## Project title:
Air to Fuels – can direct air capture of CO2 help displace fossil fuels in transportation?

## Project duration:
10 weeks – Nov 25, 2019 to Feb 14, 2020 (2 weeks break at Christmas/New Year)

## Description:
As the world begins to take action on climate change, the transportation sector looms as one of the largest and most challenging transformations. There are two main pathways decarbonisation of this sector may be achieved. The first is electrification of transport and the decarbonisation of the electricity sector. The second involves manufacturing analogous liquid fuels from non-fossil sources. This project will focus on the later.

Direct capture of CO2 from the ambient air has been proposed as a means of reducing the CO2 concentration in the atmosphere and thereby reducing the main driver for climate change. However, the question remains - what to do with the CO2 once it is captured. Geological sequestration is frequently touted as an option and whilst effective has geological limitation and societal roadblocks in a number of regions. Recycling the CO2 to fuel and in the process displacing crude oil has the potential to deliver carbon neutral transportation. Such a process may utilise low carbon electricity to make H2 which is then combined with CO2 from the air to produce liquid or gaseous fuels which are readily substituted into existing technologies.

This process will evaluate air to fuels technologies with a variety of fuels as the final product. The project will be desktop based, using Aspen or Hysys to do the process flow sheeting.

## Expected outcomes and deliverables:
Students will develop their technoeconomic analysis and process design skills. Expected outcomes include a report and potentially a journal paper.

## Suitable for:
This project is suitable for final year Chemical Engineering students. Students who have an interest and aptitude for process flow sheeting (Aspen/Hysys) are encouraged to apply.

## Primary Supervisor:
Simon Smart (academic)
Mojgan Tabatabaei (direct)

## Further info:
Please contact us to discuss the project before putting your application in.

s.smart@uq.edu.au
m.tabatabaei@uq.edu.au
# Project Description - Chemical Engineering

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Electrochemical oxidation of fluorinated pollutants in groundwater using perovskite type catalyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project duration:</td>
<td>10 weeks</td>
</tr>
</tbody>
</table>

**Description:**

Long term usage of fluorinated compounds in various industrial and domestic application has led to a slow but steady release of such chemicals into the environment and resulting in polluting the soil and groundwater. While the concentration of such pollutants are low but due to their persistent nature, they tend to remain and accumulate in the ecosystem over a very long duration. Perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) are an excellent example of such pollutants. They have been widely used in industrial and commercial areas for more than half century, such as textile industries, semiconductor, metal plating, and so on. PFOS and PFOA have now been frequently detected in groundwater sample in various parts of Australia and are potentially harmful to human health.

Advance oxidation processes (AOP) can be an effective method to destroy persistent or toxic pollutants. In case of persistent pollutants the technology is used to partially break down the chemicals to simpler molecules which are then susceptible for biodegradation e.g. in a typical wastewater treatment plant. However, in case of PFOS/PFOA, the primary requirement is de-fluorination of the pollutant species followed by stabilising the fluorine into a benign species. Because of a high electronegativity and a small size of the fluorine atom, the carbon-fluorine bonds are the strongest bonds in organic chemistry and hence the bond dissociation cannot easily occur without considerable energy expense. Furthermore, the stabilization of fluorine requires a strong reducing agent seldom found in conventional AOP.

In this project, we design the novel perovskite as a highly active and durable electro-catalyst that can help to achieve simultaneous oxidation-reduction reaction to facilitate the destruction and mineralization of PFOS and PFOA.

The experimental investigation will include the synthesis of the catalyst and testing its efficiency for the destruction of PFOS/PFOA pollutants using a batch reactor. Additionally, the study will also investigate the rate of reaction including the effect of temperature, pH and concentration on the reaction kinetics.

**Expected outcomes and deliverables:**

- The experimental program will provide training in basic laboratory skills and conducting batch experiments.
- Students will get to learn and operate state of the art analytical instrument for measuring low concentration of pollutants in groundwater.
- Students will gain skills in data collection, understating and interpreting results generated from analytical instruments.
- Have an opportunity to generate publications from their research or present in a conference.

**Suitable for:**

- UQ enrolled students only.
- Candidates with a background in chemical engineering, chemistry or materials science.
- 3rd or 4th year Bachelor degree students or master students.
- Student who will extend this vacation work research later as part of individual inquiry & Thesis (for example CHEE4007) or similar in the following semester will be viewed favourably.
- While prior laboratory experience is favourable but not mandatory.

**Primary Supervisors:**

Dr Xiaoyong Xu and Dr Pradeep Shukla

**Further info:**

For further information about the project and the expression of interest process described above, please contact Dr Xiaoyong Xu (x.xu@uq.edu.au) or Dr Pradeep Shukla (Pradeep.shukla@uq.edu.au)
<table>
<thead>
<tr>
<th><strong>Project title:</strong></th>
<th><strong>Field application of gas fed phototrophic bacteria</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project duration:</strong></td>
<td>10 weeks</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>This project aims to deliver processes for the large scale production of biopolymers from low cost inputs, utilising phototrophic bacteria. Feedstocks include syngas from solid wastes and carbon-dioxide-hydrogen mixes from fossil and renewable sources. The choice of phototrophic bacteria avoids the energy losses found in existing technologies by using photons instead of chemical energy for metabolic needs. This project combines multiple disciplines, enabling the production and optimisation of biopolymers in collaboration with engineers, polymer scientists and molecular biologists. Project benefits are novel technologies to produce tough, flexible and affordable biopolymers, while converting wastes and greenhouse gases to a valuable product.</td>
</tr>
<tr>
<td><strong>Expected outcomes and deliverables:</strong></td>
<td>Operation of field and laboratory pilot equipment (Pinjarra hills and partner sites), including data collection/management, extraction of biopolymers from phototrophic bacteria, mixed culture biotechnology, process modelling etc.</td>
</tr>
<tr>
<td><strong>Suitable for:</strong></td>
<td>This project is open to applications from students with a background in chemical engineering (any major).</td>
</tr>
<tr>
<td><strong>Primary Supervisor:</strong></td>
<td>Professor Damien Batstone</td>
</tr>
<tr>
<td><strong>Further info:</strong></td>
<td><a href="mailto:damienb@awmc.uq.edu.au">damienb@awmc.uq.edu.au</a></td>
</tr>
<tr>
<td>Project title:</td>
<td>Increasing the capacity of anaerobic digestion by sludge pretreatment</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------------------------------------</td>
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<tr>
<td>Project duration:</td>
<td>10 weeks</td>
</tr>
<tr>
<td>Description:</td>
<td>Due to the rapid urbanization in recent years, many anaerobic sludge digesters are facing challenges of capacity limitations. The outcome of this project could contribute to a novel process that allows anaerobic digesters to enhanced sludge reduction and methane production at a shorter retention time. This provides an attractive method for retrofitting existing anaerobic sludge digesters with capacity limitations.</td>
</tr>
</tbody>
</table>
| Expected outcomes and deliverables: | • Learn data analysis and simple mathematical modelling.  
• Capability to conduct biochemical methane potential (BMP) tests, which is a well-accepted method of assessing the methane recovery potential of anaerobic digestion of substrates.  
• Skills in academic writing.  
• Opportunity to generate a peer-reviewed publication. |
| Suitable for: | This project is open to applications from students with a background in chemical/environmental engineering, 3-4 year students or master students, UQ enrolled students only. |
| Primary Supervisor: | Dr. Haoran Duan |
| Further info: | Dr. Haoran Duan h.duan@uq.edu.au |
## Project title:
Inorganic membrane percrystallisation in hydrometallurgy

## Project duration:
10 weeks

## Description:
A novel inorganic membrane percrystallisation technology has been developed at the University of Queensland. The technology embraces reactor scaling and allows for clean water recovery and 100% salt crystallisation in a single step that can be operated continuously. This summer research study will involve experimental investigations to assess the application of the technology in hydrometallurgical processes.

## Expected outcomes and deliverables:
Inorganic membrane percrystallisation experiment operation and reporting for reactor fluxes and determination of suitable operating conditions. Evaluating the performance of different membrane types.

## Suitable for:
This project is most suited to metallurgical, chemical or materials engineering students with an interest in membrane technology or hydrometallurgy.

## Primary Supervisor:
A/Prof James Vaughan

## Further info:
James.vaughan@uq.edu.au
### UQ Summer Research Project Description – Chemical Engineering

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Ionic Liquids as a “Green” Lubricant Additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project duration:</td>
<td>10 weeks</td>
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</tbody>
</table>
| **Description:**                    | Lubrication plays a pivotal role in sustainability and performance of energy efficient and durable mechanical systems, which includes those utilised in renewable energy such as wind turbines. Some current additives in lubricants have long-term toxicity concerns and produce undesirable side-product compounds. This project focuses on ionic liquids (IL), which are emerging as an entire new class of so-called “green” lubricants. The benefit of IL is that they can be “tuned” using different types of anions and cations, and thus designed to act as the lubricant or as an additive to oil. A technical barrier as an additive is designing them to be miscible in nonpolar oils, such as polyalphaolefin (PAO).  

The aim of this project is to design and evaluate environmentally-friendly oil-miscible ILs as oil additives and compares to standard formulations. This will involve fabrication of ILs and measurement of rheology, friction and wear using state-of-the-art facilities. |
| **Expected outcomes and deliverables:** | Students may gain knowledge/skill in concepts/measurement of rheology and tribology, general data collection and analysis techniques. A written report and an oral presentation are required at the end of the project.  

Results from this project may contribute or partly contribute to a publication. Therefore, there may be an opportunity of an authorship or co-authorship of a general paper.  

Student will attend weekly meetings with Prof Jason Stokes’ group. |
| **Suitable for:**                   | This project requires a chemistry and engineering background as it requires both synthesis and characterization methods. Students with a background in chemical engineering/chemistry at either 3rd or 4th year are desirable. |
| **Primary Supervisor:**             | Professor Jason Stokes and Mr Amir Beheshti  |
| **Further info:**                   | For more information please contact Amir Beheshti, Email: a.beheshti@uq.edu.au |
## UQ Summer Research Project Description – Chemical Engineering

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Metagenomic investigation for the anaerobic methane oxidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project duration:</td>
<td>10 weeks</td>
</tr>
<tr>
<td>Description:</td>
<td>This project aims to investigate anaerobic methane oxidation coupled with iron reduction with state-of-the-art bioinformatic analysis. This process is newly discovered, globally significant but yet poorly understood due to difficulties in cultivation. Metagenomic analysis has been show extremely powerful to elucidate microorganism of such nature and will be used to study these microorganisms in this project. The project expects to generate valuable insights regarding the identity, diversity, and metabolic functions of these microorganisms, and also consolidate the metagenomic methodology for future research.</td>
</tr>
<tr>
<td>Expected outcomes and deliverables:</td>
<td>The candidate would have the opportunities to study and work with state-of-the-art bioinformatic tools to analyse metagenomic data. He/she will obtain insights in the field of molecular ecology and microbial physiology. The expected outcome of this project includes a written report and an oral presentation, as well as potential scientific publications.</td>
</tr>
<tr>
<td>Suitable for:</td>
<td>This project is open to students with a background in molecular ecology, basic command-line operations capability is needed, 3-4 year students, UQ enrolled students only.</td>
</tr>
<tr>
<td>Primary Supervisor:</td>
<td>Dr. Gaofeng Ni</td>
</tr>
<tr>
<td>Further info:</td>
<td>Please contact <a href="mailto:Gaofeng.ni@awmc.uq.edu.au">Gaofeng.ni@awmc.uq.edu.au</a> for enquiries for this project.</td>
</tr>
</tbody>
</table>
### UQ Summer Research Project Description – Chemical Engineering

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Recovery of spent lithium-ion battery through a novel green approach.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project duration:</td>
<td>10 weeks</td>
</tr>
<tr>
<td>Description:</td>
<td>This proposed project aims to develop a sustainable, cheap, and highly effective process to recover valuable cobalt and lithium elements from rocketing volume of spent lithium-ion batteries (LIB) based on deep eutectic solvent (DES) leaching and electrorefining processes. The proposed novel processes will circumvent challenges faced by conventional LIB recycle methods, such as solvent dissolution, thermal treatment and ultrasonic-assisted treatment, which are either costly, inefficient or toxic. Expected outcome from this project is a proof-of-concept of novel process and the identification of deep eutectic solvents (DES) that are effective and selective to dissolve lithium and cobalt compounds from spent LIBs.</td>
</tr>
<tr>
<td>Expected outcomes and deliverables:</td>
<td>Scholar may gain skills in experimental design, data collection and analysis, communications, and teamwork. There is also opportunity to generation publications from their research. At the end of this project, student may also be asked to produce a report and oral presentation at the end of their project.</td>
</tr>
<tr>
<td>Suitable for:</td>
<td>The project is open to applications from students with a background in chemical engineering or chemistry, 3-4 year students, UQ enrolled students only, etc.</td>
</tr>
<tr>
<td>Primary Supervisor:</td>
<td>Aaron Li</td>
</tr>
<tr>
<td>Further info:</td>
<td>Aaron Li, <a href="mailto:m.li6@uq.edu.au">m.li6@uq.edu.au</a></td>
</tr>
<tr>
<td>Project title:</td>
<td>Responsiveness of viscoelastic biological surface films</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Project duration:</td>
<td>10 weeks</td>
</tr>
<tr>
<td>Description:</td>
<td>It is known that adsorption of proteins or polysaccharides to soft surfaces improves lubrication, as measured using soft contact tribology, and the film thickness, measured using Quartz crystal microbalance with Dissipation (QCM-D). This adsorption has been shown to be relevant to the sensory mouthfeel of foods and beverages. The majority of existing literature measuring tribology of the food components and its relationship to adsorbed film thickness has been carried out in the absence of Human whole saliva (HWS), yet we know that saliva plays a key role in the sensory perception of foods.</td>
</tr>
<tr>
<td>Expected outcomes and deliverables:</td>
<td>The student will utilise the Quartz crystal microbalance with Dissipation (QCM-D) to study how dairy and meat proteins, polysaccharides and solvent quality, influence the viscoelasticity, hydration, structure, and lubricity of pre-adsorbed saliva-films.</td>
</tr>
<tr>
<td>Suitable for:</td>
<td>This project is open to applications from 2nd-4th year students with a background in, materials engineering, chemistry, or chemical engineering who have completed all compulsory requirements for their current year of study.</td>
</tr>
<tr>
<td>Primary Supervisor:</td>
<td>Dr Heather Shewan</td>
</tr>
<tr>
<td>Further info:</td>
<td>For further information including full information pack regarding saliva donation, please contact Heather Shewan <a href="mailto:h.shewan@uq.edu.au">h.shewan@uq.edu.au</a>.</td>
</tr>
</tbody>
</table>
**Project title:** Rheology properties of casein micelles at neutral condition  

**Project duration:** 10 weeks  

**Description:** Milk proteins are the key ingredient in a vast range of nutritionally rich foods and beverages. A key challenge is having utmost control over protein functionality to form structures and control texture and mouthfeel. Milk proteins consist of around 80% casein, with 95% of these in the form of so-called casein micelles that are a large aggregated colloid. While there is considerable literature examining the properties of aggregated casein micelles at low pH when forming gels (e.g. yogurt), there has been limited investigations under neutral conditions. Here we aim to examine the rheology of casein micelles at neutral conditions in the presence of different ions, e.g. calcium, phosphate. The knowledge gained will be utilised within a research partnership with a major international dairy company.  

**Expected outcomes and deliverables:** Students will gain an insight into industrial research. Students may gain knowledge/skill in concepts/measurement of rheology and tribology, general data collection and analysis techniques. A written report and an oral presentation are required at the end of the project. Results from this project may contribute or partly contribute to a publication. Therefore, there may be an opportunity of an authorship or co-authorship of a general paper. Student will attend weekly meetings with Prof Jason Stokes’ group.  

**Suitable for:** This project is open to applications from students with a background in chemical engineering (UQ enrolled students).  

**Primary Supervisor:** Dr Heather Shewan and Mr Nengneng Fan  

**Further info:** Please contact Mr Nengneng Fan (n.fan@uq.edu.au)
## UQ Summer Research Project Description – Chemical Engineering

<table>
<thead>
<tr>
<th><strong>Project title:</strong></th>
<th><strong>Solidification of oxide melts</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>Project duration:</strong></td>
<td>10 weeks</td>
</tr>
</tbody>
</table>
| **Description:** | Slags are now treated by industry as important by-products of metallurgical operations rather than waste materials. The applications include raw materials for Portland cement and construction materials. Slags are treated to recover dissolved or entrained minor elements. The solidification of oxide melts from metallurgical melts is becoming a more important topic as the focus on sustainability and environmental impact is increasing.  
Key to the physical and chemical properties of these oxide materials are the phases and microstructures formed on solidification. Whilst the solidification of metal alloys is a cornerstone of many metal processing technologies in comparison, the topic of oxide solidification has received relatively little attention.  
The Pyrometallurgy Innovation Centre (PYROSEARCH) has developed new experimental techniques to enable controlled cooling of these melts and the examination of the phases and microstructures formed at each stage. The project will build on existing research and provide new experimental data on a range of slag compositions and solidification conditions. |
| **Expected outcomes and deliverables:** | Student will work with an existing research team, obtain practical experience in high temperature laboratory based research, and is expected to produce a professional quality report and oral presentation at the end of their project. |
| **Suitable for:** | This project is open to applications from students with a background in chemical engineering, chemical and materials engineering, chemical and metallurgical engineering 3-4 year students, UQ enrolled students only. Location Banksia Building Long Pocket |
| **Primary Supervisor:** | Prof Peter Hayes. |
| **Further info:** | Prof Peter Hayes p.hayes@uq.edu.au |
### Project title:
Structural characterization of FeO-Fe2O3-SiO2 liquid slags using Raman spectra and their relationship with viscous behaviours

### Project duration:
10 weeks

### Description:
This project aims to investigate the structures of FeO-Fe2O3-SiO2 liquid slags through the glass phase, and the relationship between structures and the properties of slags, namely, viscous behaviours. It is believed that the macro properties of the slags are determined by their microstructures. Therefore, clarifying the microstructures of slags will be able to predict their properties. Moreover, the modification of slags properties for industrial purposes can also be deepened into the microstructural level. FeO-Fe2O3-SiO2 is a basic system in many industrial processes and natural system. Accurate viscosities of the slags have been measured at high temperature and Raman spectra have been obtained from the glass. The present project will analyse the available data to understand the micro-macro relationship of this slag system.

### Expected outcomes and deliverables:
The experiments have been performed using the research technique developed at UQ where the experimental conditions are accurately controlled. The chemical compositions of the slags after quenching have been analysed using the EPMA. The microstructures of the quenched slags have been measured using the Raman spectra the viscosities of the slags have been measured and will also be predicted using the FactSage software. The FeO/Fe2O3 ratio in the slags will be obtained from FactSage. A report is expected at the end of the project and a publication may be produced from the results.

### Suitable for:
This project is suitable for the students from relevant majors in engineering who have completed at least two years undergraduate study.

### Primary Supervisor:
Dr Yongqi Sun

### Further info:
[ujysun16@uq.edu.au](mailto:ujysun16@uq.edu.au)
### Project title:
**Synthesis of adsorption materials from clay minerals**

### Project duration:
10 weeks

### Description:
Currently, most clay minerals in the mining tailings or low-quality clay ores is perceived as the waste due to high-cost process and limited market. Recently, we have developed a sustainable way with low cost to utilise these clay minerals. By manipulating kinetics and crystallization process, various types of zeolite-like adsorption materials can be synthesized which can be used as high-performance absorbents for the heavy metal removal in the aqueous/soil environment. This project followed on the previous research project on synthesis of zeolites from low grading bauxite or kaolin for heavy metal removal. In this study, we will extend the investigation on utilising different clay minerals. We aims to conduct proof-of-concept study on synthesis the various types of zeolites from different feeding source. Then, these zeolites will be tested for different applications such as ethanol dehydration and gas separation and ion exchange et al. This project is supported by pathfinder fund from UniQuest.

### Expected outcomes and deliverables:
The student will gain skills in experimental skills in sample sintering and alkaline leaching. There will likely be liquid and solid sample characterisation by ICP, XRD and SEM. The student will present project outcomes to the hydrometallurgy research group. The deliverable will be a functioning mass and energy balance model for the process and outcomes of the sensitivity analysis.

### Suitable for:
This project is most suited to metallurgical/chemical/environmental engineering students with an interest in the environmental engineering and product synthesis.

### Primary Supervisor:
Dr Hong Peng (h.peng2@uq.edu.au)

### Further info:
If you are interested, please meet with Dr Hong Peng (h.peng2@uq.edu.au) to discuss the project.
**UQ Summer Research Project Description – Chemical Engineering**

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Using low-cost adsorbents for separating fluorinated pollutants from groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project duration:</td>
<td>10 weeks</td>
</tr>
</tbody>
</table>

**Description:**

Long term usage of fluorinated compounds in various industrial and domestic application has led to a slow but steady release of such chemicals into the environment and resulting in polluting the soil and groundwater. While the concentration of such pollutants are low but due to their persistent nature, they tend to remain and accumulate in the ecosystem over a very long duration. Perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) are an excellent example of such pollutants. They have been widely used in industrial and commercial areas for more than half century, such as textile industries, semiconductor, metal plating, and so on. PFOS and PFOA have now been frequently detected in groundwater sample in various parts of Australia and are potentially harmful to human health. The conventional techniques of water and waste-water treatment including biological degradation, oxidation and reduction have failed to destruct PFOS in ambient environments due to their stability and persistent nature. The adsorption technology has been found to be a promising method to separate PFOS and PFOA from water and is currently used as a commercial technique for groundwater remediation. However, the commercial adsorbents such as activated carbon or resins are expensive and difficult to regenerate. As these adsorbents gets saturated, they are dumped into landfills thus making the remediation process economically unfavourable. In this project, we propose to use the low-cost adsorbents, such as bentonite and fly ash for PFOS and PFOA removal from groundwater. Apart from being significantly cheaper than commercial activated carbon and resins, these adsorbents are abundantly available. The experimental investigation will include measuring the adsorption capacity of PFOS and PFOA pollutants on the selected adsorbents and comparing their capacity with the commercially available adsorbent materials. Additionally, the study will also investigate the rate of adsorption including the effect of temperature, pH and loading on the adsorption kinetics.

**Expected outcomes and deliverables:**

- The experimental program will provide training in basic laboratory skills and conducting batch experiments.
- Students will get to learn and operate state of the art analytical instrument for measuring low concentration of pollutants in groundwater.
- Students will gain skills in data collection, understating and interpreting results generated from analytical instruments.
- Have an opportunity to generate publications from their research or present in a conference.

**Suitable for:**

- UQ enrolled students only.
- Candidates with a background in chemical engineering, chemistry or materials science.
- 3rd or 4th year Bachelor degree students or master students.
- Student who will extend this vacation work research later as part of individual inquiry & Thesis (for example CHEE4007) or similar in the following semester will be viewed favourably, but it is not a mandatory requirement.
- While prior laboratory experience is favourable but not mandatory.

**Primary Supervisors:**

Dr Xiaoyong Xu and Dr Pradeep Shukla

**Further info:**

For further information about the project and the expression of interest process described above, please contact Dr Xiaoyong Xu (x.xu@uq.edu.au) or Dr Pradeep Shukla (Pradeep.shukla@uq.edu.au)
**Project title:** Viscoelastic Lubrication  
**Project duration:** 10 weeks

**Description:** Lubrication is critical for functionalities of many biological systems including mussel, joint and tongue. The relative sliding motion between two viscoelastic substrates is often encountered in those systems, at which surfaces deform during the sliding. Sliding between viscoelastic substrates causes a dynamic entrainment and confinement of fluid lubricant at interfaces, as such properties of lubricant fundamentally determine the overall lubrication behaviour. Lubricants involved in most biological systems are complex fluids or soft matters with non-Newtonian behaviours and viscoelasticity, which makes it challenging to characterise the lubrication between viscoelastic contacts.

The aim of this project is to collectively characterise the interface friction and mechanics (termed ‘tribology’) and fluid/soft matter mechanics (termed ‘rheology’), from which it is deemed to form a correlation between frictional behaviour and fluid rheology. Specifically, the student will measure the tribology between soft contacts using a range of lubricants, and will be encouraged to further investigate the effect of lubricant rheology on the overall frictional behaviour. Student will document a literature review and conduct experimental works under supervision of a senior lab user. Experimental work including rheology and tribology measurement will be completed in “Rheology, Tribology and Biointerfaces Laboratory”, led by Professor Jason Stokes.

**Expected outcomes and deliverables:** Students may gain knowledge/skill in concepts/measurement of rheology and tribology, general data collection and analysis techniques. A written report and an oral presentation are required at the end of the project. Results from this project may contribute or partly contribute to a publication. Therefore, there may be an opportunity of an authorship or co-authorship of a general paper. Student will attend weekly meetings with Prof Jason Stokes’ group.

**Suitable for:** This project is suitable for 2nd to 4th year undergraduate student or course work post-graduate student majoring in Chemical Engineering or its varieties.  
*It is expected that undergraduate applicants have finished all compulsory courses listed for their program up to the year of their study.*

**Primary Supervisor:** Dr Yuan Xu  
**Further info:** y.xu5@uq.edu.au
<table>
<thead>
<tr>
<th><strong>Project title:</strong></th>
<th><strong>Viscoelastic Polyelectrolyte Multilayers</strong></th>
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<tbody>
<tr>
<td><strong>Project duration:</strong></td>
<td>10 weeks</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Polyelectrolyte Multilayers (PEM) are currently seeing a resurgence in scholarly interest for the purposes of understanding the contribution of surface films to tribological phenomena and performance (friction, lubrication and wear). To provide insight at the nanoscale, an Atomic Force Microscope (AFM) is typically implemented. Unfortunately, despite the wealth of publications produced in the past decade (owing to their popularity in biomedical applications), most papers fail to comprehensively investigate and present all tribologically significant properties at the nanoscale when varying fabrication parameters. As such, it is necessary that a comprehensive analysis is performed to understand the impact of fabrication parameters and enable fine tunability of PEM for nano-tribological applications. This project intends to investigate the complex interplay and sensitivity involved in the systematic variation of solvent quality and cross-linking density on the growth and tribo-mechanical properties of PEMs. In particular, the viscoelastic behaviour, interfacial adhesion, roughness and wettability will be evaluated at the sub-asperity scale using AFM and the Quartz Crystal Microbalance with dissipation monitoring (QCM-D). These properties are then to be evaluated at the macroscale using a mini-traction machine (MTM) tribometer.</td>
</tr>
<tr>
<td><strong>Expected outcomes and deliverables:</strong></td>
<td>The student will be given the opportunity to gain experience and in-depth understanding of both nanoscale and macroscale soft contact tribology and rheology. It is anticipated that the student’s findings will generate a publication or part thereof. Students will be expected to produce a report and oral presentation at the end of their project. Student will attend weekly meetings with Prof Jason Stokes’ group</td>
</tr>
<tr>
<td><strong>Suitable for:</strong></td>
<td>Applications from 3rd-4th year students are preferred with a background in mechanical engineering, materials engineering, chemical engineering or physics. It is expected that the student is competent with MATLAB.</td>
</tr>
<tr>
<td><strong>Primary Supervisor:</strong></td>
<td>Professor Jason Stokes and Mr Ben Cartwright</td>
</tr>
<tr>
<td><strong>Further info:</strong></td>
<td>For further information, please contact Ben Cartwright @ <a href="mailto:b.cartwright@uq.edu.au">b.cartwright@uq.edu.au</a>.</td>
</tr>
</tbody>
</table>