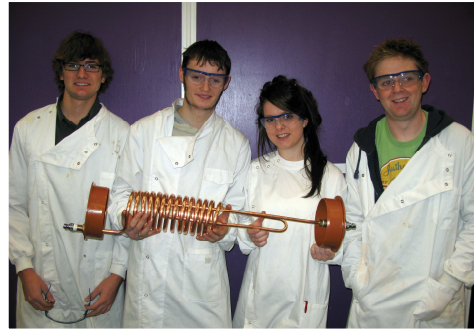
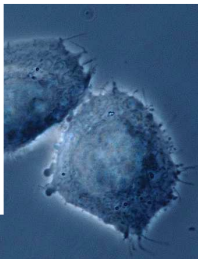
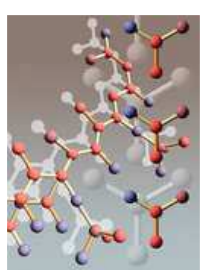


# Chemical & Bioprocess Engineering



...bringing science to life

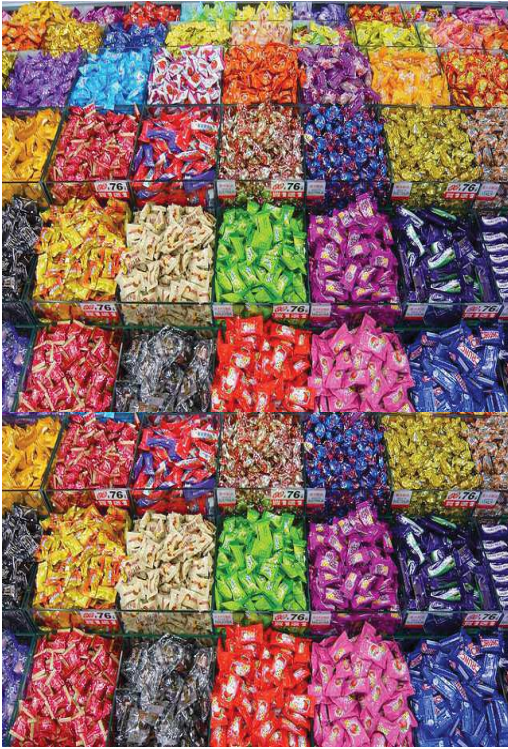
# UCD Chemical & Bioprocess Engineering



**'Make your mind up' time.....**

**Dr. Ioscani Jiménez del Val**  
[ioscani.jimenezdelval@ucd.ie](mailto:ioscani.jimenezdelval@ucd.ie)

## Where to... after Stage 1 Engineering...?

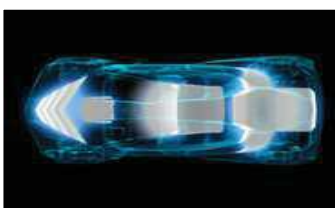


- **Chemical & Bioprocess Engineering**
- Engineering with Business
- Energy Systems Engineering
- Biomedical Engineering
- Mechanical Engineering
- Electronic & Electrical Engineering
- Biosystems Engineering
- Civil Engineering

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## Is Chemical & Bioprocess Engineering for YOU?



[www.ucd.ie/eacollege/chembioeng/](http://www.ucd.ie/eacollege/chembioeng/)

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# What skills do *all* Engineers need...?

Fundamental understanding of physical phenomena

Logical, analytical, numerical approach

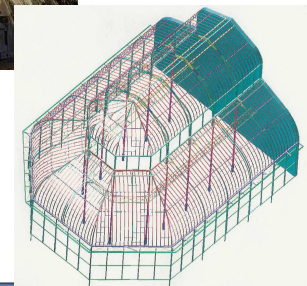
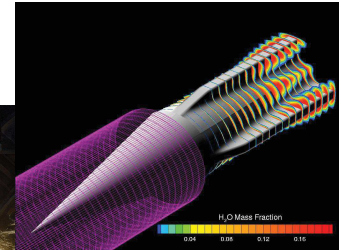
Communication skills

**Creativity**

Teamwork

Ability to view problems in context

A capacity for life-long learning



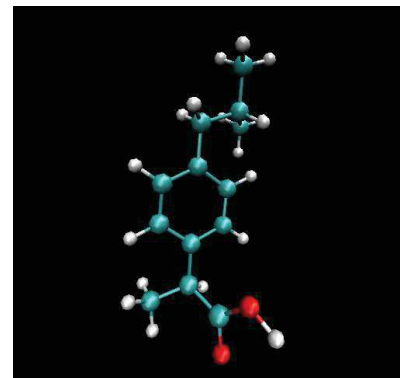
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# Applying Chemical & Bioprocess Engineering skills?



**isobutylbenzene**



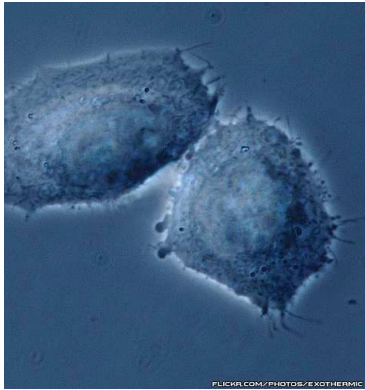
**ibuprofen**



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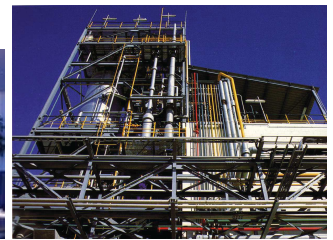
# Applying Chemical & Bioprocess Engineering skills?



**Chinese Hamster Ovary (CHO) Cells**



**ENBREL®**



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# Applying Chemical & Bioprocess Engineering skills?



**laboratory**



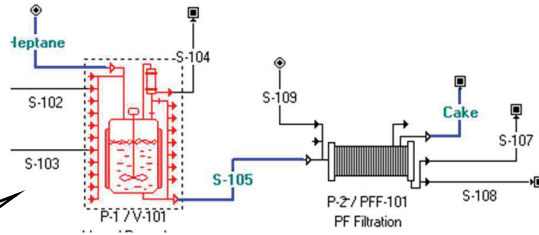
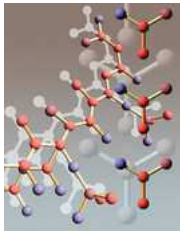
**production-scale**



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# What do Chemical & Bioprocess Engineers do?



process development,  
scale-up & design

plant design,  
construction, operation,  
management



production



UCD Chemical & Bioprocess Engineering

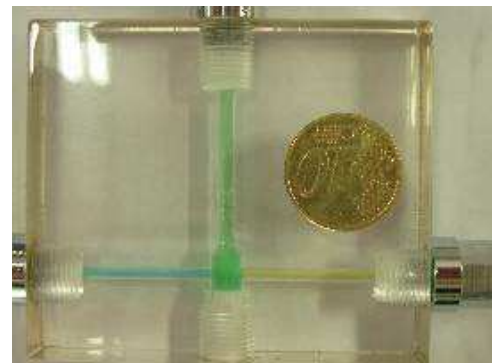
...bringing science to life

# Applying Chemical & Bioprocess Engineering skills?

## Making processes more efficient?



existing reaction  
equipment



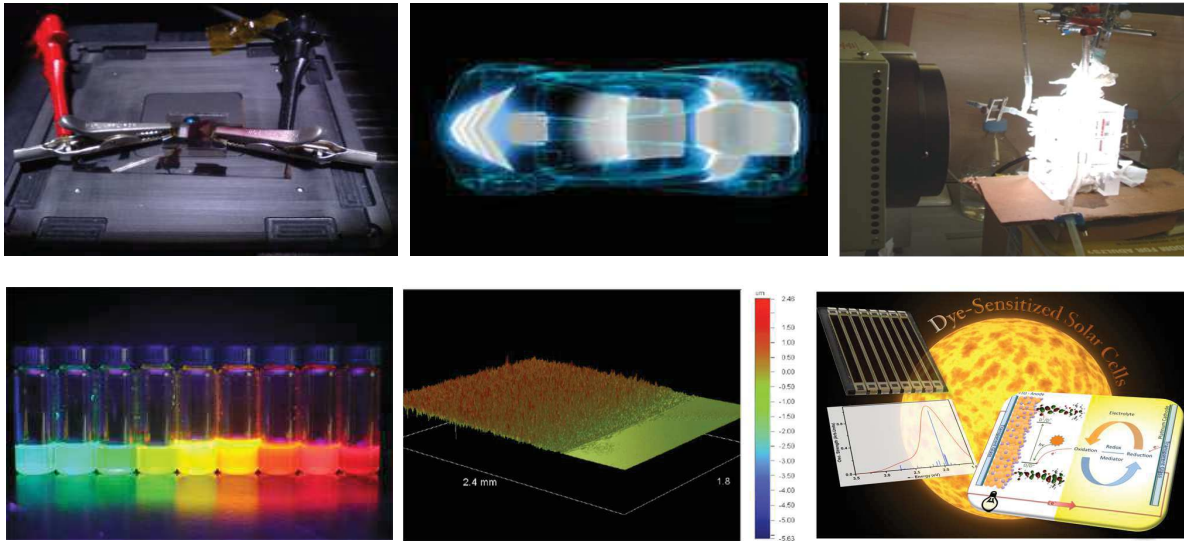
UCD-developed  
alternative

UCD Chemical & Bioprocess Engineering

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# Applying Chemical & Bioprocess Engineering skills?

## Developing new processes and materials?



## Solar Energy

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# World leaders in Energy from UCD ChemE?



**David O'Reilly**  
BE (1968)

**Eddie O'Connor**  
BE (1970)



**Martin McAdam, BE (1982)**



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## After graduation?

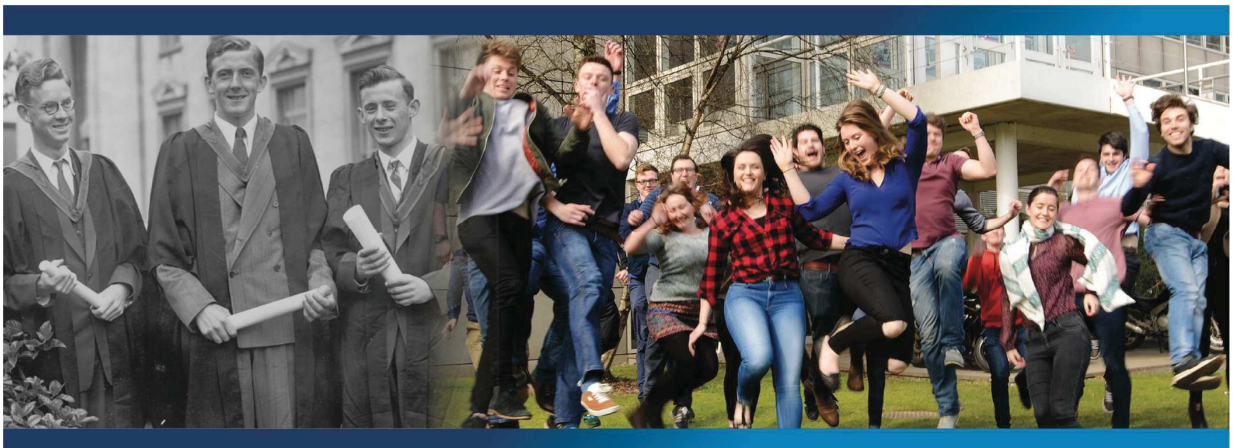


MSD, Ballydine, Co. Tipperary

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## UCD ChemE Graduates: Where are they?



1956-2017: >1500 graduates

Destination  
by location



70%



10%



10%



5%

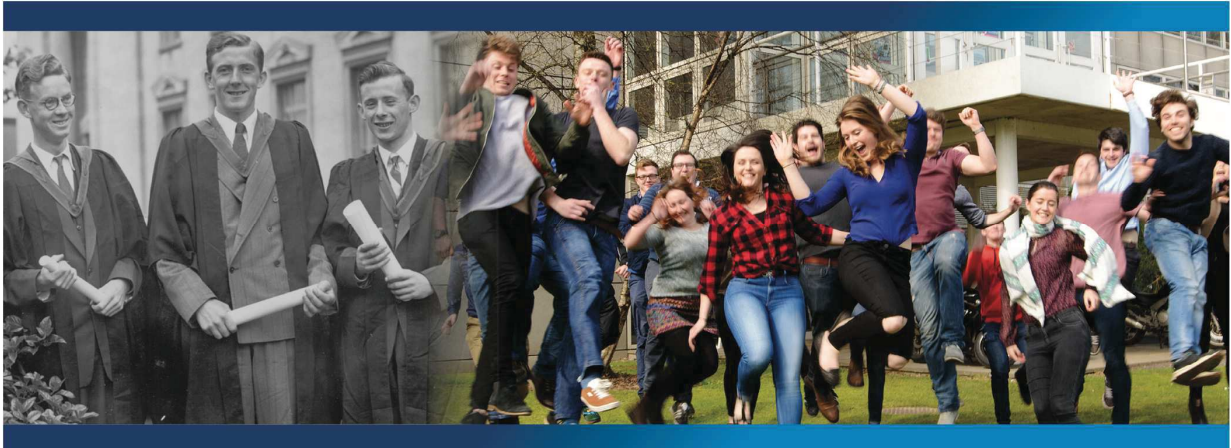
Rest of  
World

5%

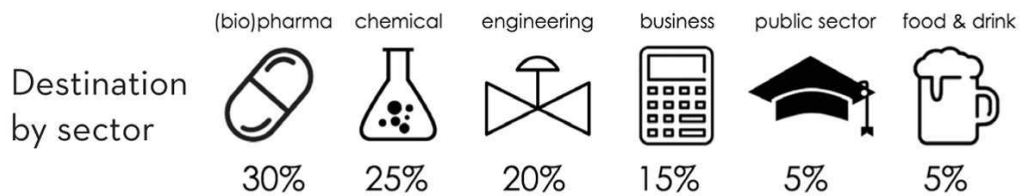
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# UCD ChemE Graduates: Where are they?



**1956-2016: >1500 graduates**



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## Bio/Pharmaceutical Industry in Ireland

- 9 of the world's top 10 Pharmaceutical and Biotechnology companies
- Annual exports exceeding €50 billion
- Employment over 23,000 50% graduates



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## Chemical & Bioprocess Engineering Class of 2015



**Where are they now?**

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## Chemical & Bioprocess Engineering Class of 2015



**Working in Industry – in Ireland**

APC, AbbVie, BioMarin, BMS, Diageo, Eli Lilly, Exxon Mobile, FDT, Glanbia, Irish Cement, Jacobs Engineering, MSD, Pfizer, PM Group, Sanofi-Genzyme

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## Chemical & Bioprocess Engineering Class of 2015



### Working in Industry – in Ireland

APC, AbbVie, BioMarin, BMS, Diageo, Eli Lilly, Exxon Mobile, FDT, Glanbia, Irish Cement, Jacobs Engineering, MSD, Pfizer, PM Group, Sanofi-Genzyme

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## Chemical & Bioprocess Engineering Class of 2015



### Working in Industry – in Ireland

APC, AbbVie, BioMarin, BMS, Diageo, Eli Lilly, Exxon Mobile, FDT, Glanbia, Irish Cement, Jacobs Engineering, MSD, Pfizer, PM Group, Sanofi-Genzyme

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## Chemical & Bioprocess Engineering Class of 2015



### Working in Industry – overseas

Aki Technologies [US], Diageo [UK], Exxon Mobile [UK], Glanbia [US]

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## Chemical & Bioprocess Engineering Class of 2015



### Further Studies

**PhD:** UCD (2), University College London (2) **[all fully funded]**

**Masters:** Biopharmaceutical Eng, Actuarial Studies, Management

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## Chemical & Bioprocess Engineering Class of 2015



### Something different!

Trader [Citi Bank, UK], Consultants [Accenture, Ireland],  
Business [Stripe]

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## Alternative Career Paths...?



### Oliver Tattan [BE, 1985]

Former CEO ITB, VHI, Vivas Healthcare  
Founder, Director, Insurance  
Regulatory Capital



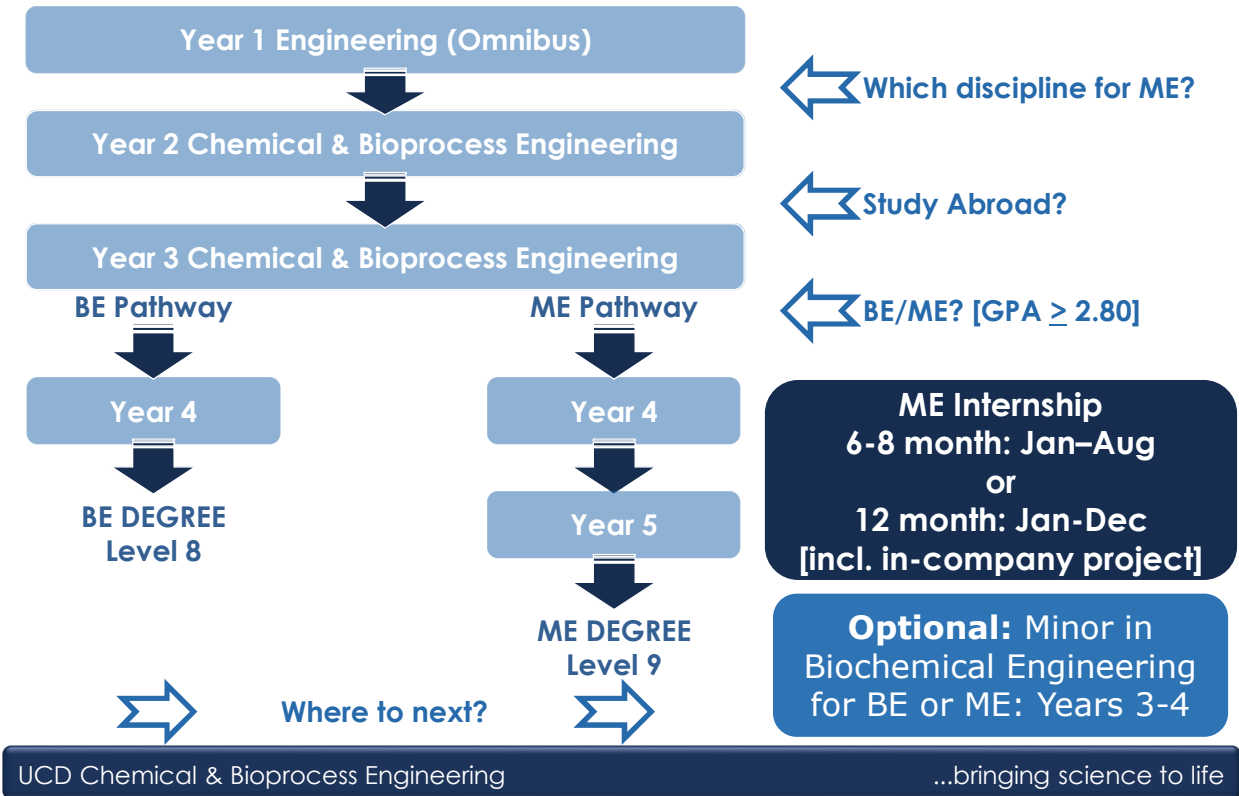
### Laura Dillon [BE, 2001]

McKinsey  
Harvard MBA  
Venture Capital  
now VP Transacting,  
Riverside Partners  
Europe

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# ChemE: BE & ME Programme Structures



# What do our students say?



BE Chemical & Bioprocess Engineering Class 2017

Hear from our current final years...



**ALICE BRENNAN**  
BE 2018



**SANDI NDEBELE**  
ME 2019

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## CHEMICAL & BIOPROCESS ENGINEERING

My experiences (so far)

Alice Brennan



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# Pat McAdam Scholarship

Colorado, Summer of 2016

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## Morphology Tuning of Na<sub>2</sub>S Nanocrystals for Next Generation Batteries

Alice Brennan<sup>1</sup>, Yangzhi Zhao<sup>2</sup>, Xuemin Li<sup>2</sup>, Yongan Yang<sup>2\*</sup>, Colin Wolden<sup>2\*</sup>  
1. University College Dublin 2. Colorado School of Mines



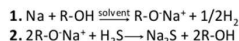
### Introduction:

- Improvements in battery technology are required to enable full deployment of renewable energy (solar, wind, etc.).
- Sodium-sulfur batteries represent an earth abundant, low cost solution to stationary storage for grid management.
- Nanostructured sodium sulphide (Na<sub>2</sub>S) is a promising material for ambient temperature storage solutions.
- Yang and Wolden developed a reactive precipitation process for synthesis using H<sub>2</sub>S and Na-naphthalenide. [1]



### Synthesis:

- The new process replaces naphthalene with alcohols, creating a two-step synthesis that enables recovery of valuable H<sub>2</sub>.



### Challenges with the new process:

- To achieve sufficient reactivity
- To control morphology
- To maximize materials utilization due to high solubility

### Goals:

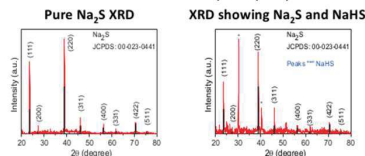
- Identify suitable alcohol/ solvent combinations
- Directly control morphology of synthesised crystals

### Parameters Explored:

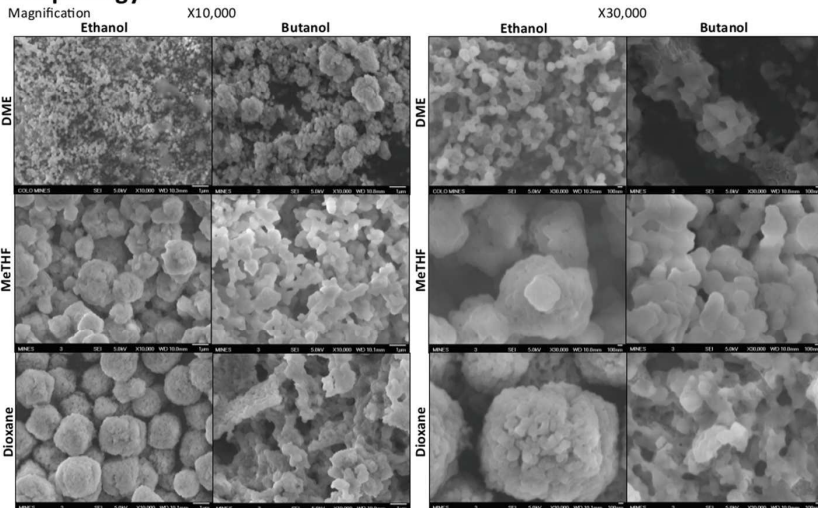
- Reagents: Ethanol, butanol, hexanol, octanol, cyclopentadiene
- Solvents: Dimethoxyethane (DME), dibutyl ether (DBE), methyltetrahydrofuran (MeTHF), dioxane
- Metrics: Reactivity, purity, morphology, utilization

### Preliminary Results:

- Cyclopentadiene eliminated as kinetics are too slow.
- DBE eliminated as solvent due to phase purity concerns.



### Morphology:



### Highlights:

- Complete H<sub>2</sub>S abatement in all cases
- H<sub>2</sub> production in all cases
- Recyclable auxiliary reagents (alcohols & solvents)
- Scalable, high purity, easy separation
- Encouraging product yield

### Conclusions:

- Ethanol and butanol can be used to synthesise Na<sub>2</sub>S
- Longer-chain alcohols are not suitable
- DME, MeTHF & dioxane are suitable solvents
- DBE did not produce the desired product
- Morphology of the Na<sub>2</sub>S nanocrystals can be tuned by changing both the alcohol and the solvent.

### Future Work:

- Assess electrochemical performance of cathodes assembled from different sized nanocrystals.
- Optimise yield by investigating solubility
- Incorporate the nanoparticles into a carbon scaffold.

### Acknowledgements and References:

I would like to express my sincere gratitude to a number of individuals and institutions for making this project possible and providing me with such a valuable research experience; Prof. Colin Wolden, Mr. Martin McAdam, University College Dublin, Colorado School of Mines and The Colorado Office of Economic Development.

[1] Li X., Morrish R.M., Yang Y., Wolden C.A., Yang Y., (2015). "Thermodynamically Favorable Conversion of Hydrogen Sulfide into Valuable Products through Reaction with Sodium Naphthalenide". ChemPlusChem, 80, 1508-1512

## Poster Presentation



## Publication

### Reactive Precipitation of Anhydrous Alkali Sulfide Nanocrystals with Concomitant Abatement of Hydrogen Sulfide and Cogeneration of Hydrogen.

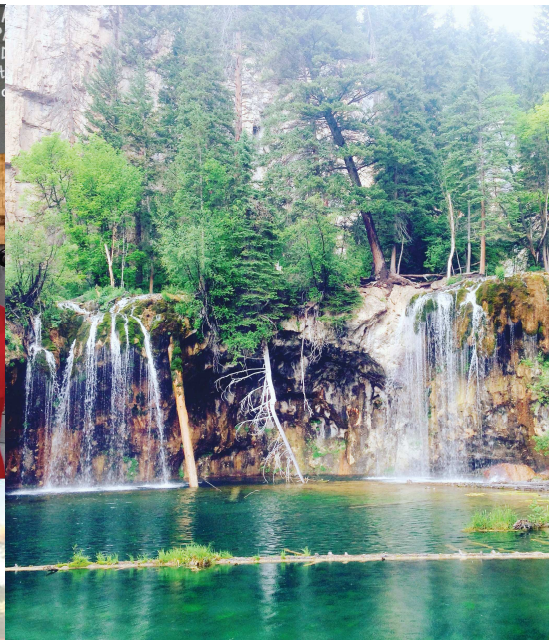
Li X<sup>1</sup>, Zhao Y<sup>1</sup>, Brennan A<sup>2</sup>, McCeig M<sup>1</sup>, Wolden CA<sup>2</sup>, Yang Y<sup>1</sup>.

#### ⊕ Author information

#### Abstract

Anhydrous alkali sulfide ( $M_2S$ ,  $M=Li$  or  $Na$ ) nanocrystals (NCs) are important materials central to the development of next generation cathodes and solid-state electrolytes for advanced batteries, but not commercially available at present. This work reports an innovative method to directly synthesize  $M_2S$  NCs through alcohol-mediated reactions between alkali metals and hydrogen sulfide ( $H_2S$ ). In the first step, the alkali metal is complexed with alcohol in solution, forming metal alkoxide (ROM) and releasing hydrogen ( $H_2$ ). Next,  $H_2S$  is bubbled through the ROM solution, where both chemicals are completely consumed to produce phase-pure  $M_2S$  NC precipitates and regenerate alcohol that can be recycled. The  $M_2S$  NCs morphology may be tuned through the choice of the alcohol and solvent. Both synthetic steps are thermodynamically favorable ( $\Delta G_m^0 < -100 \text{ kJ mol}^{-1}$ ), proceeding rapidly to completion at ambient temperature with almost 100% atom efficiency. The net result,  $H_2S + 2m \rightarrow M_2S + H_2$ , makes good use of a hazardous chemical ( $H_2S$ ) and delivers two value-added products that naturally phase separate for easy recovery. This scalable approach provides an energy-efficient and environmentally benign solution to the production of nanostructured materials required in emerging battery technologies.



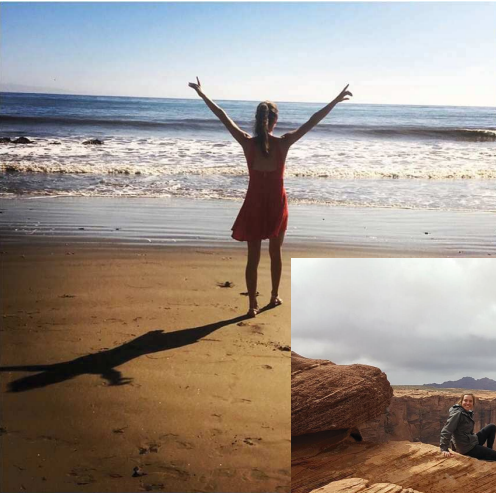


## Exchange Opportunities in 3<sup>rd</sup> Year

- Europe, United States, Australia, Asia.....
- Year/ semester long
- Maintain good GPA
- GREAT opportunity!



UCSB



## Academics

### Fall

- Fluid Transport
- Vector Calculus
- Separations
- Computational Methods

### Winter

- Heat Transport
- Thermodynamics
- Biophysics & Biomaterials
- Diet & Climate Change

### Spring

- Mass Transport
- Thermodynamics
- Reactions
- Sport Psychology



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## Career

Lots of great opportunities;

- Academia and industry
- Ireland and abroad

Food Sector:



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## Questions

- Do I need to have studied chemistry for the Leaving Cert?
- Are there only job opportunities in the pharmaceutical industry?
- Masters/BE?
- My favourite thing? Small class sizes with lots of student professor interactions

???

## CHEMICAL & BIOPROCESS ENGINEERING

My experiences (so far)

Sandi Ndebele



## What You'll Learn



- Lab Techniques
- Measurement & Data Analysis Techniques
- Unit Operations
- Heat Transfer
- Biotechnology
- Process Design, Safety, Finance and Control

## What You'll Learn

- Fluid Mechanics
- Heat Transfer
- Unit Operations
- Biotechnology
- Process Control
- Process Design
- Process Safety

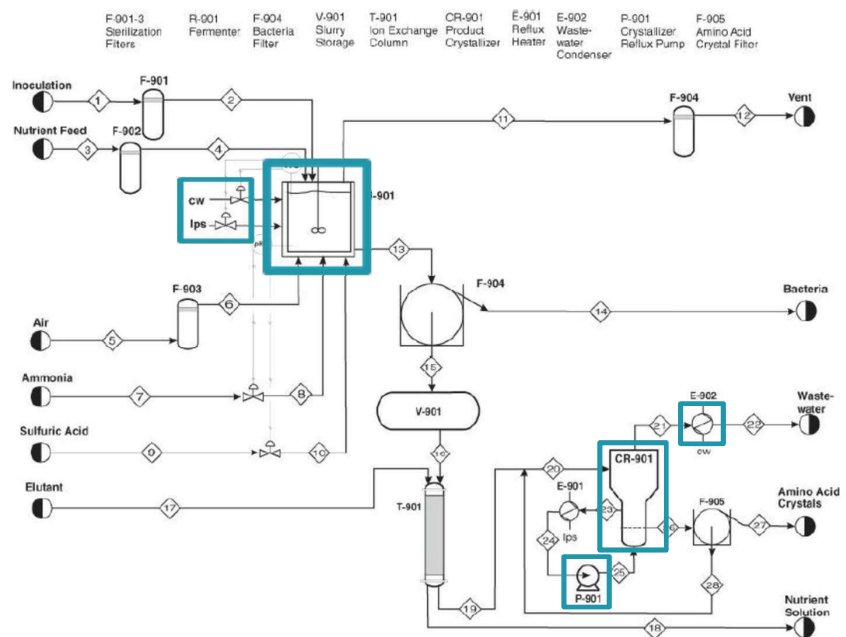
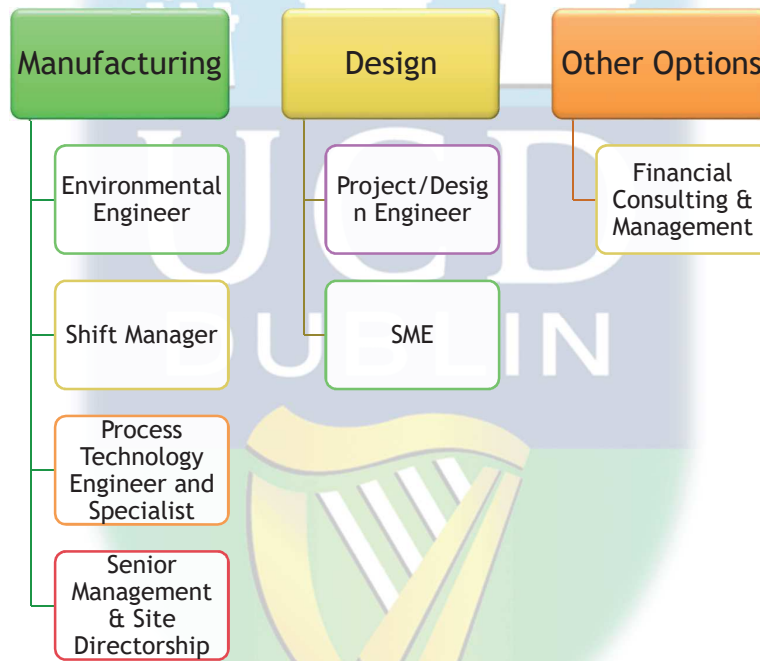


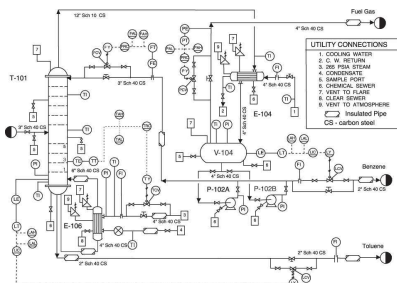
Figure 5: PFD for batch production of amino acid species.

# What You'll Use It All For



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## INDUSTRIES

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# MY EXPERIENCES



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## Work Experience

- 2 x Internships with AbbVie in Cork
- Doing Master's Internship in Sligo API facility



abbvie

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## Work Experience

abbvie

Business Excellence Intern

- Design of Reporting Tools
- Reduction of Non-Value Added Time

abbvie

Production Intern

- Process Improvement (2 Hour Reduction of process Cycle Time)
- Data Analysis & Modelling of Costs
- Process Performance Measurement

## Work Experience

abbvie

Extra Training

- Business Excellence Training
- Project Management Training
- Presentation Skills & Outlook Training

abbvie

"Extra Fun Stuff"

- Team Building (Coasteering, Swimming in Caves, Go Karting)
- Networking Dinner With Snr Mgmt Team
- Young Engineers Ireland Ball
- Money



## Work Experience

- Extremely useful industry links & networking
- Upskilling & Exposure to Non-Engineering Related Fields (Business Excellence, Supply Chain, Quality Assurance, Quality Control)
- Exposure to high level management techniques and senior management with years of experience
- Exposure to real engineering problems
- Painted my first wall and jumped off my first cliff in one summer
- Money

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## Work Experience



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## Social Aspects

- All Ireland Sports Day
- Frank Morton Sports Day
- ChemE society events

## What I Want To Do

- Graduate Program
- Travel
- Leadership Training
- Fast Track Into Management



# QUESTIONS ?