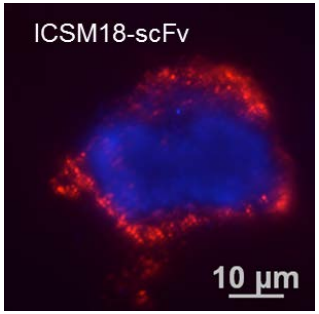
High-throughput design and characterization

CELL SURFACE DISPLAY

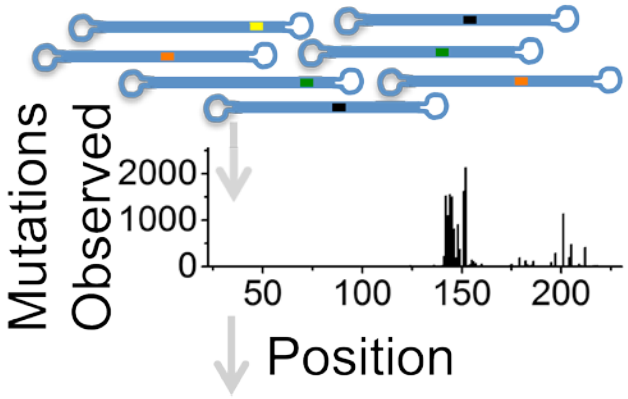


FLOW CYTOMETERY/ FLOURESCENT MICROSCOPY





NEXT-GENERATION SEQUENCING



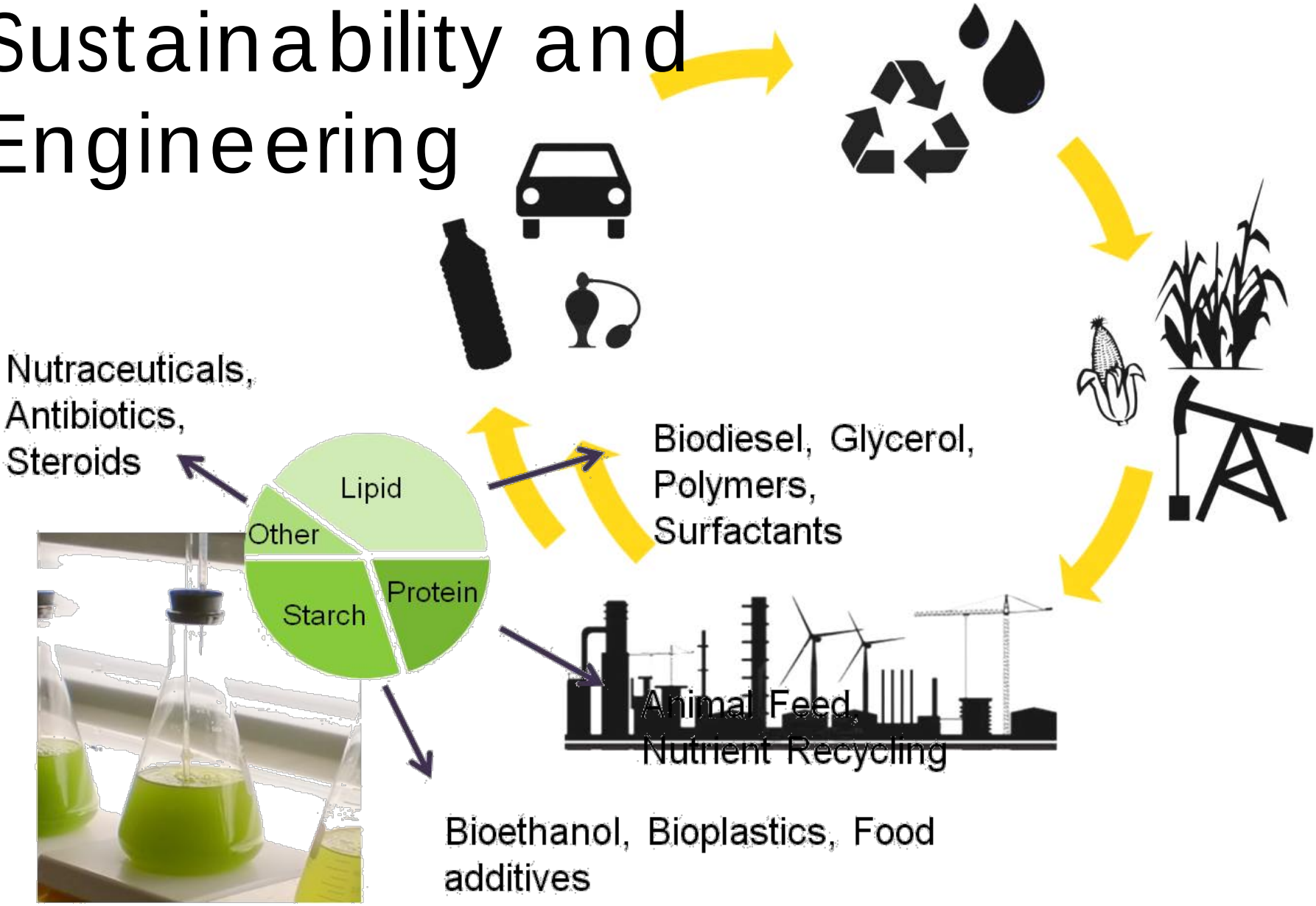
Identify solution, amino acid and conformation specific determinants of protein fitness landscape and isolation of "improved" function proteins

Doolan
Experimental Skills and Availability

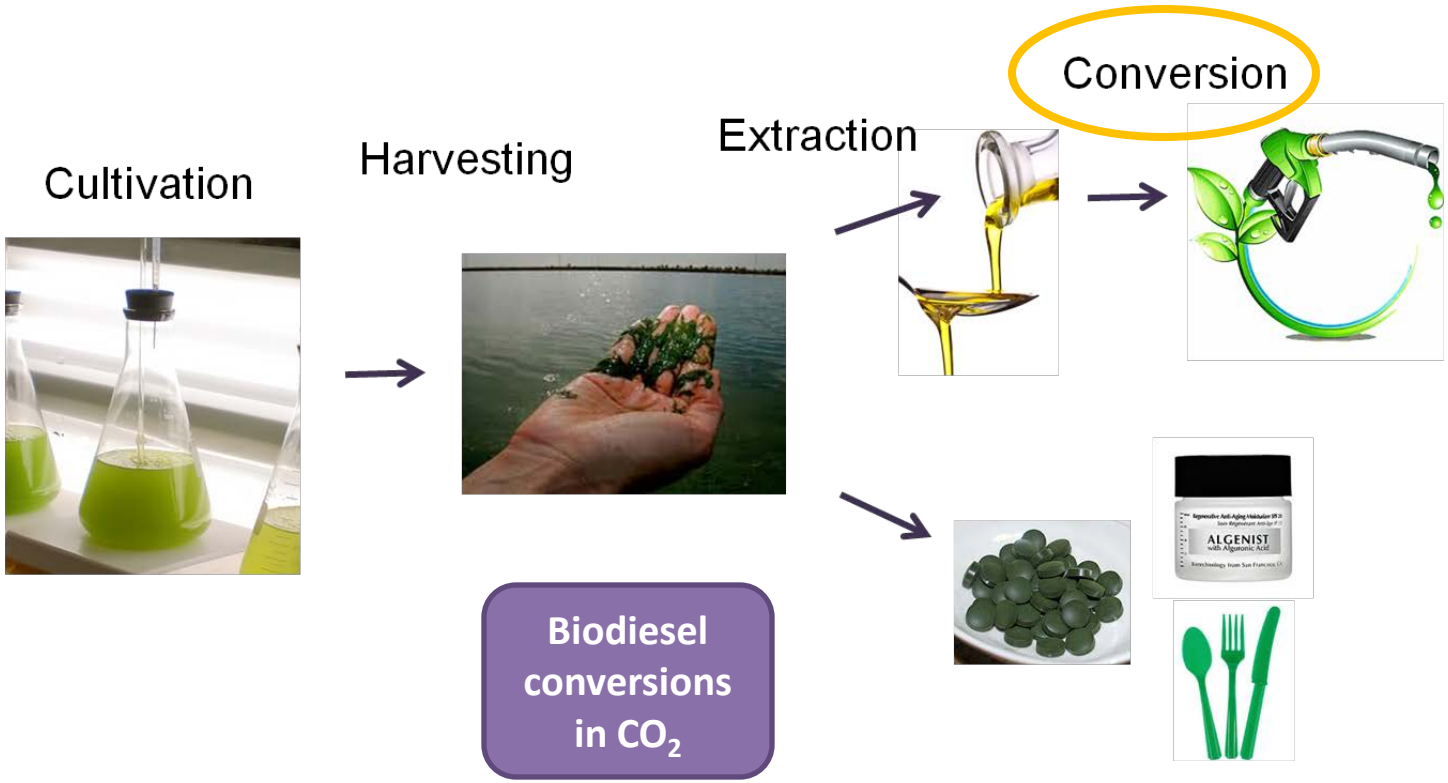
- Cell culture
  - bacterial, yeast, and mammalian cells
- Recombinant DNA Technology
  - PCR
- Yeast Surface Display
  - Immunolabeling and Confocal Microscopy
- Bioinformatics
  - Deep Sequencing and Data Analysis

Opportunities available:
EXCEL and Clare Booth Luce scholars (2 for SU 16)

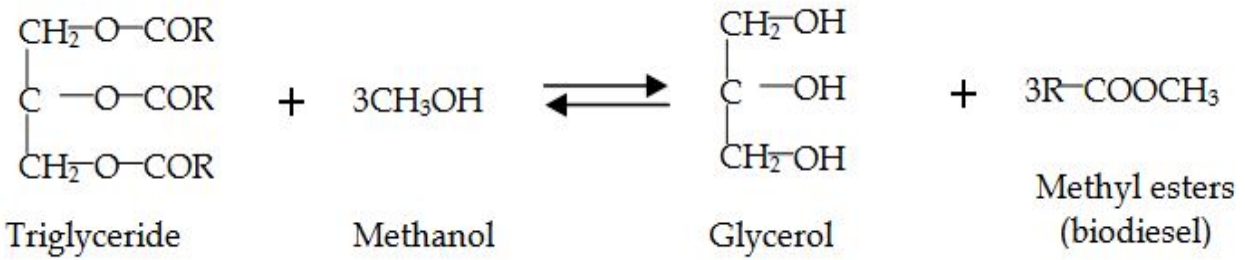
Sustainability and Engineering



Biodiesel Production Process



Biodiesel conversions in CO_2

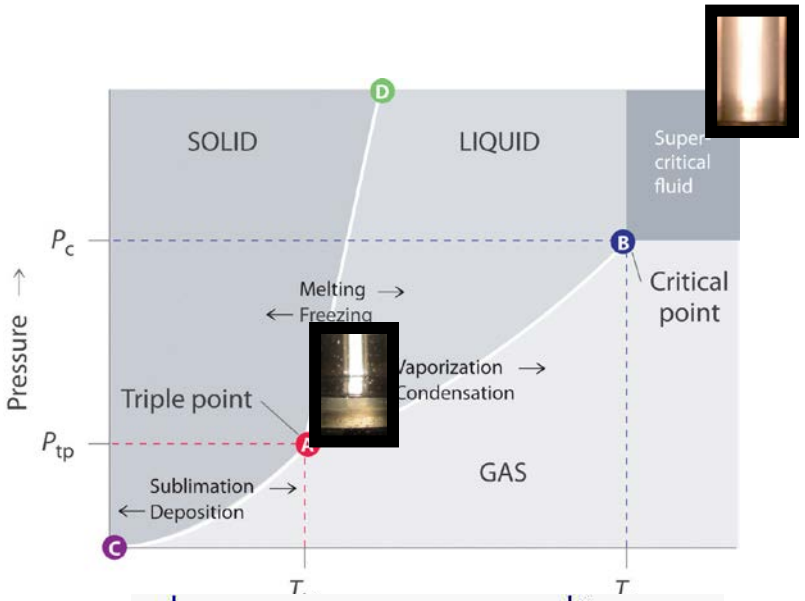


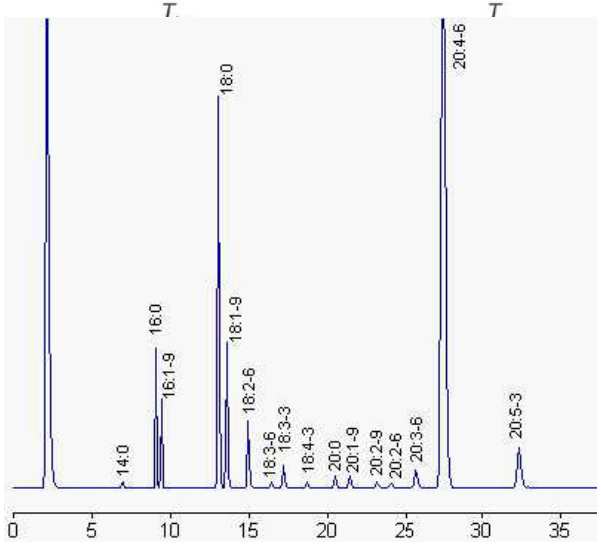
Biodiesel cold flow properties

Skills and Availability

Skills

1. Experimental Design
2. Reactions at ambient and supercritical conditions
3. Gas chromatography
4. Differential Scanning Calorimetry





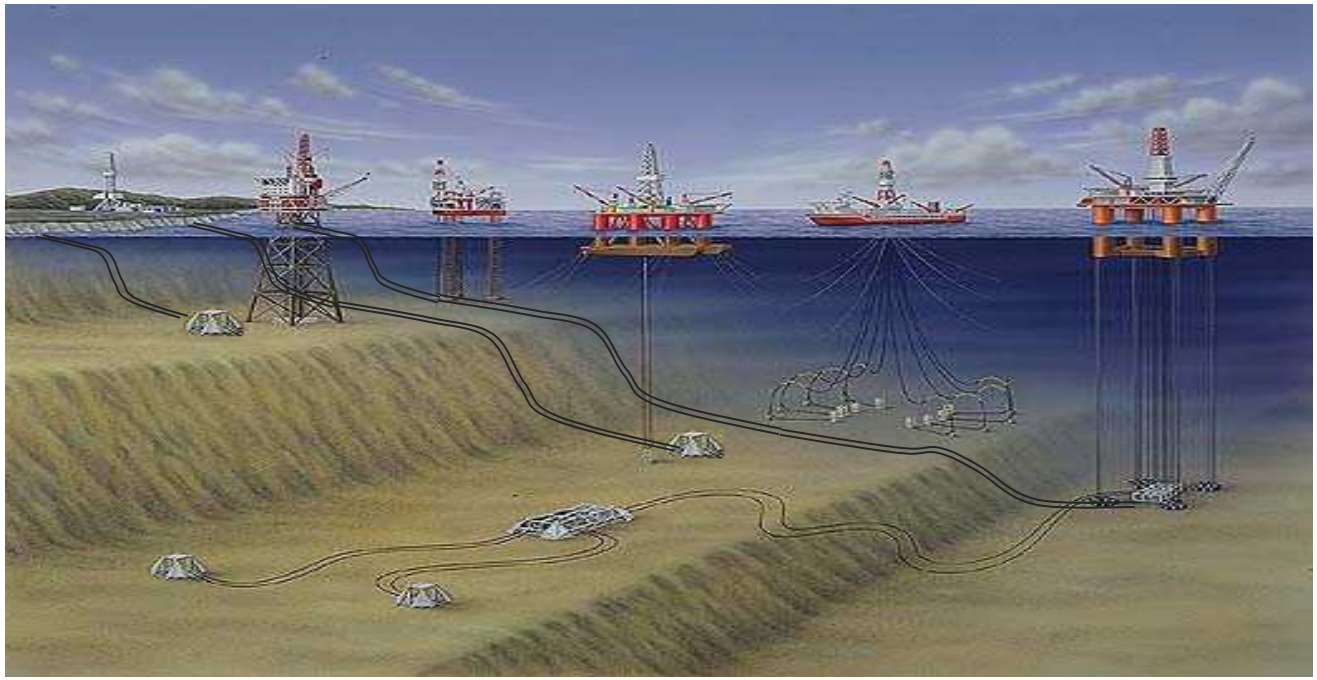
Availability

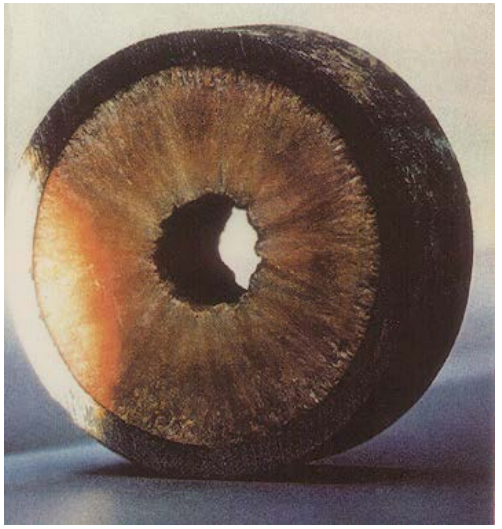
Excel Scholars (SU16, AY(16)-17)
Honor's Thesis (AY16-17)
Independent Study (Spring17)

Green Faculty Collaboration

- A major disadvantage of using biofuels is **cold flow properties**.
  - Impacts ability for engines to run
- Interested in how particular components of oils and additives influence cold flow properties.

Keeping Things Flowing Under the Sea…

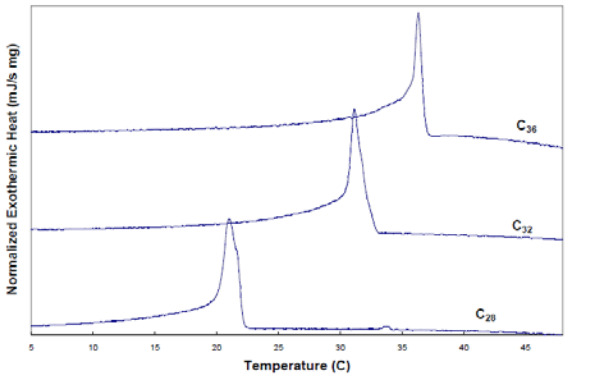




- Issue faced in petroleum transportation
  - Cold water temperatures → crystallization (cloud point) → deposition and gelation (pour/gel point)
  - Chief component of deposits: n-alkanes (waxes)
  - Impacted by presence of other materials

Equipment/Skills

- Conducting measurements of flow properties important in the energy industry.
- Rheometry
- Differential Scanning Calorimetry



Opportunities available:

EXCEL/CBL scholars (SU 16 and AY 16-17)

Honors Thesis and Independent Study (AY 16-17)

Polly R. Piergiovanni

Current Research Interests

- Development of experiential activities in food engineering
- Kinetics of dye – textile adsorption
- Developing engineering students' critical thinking skills

Independent Study Projects available for Fall 2016

Research Interests

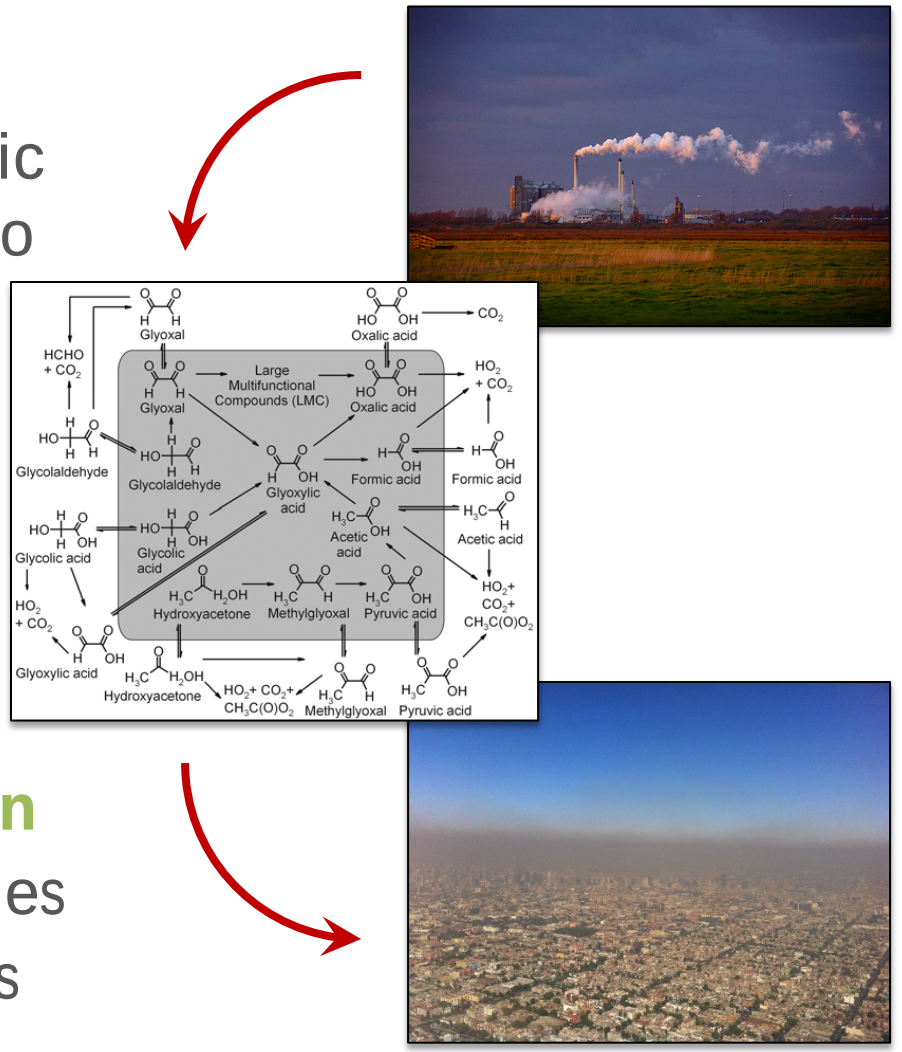
Polly R. Piergiovanni

- Adsorption thermodynamics and kinetics

Atmospheric Aerosol Chemistry

Impetus:

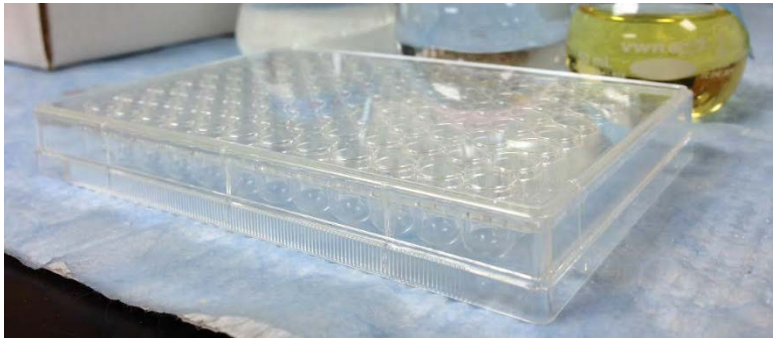
Accurate prediction of organic aerosol chemistry is crucial to understand its **effect on atmospheric chemistry** and overall **contribution to climate change**.

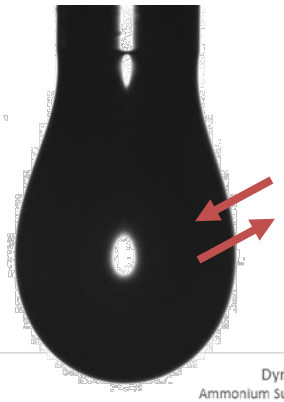


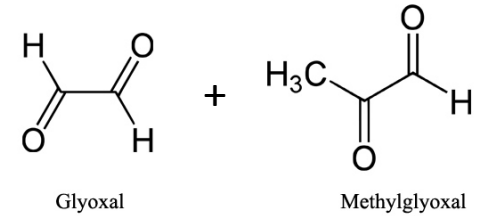
What we need to know:

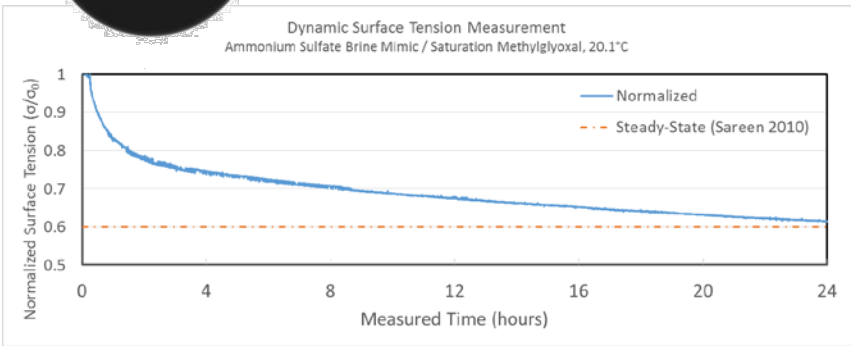
- Relative **rates of formation**
- **Light absorbance** properties
- **Surface tension** properties

ATMOSPHERIC AEROSOL CHEMISTRY





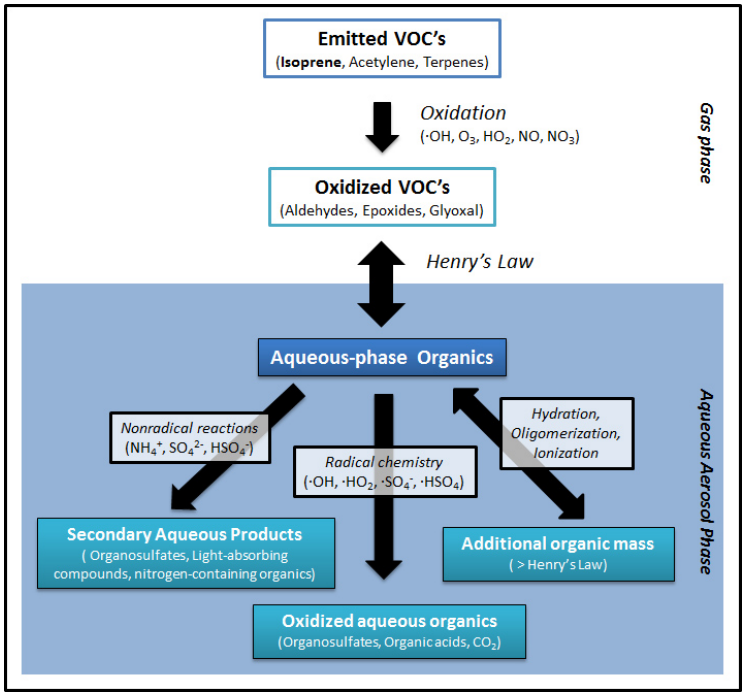




Experimental Work:

- Measurement of **light absorbing cross-products** from water-soluble organics
- Dynamic **surface tension studies** of water-soluble volatile organics
- **Research opportunities available!**

Atmospheric Aerosol Chemistry



Computational Work:

- Developed and operated on **MATLAB**
- Refinement and improvement of **mass uptake** coefficients, **reaction rate** constants
- Aerosol **absorbance and surface tension models** from experiments
- **Research opportunities available!**

Input parameters
[E], [d], [y_0], RH, pH, T, wL
[k_{photo}], [t_span]

→

GAMMA
[k_{gas}], [k_{aq}]

→

Output values
[y]

[y] = [y_0]

Predicted gas concentrations, Aqueous phase SOA (aqSOA) mass

Uses MATLAB ODE solver [ode15s] to follow time dependence of tracked species.

IDEAL

INNOVATION • DESIGN
ENTREPRENEURSHIP
AND • LEADERSHIP

Mission :

The IDEAL Center for Innovation serves a platform for engaging **external partnerships** and facilitating experiential learning to showcase the **connection** between the liberal arts and engineering unique to Lafayette with **impact** beyond the academy.

Find out more: ideal.lafayette.edu

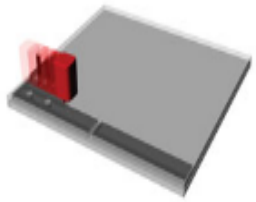
Additive Manufacturing Institute

Additive Manufacturing Institute (AMI)

Digital part materialization for the community, the region, and the nation

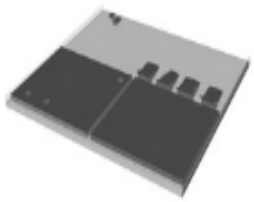
The Additive Manufacturing Institute (AMI) at Lafayette College is a resource for digital part materialization for the community, the region, and the nation. In cooperation with the Exone Company, the AMI promotes widespread adoption of additive manufacturing and provides hands-on demonstrations with student teams and faculty to foster familiarity and commercial application of innovative additive manufacturing technologies.

The AMI meets the needs of students, entrepreneurs, and potential industry adopters using state-of-the art 3D printers through workshops, seminars, Maker Meet-ups, and design challenges hosted by AMI. These experiences prepare students for innovative work environments while growing the entrepreneurial ecosystem at the College.



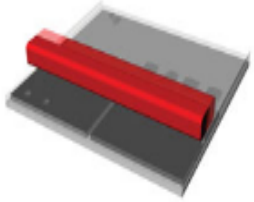
1. Print

Selectively dispense binder using inkjet printing technology



2. New layer

The build platform is lowered by a set increment.



3. Spread

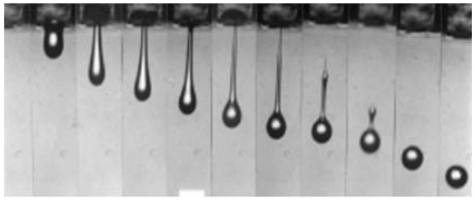
Spreads a new layer of powdered metal.

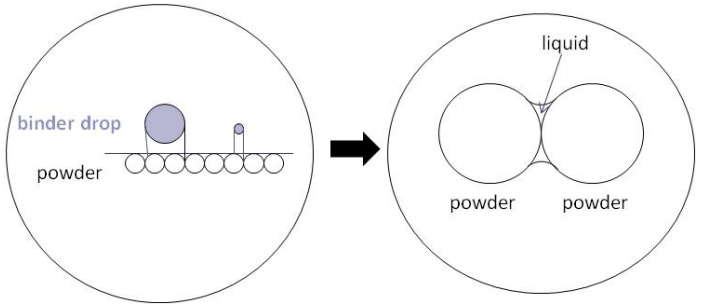
4. Repeat

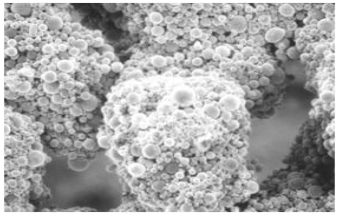
Repeat Steps 1-3, until the part is built.

5. Finishing

Unbound metal is removed. Metal parts are thermally processsed.







[ExOne Prometal Printing Process]

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

FOREIGN LANGUAGES
AND LITERATURES

CIVIL ENGINEERING

COMPUTER SCIENCE

INFORMATION
TECHNOLOGY SERVICES

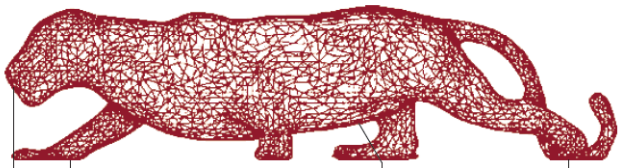
SKILLMAN LIBRARY

IDEAL IPrize 2016

sustainability challenge

Grand Prize $5,000
First Prize $2,000
Second Prize $1,000

prizes are externally sponsored



The IPrize challenge of the IDEAL Center seeks to inspire the Lafayette Community to explore collaborative opportunities connecting liberal arts and engineering.

The 2016 IPrize focuses on sustainability; each entry must address Economic Growth and one other United Nations Sustainable Development Goal. IPrize entries can be based on an original idea or from a list of sponsored challenges.

March 31 Registration closes
April 30 Submission deadline

ideal.lafayette.edu/IPrize

Leopard LIDAR:	MBY
Drawn by:	ADC
QA:	DCA
MFG:	CBC
Approved:	JKF
Checked:	

The IDEAL Center for Innovation

email: ideal@lafayette.edu

twitter: @IDEAL_Lafayette

Size	DWG No.	Rev
B	Laf_IPrize_2016	1

Scale 1:2 | Sheet 1 of 1

I’m interested…What do I do next?

- **Summer EXCEL and CBL Scholars (pay)**
  - SU 16: Talk to faculty ASAP; deadline March 7.
  - AY 16/17: Decision by late summer
- **Independent Research (credit only)**
  - AY 16/17: Limited to faculty availability; discuss with faculty over the summer.
- **Honors Thesis (seniors only, credit only)**
  - Plan early
  - For non-seniors, get research experience