SCHOOL OF CHEMICAL ENGINEERING
UQ Summer Research Project Description

Project title:	**Degradation of residual organics in wastewater by oxygen nanobubbles**
Project duration:	10 weeks
Description:	Xanthate is one of the most common organic sulphur-based collectors which are widely used in the froth flotation of sulphide minerals as well as in the production of viscose rayon and pesticides. However, the residual xanthate and its by-products in wastewater are not allowed to be disposed of into environmental streams due to both strong odour and being toxic to biological systems. In recent years, especially with increasing effort on environmental protection from community and governments, many methods have been developed to remove the xanthate and its by-products from wastewater tailings, such as chemical precipitation or chemical oxidation. Several oxidizing reagents such as hydrogen peroxide (H_2O_2) or Fenton's reagent are used to decompose the xanthate. Because of its strong oxidation ability, ozone also has high potential in the treatment of wastewater. Hydrogen peroxide can be used to accelerate the oxidation of contaminants by ozone. However, the efficiency of ozone oxidation is limited by the rapid decomposition rate of dissolved ozone in water, which is much faster than that in the gas phase. Methods to extend the reactivity of aqueous-phase ozone are thus urgently needed. Owing to their small diameter, nanobubbles present high internal pressures and rapid mass transfer rates, which can significantly improve gas solubility. Compared with normal bubbles, nanobubbles have lower rising velocity in the liquid phase. Nano-bubbles can persist in water for long periods of time. Those with radii of 150–200 nm have been shown to remain stable for over days. Because of their long life time in water, nanobubbles can migrate with the water flow and provide continuous gas supply for the dissolution phase. The oxygen nanobubbles should enable extended reactivity for degradation of residual organics. This project aims to explore the environmental application of nanobubble generator technology in the hydrometallurgy lab and develop the fundamental understanding of nanobubble formation.
Expected outcomes and deliverables:	Aqueous samples will be characterised by UV/Vis and ICP. The student will present project outcomes to the hydrometallurgy research group.
Suitable for:	This project is most suited to metallurgical/chemical/environmental engineering students with an interest in waste water processes.
Primary Supervisor:	Dr Hong Peng (h.peng2@uq.edu.au)
Further info:	If you are interested in this project and wish to discuss it, please email Dr Hong Peng to arrange a meeting either face to face or via zoom (h.peng2@uq.edu.au).

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Rare earth element recovery**
Project duration:	10 Weeks
Description:	This project aims to define process options to recover rare earth elements from Queensland resources.
Expected outcomes and deliverables:	Summer scholars will gain skills in team work, lab techniques, equipment operation, data collection and analysis, presentation skills, and may have an opportunity to generate publications from this research. Students will be expected to produce an oral presentation at the end of their project.
Suitable for:	This project is most suitable for students with a background in chemical-metallurgical engineering, chemical engineering, materials engineering, or chemistry.
Primary Supervisor:	A/prof. James Vaughan
Further info:	If summer scholars would like contact us for further information. A/prof. James Vaughan: james.vaughan@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Advanced Oxidation in for Selective Leaching of Nickel**
Project duration:	10 Weeks
Description:	This project aims to use advanced oxidation processes (AOPs) to promote hydrometallurgical leach of mixed hydroxide precipitate (MHP), supporting pure nickel sulphate production. Experimentation will test the effect of oxidant types, pH, solid loading, reaction time and temperature.
Expected outcomes and deliverables:	Summer scholars will gain skills in team work, lab techniques, equipment operation, data collection and analysis, presentation skills, and may have an opportunity to generate publications from this research. Students will be expected to produce an oral presentation at the end of their project.
Suitable for:	This project is most suitable for students with a background in chemical-metallurgical engineering, chemical engineering, materials engineering, or chemistry.
Primary Supervisor:	A/prof. James Vaughan
Further info:	If summer scholars would like contact us for further information. A/prof. James Vaughan: james.vaughan@uq.edu.au Dr. Weng Fu: w.fu1@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Selective precipitation of nickel-cobalt-manganese precursor for lithium ion batteries**
Project duration:	10 Weeks
Description:	This project aims to use precipitation method to selectively obtain the nickel-cobalt-manganese (NCM) precursor from the dissolved impurities, supporting sustainable production of lithium battery materials. Experimentation will test the effect of different alkaline, pH, solid loading, particle size distribution, reaction time and temperature.
Expected outcomes and deliverables:	Summer scholars will gain skills in team work, lab techniques, equipment operation, data collection and analysis, presentation skills, and may have an opportunity to generate publications from this research. Students will be expected to produce an oral presentation at the end of their project.
Suitable for:	This project is most suitable for students with a background in chemical-metallurgical engineering, chemical engineering, materials engineering, or chemistry.
Primary Supervisor:	A/prof. James Vaughan
Further info:	If summer scholars would like contact us for further information. A/prof. James Vaughan: james.vaughan@uq.edu.au Dr. Weng Fu: w.fu1@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Self-luminating quantum dot composite glass**
Project duration:	8 weeks
Description:	This project will aim to advance the new generation of glass materials, made from metal ions and organic ligands. Different from conventional inorganic, organic and metallic glasses, the new materials enable significant opportunity for functionalisation. The project will incorporate luminating semiconducting materials into the glass substrates, and by tuning the interfacial properties the luminating performance of the composite glass will be evaluated and optimised.
Expected outcomes and deliverables:	The student will gain skills in nanomaterial fabrication and testing, including mechanochemical process, x-ray crystallography, thermal characterisation and optical properties evaluation. Student will be expected to product a report at the end of their project, and it will potentially lead to journal publications.
Suitable for:	This project is open to applications from undergraduate students with a background of materials chemistry and materials science.
Primary Supervisor:	Dr. Jingwei Hou
Further info:	For any inquires please contact Dr. Jingwei Hou by Jingwei.hou@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Predicting electrolyte solution properties for improved energy storage devices.**
Project duration:	*10 weeks*
Description:	This project aims to predict the properties of electrolyte solutions in order to develop improved energy storage devices. Electrolyte solutions play a central and fundamental role in a huge range of important systems and applications. They carry the electrical currents that make life possible, they control the chemical properties of the ocean such as its acidity ability to absorb carbon dioxide. They also carry the electrical charge between the positive and negative terminals of electrical energy storage devices. Optimising the electrolyte is, therefore, crucial to improving the stability, charging rate and lifetime of the battery. To do this we need accurate predictive models of the properties of electrolyte solutions. Unfortunately, we still cannot predict even the most basic properties of electrolytes solutions from first principles. In this project, we will use state of the art physics to directly simulate the solvation of ions in water. Approximate models will then be used to quickly predict important properties of electrolyte solutions from these simulations. These results will be useful in identifying new electrolyte solutions for energy storage and other applications
Expected outcomes and deliverables:	By joining this project, the candidate will have an excellent opportunity to develop skills in programming, computational chemistry and energy storage technology. They will have an opportunity to generate publications from their research. Students will be expected to produce a short report and at the end of their project.
Suitable for:	This project is open to applications from 3 - 4 year UQ enrolled students. Students with a background in chemistry, physics or mathematics or programming may be suitable.
Primary Supervisor:	Dr Tim Duignan
Further info:	Please contact me at t.duignan@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	Metabolic-bioprocess modelling of purple phototrophic bacteria for resource recovery
Project duration:	10 weeks
Description:	Purple phototrophic bacteria (PPB) have recently appeared as promising candidates for resource recovery from waste streams via biological uptake. The proof-of-concept of the technology has already been performed, with current research rapidly moving towards upscaling. In this context, assessing the feasibility of PPB-based processes is crucial. To achieve this, it is necessary to identify the most promising value-added products that can be generated (*i.e.* single-cell protein, polyhydroxyalkanoates (bioplastics), fertilisers, hydrogen, carotenoids, etc.). After product identification, research should focus on maximising their yields and production rates, aiming at achieving economically-feasible processes. The development of mathematical models able to predict potential outcomes based on metabolic capabilities and environmental conditions is the main aim and focus of this project, as it will allow the theoretical estimation of potential revenues, as well as optimizing the achieved performances.
Expected outcomes and deliverables:	The student will gain metabolic and bioprocess modelling skills, as well as insight into environmental processes for resource recovery. The student will be expected to produce a report and oral presentation at the end of their project about their work.
Suitable for:	Chemical and bioengineering UQ students in 3-4 year.
Primary Supervisor:	Dr Adrian Oehmen
Further info:	a.oehmen@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Lithium cobalt recovery from spent lithium-ion battery through a novel combined solvent leaching and electrorefining approach**
Project duration:	8 weeks
Description:	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.
Expected outcomes and deliverables:	The expected outcomes include a proof-of-concept process to use the DES to dissolve the lithium cobalt oxide and purify the metals through electrorefining processes. Scholars may gain skills in data collection, or have an opportunity to generate publications from their research. Students will be expected to produce a 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, 4th year UQ enrolled students only.
Primary Supervisor:	Dr Aaron Li
Further info:	We wish to be contacted with Dr Aaron Li via m.li6@uq.edu.au prior to submitting an application.

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Meat analogues**
Project duration:	10 weeks
Description:	Meat analogues made from plant proteins are considered a potential solution to the growing demand for food globally, as well as the increasing awareness on animal welfare and environmental-friendly diet. To produce such kind of product, it is important to create material properties such as elasticity and viscosity similar to meat, thus acceptable to consumers, meanwhile maintaining desirable functional properties such as nutrition. Hydrogels consisting of soy-based protein are a major and most available catalogue of meat analogue, at which the structural anisotropy (texture similar to natural meat) is created by shear forces, such as extrusion, spinning or flow, during gelation. This project is to investigate the gelation process of several meat analogues recipes, from which it is anticipated to uncover the structure and property of soy protein hydrogel as a function of gelation condition and formulation. Specifically, the student will measure the rheological properties of these recipes, determine the gelation condition, and characterise the microstructure of final products. The student will be further encouraged to investigate the fundamental mechanism of gelation, colloidal/emulsional behaviour of soy protein mixture, and control over microstructural anisotropy. Student will document a literature review and conduct experimental works under supervision of a senior lab user. Experimental will be completed in "Rheology, Tribology and Bio-interfaces Laboratory" led by Prof. Jason Stokes.
Expected outcomes and deliverables:	Students may gain knowledge/skill in concepts/measurement of rheology, microstructures and colloidal properties, and general data collecting 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.
Suitable for:	This project is suitable for 2nd to 4th year undergraduate student or course work post-graduate student majored 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 Prof. Jason Stokes
Further info:	y.xu5@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Viscoelastic Lubrication of Food Emulsions**
Project duration:	10 weeks
Description:	With the increasing consumer interests in healthier low-fat products, the food industry is facing the challenge of developing products with reduced level of fats while maintaining texture and mouthfeel. It is well known that 'creaminess' perception of food is related to lubrication and yet the underlying mechanisms and physics, especially on viscoelastic soft contacts, are poorly understood. Literature has shown that stability and droplet coalescence play an important role in lubrication of emulsions. This project aims to establish connections between stability, adsorption, spreading of emulsion droplets and viscoelastic lubrication of emulsions on soft solid surfaces. The student will observe the flow behaviours and adhesions of emulsions through flow microscopy and study the influence of surfactants and surface properties such as hydrophobicity and roughness. These observations will be used to interpret the underlying physics driving the friction measurements of emulsions on a Mini-Traction Machine (MTM) tribometer under similar conditions.
Expected outcomes and deliverables:	Students may gain knowledge/skill in concepts/measurement of emulsion design, flow microscopy and tribology. 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 and opportunity of authorship or co-authorship. Student will attend weekly meetings with Prof Jason Stokes' group.
Suitable for:	This project is suitable for 2^{nd} to 4^{th} year undergraduate student or course work post-graduate student majoring in Chemistry, 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:	Professor Jason Stokes and Mr Ming Yao Lim
Further info:	For further information, please contact Ming Yao Lim, ming.lim@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Effect of particle-size on the functional and pasting properties of Bunya nut and Bunya nut-based composite flours**
Project duration:	10 weeks
Description:	The demand for low-gluten and gluten-free products is increasing, which makes it necessary to utilise new raw materials in the food industry. Bunya nut flour has potential for use in gluten-free bakery products. Bunya nut is a traditional indigenous food that is usually consumed boiled or roasted. The production of flour from the nut could be an interesting way to partially or totally substitute wheat, rice or corn flours in bakery products. The aim of the project will be to investigate the effect of particle size on the functional and pasting properties of bunya flour, as well as the effect of different types of composite flours (bunya + commercial flour) on the same properties. The student will prepare Bunya flour with different particle size distribution by grinding the dry raw nuts. The student will also prepare blends of bunya and a range of commercial flours in different proportions. The experiments will include measuring particle size distribution in a laser diffraction particle size analyser (Mastersizer), measuring starch pasting profile (Anton Paar Rheometer – starch cell) and other functional properties such as water/oil absorption capacity, foaming capacity, bulk density, solubility index and least gelation concentration. Experimental work will be completed in "Rheology, Tribology and Biointerfaces Laboratory".
Expected outcomes and deliverables:	Students will gain skill in concepts of unit operations involved in the preparation of flours, physico-chemical and functional properties of foods/flours, food product development, general data collection and analysis techniques. Students may also gain insight on indigenous knowledge regarding nuts from Australia. 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 for 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:	Professor Jason Stokes and Jaqueline Moura Nadolny
Further info:	j.mouranadolny@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Viscoelastic Lubrication**
Project duration:	10 weeks
Description:	Lubrication is critical for functionalities of many biological systems including muscle, joint and tongue. The relative sliding motion between two soft (viscoelastic) substrates is often encountered in those systems, at which surfaces/substrate deform during the sliding. Sliding between viscoelastic substrates causes a dynamic entrainment of lubricant into the interfacial separation, as such properties of lubricant and the interfacial deformation fundamentally determine the overall lubrication behaviour. Lubricants involved in most biological systems are complex fluids with non-Newtonian behaviours, and that the contact substrates have unique viscoelasticity, which makes it challenging to characterise the lubrication between viscoelastic contacts. The aim of this project is to characterise the interface friction and mechanics (termed 'tribology'), fluid/soft matter mechanics (termed 'rheology') and soft contact mechanics, from which it is deemed to form a correlation between friction, fluid rheology and mechanical property of contact material. 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 and material mechanical property on the overall frictional behaviour. Student will document a literature review and conduct experimental work under supervision of a senior lab user. Experimental work including rheology and tribology measurement will be completed in "Rheology, Tribology and Bio-interfaces Laboratory" led by Prof. Jason Stokes.
Expected outcomes and deliverables:	Students may gain knowledge/skill in concepts/measurement of rheology, tribology and contact mechanics, and general data collecting 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.
Suitable for:	This project is suitable for 2nd to 4th year undergraduate student or course work post-graduate student majored 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 Prof. Jason Stokes
Further info:	y.xu5@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Net Zero Australia**
Project duration:	10 weeks
Description:	The project will build on existing GIS tools and scripts to develop a temporal and spatial depiction of what a net zero Australia by 2050 will look like under a several scenarios. The work will focus on the electricity and/or hydrogen sectors.
Expected outcomes and deliverables:	The expected outcome is a report detailing a case study on one or more of the scenarios for Australia (or QLD). Scripts and a user manual will also need to be developed to ensure continuity with the next phase of work. *If the student chooses to focus on hydrogen then it is likely a journal publication could be developed as a deliverable.*
Suitable for:	This project is open to any 4th year undergraduate engineer. Programming skills are valuable – in particular Matlab / Python. Skills with ARCGIS would be highly relevant. Knowledge of renewable energy or hydrogen production essential. Would best suit a Chem or Mech Eng student but others will be considered.
Primary Supervisor:	A/Prof Simon Smart (s.smart@uq.edu.au)
Further info:	Please contact me if you would like to be considered for this project. We can take up to 2 students.

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Air to Fuels – can direct air capture of CO2 help displace fossil fuels in transportation?**
Project duration:	10 weeks
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 acheived. 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 gaesous fuels which are readily substitued 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 flowsheeting.
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 a strong aptitude for process flowsheeting (Aspen/Hysys) are strongly 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

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Occurrence and fate of emerging pollutants in decentralised water supply systems**
Project duration:	10 weeks
Description:	The project is centred on a pioneer facility located in the North of Brisbane, which comprises two innovative solutions for decentralised water supply designed by Bligh Tanner. These systems are part of a resilient system to deal with drought in SE Queensland. The technology may also be very applicable in SE Asia where there are opportunities to focus on decentralised systems. One of these systems collects urban stormwater and treats it to a non-potable standard for residential uses (e.g. irrigation or toilet flushing), and another treats roof water from residential properties (which is centrally collected) to a potable standard. The study involves monitoring the water collected by both systems to detect emerging pollutants that can be a health hazard in the applications proposed.
Expected outcomes and deliverables:	The student will gain experience in sampling and analytical techniques for compounds of emerging concern in water. They will also develop their knowledge on water treatment processes for potable and non-potable purposes, including a chance to work directly at a pioneer facility installed in a residential area of Brisbane. The project has the support of the water engineering consultancy Bligh Tanner. The student will be expected to make an oral presentation and write a short report of the main results at the end of their project.
Suitable for:	This project is most suitable for students of the Master of Urban Water Engineering, Chemical Engineering or Chemistry. Preference goes to students with a valid driver's license.
Primary Supervisor:	Dr. Gilda Carvalho
Further info:	g.carvalho@awmc.uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	Methane Pyrolysis to produce low emission hydrogen
Project duration:	10 weeks
Description:	Investigating the solubility of hydrogen in various molten metals and/or salts at different temperatures to contribute to understanding how prospective materials interact within the reactor.
Expected outcomes and deliverables:	This will involve gathering pressure measurements over time using a Sieverts apparatus, interpreting, explaining and presenting the results.
Suitable for:	Foundational knowledge of thermodynamics, diffusion and solubility is required. Would be suited for a third- or fourth-year student studying chemical engineering, metallurgical engineering or chemistry.”
Primary Supervisor:	A/Prof Simon Smart (s.smart@uq.edu.au)
Further info:	Please contact me or Mr Alister Sheil alister.sheil@uqconnect.edu.au) if you would like to be considered for this project.

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Surface modified polypropylene fibres for concrete reinforcement**
Project duration:	10 weeks
Description:	Polypropylene fibres are highly used reinforcing fillers for concrete structures. The fibres restrict crack propagation and positively affect several concrete properties. One limitation of using pristine polypropylene fibres is the low interfacial adhesion with concrete matrix. When subjected under stress or bending force, interfacial delamination can occur, which eventually can create paths for moisture penetration. This is specifically disadvantageous for high-moisture/flood affected areas where continuous moisture penetration can cause severe damage to structural concrete's steel reinforcements. In this project, surfaces of commercial polypropylene fibres will be chemically/thermally modified with fibrous nanomaterial, and the resultant fibres will be used for concrete reinforcement. The surface nanomaterials are expected to provide additional mechanical anchoring with the concrete matrix and reduce the extent of interfacial delamination. The properties of fresh concrete and surface-modified fibre reinforced concrete will be determined and compared in terms of fibre-matrix interfacial shear strength, moisture permeability and microscopic imaging of the cracked surfaces.
Expected outcomes and deliverables:	The student will gain visual or hands-on experience on laboratory equipment (such as ultrasonic probe, vacuum oven, mechanical tester, and microscope), materials handling, data collection and data analysis. The student will be expected to produce a report and oral presentation at the end of the project. It is also anticipated that, depending on the significance of outcomes, the student will participate in producing and publishing a scholarly research article.
Suitable for:	This project is open to applications from students with a background in chemical/mechanical/materials engineering.
Primary Supervisor:	Dr Shazed Aziz
Further info:	Applicants may contact the supervisor prior to submitting an application. Contact email: shazed.aziz@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Printed thin-film batteries for Internet-of-Things devices**
Project duration:	*10 weeks*
Description:	The advent of the era of electronics has witnessed increasingly booming trends in developing printed electronics and the Internet of Things (IoT) devices, with broad applications in next generation of flexible sensors, photovoltaics, medical devices, wearable/implantable electronics, paper-like displays, active RFID devices and ultra-thin electronic skins based on highly stretchable organic transistors, etc. In most of these printed electronics, the flexible thin-film battery is an integral component with a predicted market of USD 1.72 billion by 2025 (Grand View Research, Inc.). These large emerging markets have attracted tremendous attention from industries, leading to companies such as Imprint Energy (USA), Enfucell (Finland), Semiconductor Energy Laboratory (Japan) and Printed Energy (Australia), etc. Among these companies, developing low-cost, non-toxic and roll-to-roll printable thin-film batteries is strategically important for taking leadership in the emerging markets in printed electronics. *Aim of the project: Develop printed rechargeable Zn-MnO_2 thin-film batteries for powering IoT devices (flexible temperature sensors with credit card size with functions of sending real-time temperature information to mobile phone).* *Hypothesis: Selection and optimization of battery inks are one of the key steps for achieving high-performance Zn-MnO_2 batteries with decent cycling stability. Different combinations of Zn-MnO_2 battery components with particular focus on the electrolyte chemistries will be prioritized in this project to achieve targeted battery performance.*
Expected outcomes and deliverables:	The applicants will learn how the procedure of assembling a thin-film batteries on your own. In addition, problem-solving in battery research as well as the use of most important battery research facilities can be learned throughout the project. By the end of the project, a demo of printed batteries with integration of temperature sensor will be developed. *Students will be expected to produce a report and oral presentation at the end of their project.*
Suitable for:	T*his project is open to applications from* students with a background in chemical engineering, material engineering or mechanical engineering 3-4 year students.
Primary Supervisor:	Dr Miaoqiang Lyu
Further info:	You are more than welcome to contact the supervisor prior to submitting an application (m.lyu@uq.edu.au). Further information: https://researchers.uq.edu.au/researcher/21555 https://stories.uq.edu.au/research/bending-the-rules-with-flexible-batteries/index.html

SCHOOL OF CHEMICAL ENGINEERING
UQ Summer Research Project Description

Project title:	**Synthesis and characterisation of 'boronolectins' for cell therapy applications**
Project duration:	*10 weeks*
Description:	While researchers and companies in the human mesenchymal stem cell (hMSC) manufacturing field can attain appropriate numbers of hMSCs from individual donors for a multitude of tissue engineering applications, they are not of the right quality and have failed in clinical trials to show efficacy and effect little repair by actually differentiating into the targeted tissue cell type. Independent of the ex vivo culture practice (method, media or culture substrate) used to expand MSCs, during scale-up there is a continual increase in the number of cells entering premature senescence (losing their proliferative and clonogenic capacity), and this is accompanied by a progressive loss in differentiation capacity across the population. This culture-acquired senescence or aged-phenotype is a key determinant in their poor performance in clinical trials. New approaches are required to overcome this roadblock and achieve long-term 'potent' expansion – we are proposing to do this by engaging the stem cell *glycome*, offering a novel, *sweeter* approach to overcoming a long standing scale-up problem for stem cell therapies. **This project:** Aims to synthesise novel cell surface-binding polymers that can invoke hMSC adhesion, spreading, and expansion in the multipotent state. You will synthesise statistical copolymers from a range of monomers in a high throughput manner (using automated liquid handlers) to form lectin mimics (boronolectins). The ability of these polymers to bind to defined glycan (sugar) molecules shown by us in earlier screens to be present on hMSC surfaces will be assessed and characterized. Once functional boronolectins are produced and validated, they will be applied to culture surfaces to assess their ability to support extended culture of hMSCs.
Expected outcomes and deliverables:	The applicant can expect to gain skills in high throughput polymer synthesis, automation, programming, chemical and physical characterisation, polymer surface engineering and processing, stem cell culture and standard biochemical techniques. Through this project, the applicant will also gain professional skills in data collection and analysis, along with the opportunity of co-authorship in a publication from this project.
Suitable for:	This project is open to applications from students with a background in Chemical Engineering (with majors in chemical, biological or materials engineering), Biomedical Engineering and related disciplines.
Primary Supervisor:	Professor Justin Cooper-White
Further info:	http://www.chemeng.uq.edu.au/cooper-white and https://aibn.uq.edu.au/profile/3595/justin-cooper-white and www.aibn.uq.edu.au/uq-stemcare

SCHOOL OF CHEMICAL ENGINEERING
UQ Summer Research Project Description

Project title:	**Designer bioinks for cell bioprinting applications**
Project duration:	*10 weeks*
Description:	Bioprinting is centred around producing a *printed* three-dimensional (3D) tissue-mimicking construct made from a 'BioInk' – a complex non-Newtonian, '*living*' particulate suspension of human cells and polymeric and/or protein-based *precursors* that gel. This exciting, rapidly developing technology is seen to have the potential to significantly reduce the path-to-market of *person-specific* engineered tissue-in-a-dish models, and ultimately, engineered replacements for damaged or diseased organs. Such *personalised* tissue engineered (TEd) platforms, especially if produced in high throughput (HTP), would make possible therapeutic interventions *tailored* to each patient whilst also driving down costs and times for therapeutic discovery. Realisation of this potential requires, at minimum, that each personalised bioprinted tissue be biofabricated at scale reliably with assurance of reproducibility and quality. Extrusion bioprinting of 3D constructs is currently achieved through an iterative trial-and-error process in an attempt to fit within a narrow set of processing parameters that define what is well-established now as the "narrow biofabrication window". The persistence of these narrow biofabrication windows are largely a result of a 'top-down' approach having being applied to hydrogel precursor design. In our lab, we aim to disrupt BioInk design by applying a novel 'bottom-up' approach, and in doing so, expose the enormous potential to create new classes of BioInks with expansive biofabrication windows. **This project:** Aims to determine the impact of chemical composition and structure on the rheological and mechanical properties of hairy colloid BioInk precursors. You will synthesise statistical copolymer multiarm stars from a range of monomers in a high throughput manner (using automated liquid handlers) to form our 'hairy' colloids. The ability of these polymers to transition from solutions to gels and glasses as a function of polymer concentration, with the ability to 'self-heal' after being sheared or extrusion, will be characterized. Lastly, their interactions with cells as a function of cell concentration (up to tissue density) and the resulting impact on the rheological behaviour of new generation BioInks thus created will be investigated.
Expected outcomes and deliverables:	The applicant can expect to gain skills in high throughput polymer synthesis, automation, programming, chemical and physical characterisation, rheological characterisation, cell culture and standard biochemical techniques. Through this project, the applicant will also gain professional skills in data collection and analysis, along with the opportunity of co-authorship in a publication from this project.
Suitable for:	This project is open to applications from students with a background in Chemical Engineering (with majors in chemical, biological or materials engineering), Biomedical Engineering and related disciplines.
Primary Supervisor:	Professor Justin Cooper-White
Further info:	http://www.chemeng.uq.edu.au/cooper-white and https://aibn.uq.edu.au/profile/3595/justin-cooper-white and www.aibn.uq.edu.au/uq-stemcare

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Mathematical modelling of Thermal Plasma jets**
Project duration:	10 weeks
Description:	A wonderful opportunity is available for a student to learn computational fluids dynamics and mathematical modelling to develop a model of Thermal Plasma device. A thermal plasma devise is used for generating high energy plasma jet. The plasma jet technology has diverse application such as plasma jet engines, thrusters for spacecraft, chemical reaction in plasma zone, high temperature incineration, metal melting etc. The plasma energy field is mainly composed of an arc zone and a plume zone. The temperature within the arc zone ranges from 8,000-12,000 deg C, whereas the temperature on the plume zone ranges from 1,200-5,000 deg C. The extremely high temperature within the plasma jet results in some interesting physical behaviour with varied functionality. In this project, the student will learn about the developing mass and energy conservation equations within the plasma devise as well as learn about the electromagnetic phenomenon within the arc and plume. The learnings from this project will prepare the student to model and deal with any complex physical processes in industries. This project is suitable for students who have done a course in CFD and/or has keen interest in numerical method and mathematical modelling. The student will provided with fast processing computing facility and also will be given access to multi-core processing clusters.
Expected outcomes and deliverables:	The student will learn computational fluid dynamics modelling using Ansys Fluent or OpenFoam. The student will generate a working model of 3-D plasma arc model and investigate the mixing of hot plasma plume with atmospheric gas. There may also be an opportunity to participate in the testing of a real plasma jet and do high speed video recording.
Suitable for:	Suitable for 3rd or 4th year graduates in Mathematics, Physics, Chemical Engineering, Mechanical Engineering, Electrical Engineering and related discipline. Student who have done a course in CFD will be preferred but this requirement is not essential. A strong background in numerical methods and understanding of solving ODE's and PDE is essential.
Primary Supervisor:	Dr Pradeep Shukla
Further info:	The student is requested to contact the principal supervisor before applying for the project. pradeep.shukla@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Mathematical modelling of high temperature chemical kinetics inside a plasma plume**
Project duration:	10 weeks
Description:	*The research project entails the investigation of plasma assisted chemical kinetics for Hydrogen and Acetylene formation.* *Thermal plasma presents a unique source of thermal energy to facilitate reactions demanding high activation energy, which would otherwise require expensive catalyst. The heterogeneous catalytic process often demands high operational and mintaince cost. A plasma-chemical process provides an alternative route to produce important chemicals such as acetylene, cyanide, hydrogen sulphide etc.* The plasma-chemical process is distinguishable from conventional thermal chemical reactions in 2 ways: (i) the reactants are heated to extremely high plasma temperature using electric arc where atomic species are formed, and (ii) quenching the plasma flame, that can provide thermodynamic conditions of interest to make desired product and even prevent recombination to unwanted species. To achieve effective molecular dissociation/recombination in stage 1, an effective mixing of reactant species with the ionised radicals in the arc column is desirable. It is therefore imperative to understand the reaction kinetics and species mixing behaviour to optimise the design of a plasma reactor. *This summer vacation project invites motivated candidates to investigate the chemical reaction and species mixing behaviour in a high temperature plasma environment.* *The project work will include CFD modelling using Openfoam along with Chemkin computation engine to solve several hundred chemical reactions taking place in the plasma environment and predict the product yield and reactor performance.*
Expected outcomes and deliverables:	The student will learn computational fluid dynamics modelling using Ansys Fluent or OpenFoam. *Students will gain skills mathematical modelling of species transport in complex reactor system.* *Have an opportunity to generate publications from their research or present in a conference*
Suitable for:	Suitable for 3rd or 4th year graduates in Chemical Engineering Student who have done a course in CFD will be preferred but this requirement is not essential. A strong background in numerical methods and understanding of solving ODE's and PDE is essential. Students who have completed Chemical Reaction Engineering, CHEE3005 will be preferred. Student who plans to extend this vacation work research later as part of individual inquiry & Thesis in the following semester will be viewed favourably, but it is not a mandatory requirement.
Primary Supervisor:	Dr Pradeep Shukla
Further info:	The student is requested to contact the principal supervisor before applying for the project. pradeep.shukla@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Photoelectrochemical Water Splitting for Hydrogen Production**
Project duration:	*10 weeks*
Description:	This project aims at producing renewable solar hydrogen through a photoelectrocatalytic process on semiconductor photoelectrode. This will provide an appealing way to address the more and more serious fossil fuel shortage and environment pollution. With a photoelectrode stimulated by light, it will generate electrons and holes, which can be used for water reduction and oxidation reaction, that is the water splitting process. In order to achieve highly efficient solar hydrogen production, the photoelectrode will be optimized from three aspects, including the light harvesting, charge carrier transfer dynamics and surface reaction. Accordingly, this project will explore some effective strategies, including the facet engineering, defect engineering, cocatalyst loading etc.
Expected outcomes and deliverables:	The scholar will gain the skill in carrying out materials synthesis, photoelectrode fabrication, and the photocurrent data collection. The scholar will also gain advanced knowledge in semiconductor electrochemistry. He/she will have an opportunity to generate publications from their research. Students will be expected to produce a 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, 3-4 year students, UQ enrolled students only.
Primary Supervisor:	Prof. Lianzhou Wang
Further info:	l.wang@uq.edu.au;

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	Process optimisation and monitoring of beer production at pilot scale
Project duration:	10 weeks
Description:	Beer is an ancient fermentation product and its production, still today, often relies on empirical knowledge. However, it is important to understand the biological principles underpinning the process to better control and troubleshoot the system. In addition, the biochemical reactions taking place can be described through mathematical models that can be used for process optimisation. This project has two objectives: - manipulate operational conditions in the beer production process to understand the impact of key parameters on process performance and product characteristics - calibrate a mathematical model to describe the data acquired, and use the model for optimisation, to design the subsequent experiments. This project provides the opportunity to work in a pilot facility located at the School of Chemical Engineering, comprising three brewhouses and seven 100-L fermenters.
Expected outcomes and deliverables:	The student will gain experience in operating a pilot brewery, as well as on process monitoring, sampling and analytical techniques. The student will be expected to make an oral presentation and write a short report of the main results at the end of their project.
Suitable for:	This project is most suitable for students of Chemical Engineering, particularly those doing a Bioengineering major.
Primary Supervisors:	Dr. Gilda Carvalho/ Dr. Adrian Oehmen
Further info:	g.carvalho@awmc.uq.edu.au/a.oehmen@uq.edu.au

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	Bio-reduction of oxidized contaminants driven by natural gas
Project duration:	10 weeks
Description:	Natural gas is a potentially cheap carbon source. However, it is unknown if it can be utilized as electron donor to reduce emerging oxidized contaminants in groundwater. In this project, we will study the feasibility of oxidized contaminant bio-reduction driven by natural gas under oxygen-limiting conditions. We will set up several independent natural gas-based MBfRs for enriching active biofilms to achieve oxidized contaminants reduction. We will operate the reactors in continuous flow mode, and analyze the microbial communities and functional genes in the biofilms. The findings might be facilitated to the development of cost-effective strategies for ex situ groundwater remediation.
Expected outcomes and deliverables:	Scholars may gain skills in bio-samples processing, data collection, and microbiological analysis, and have an opportunity to generate publications from their research. Students will be expected to produce a report and oral presentation at the end of their project.
Suitable for:	This project is open to applications from students with a background in environmental engineering, UQ enrolled students only.
Primary Supervisor:	Dr Chunyu Lai
Further info:	Email address: chunyu.lai@uq.edu.au The supervisor wishes to be contacted by students prior to submitting an application.

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	**Inorganic microcapsules for controlled deposition and triggered release of active ingredients.**
Project duration:	8-*10 weeks*
Description:	Control of the diffusion of small active ingredients is important for a wide range of applications that require delivery of ingredients in a specific place and timeframe. Surrounding the active ingredient in a protective shell, known as encapsulation, is a common and useful technique to allow controlled release. Our group has developed novel encapsulation technologies to provide a complete barrier to the diffusion of small molecules until release is deliberately triggered. This project will investigate the properties of novel, inorganic nano-shells, used to encapsulate small molecule active ingredients, to understand potential release triggers and adhesion to surfaces for applications in pesticide delivery.
Expected outcomes and deliverables:	Students will develop skills in project planning, data collection and data analysis, and may have an opportunity to generate publications from their research. Students will be expected to produce a report and oral presentation at the end of their project.
Suitable for:	This project is suitable for students with a Chemical Engineering or Chemistry background, with an interest in Nanotechnology/Materials Science. Previous laboratory experience desirable. 3-4 year students preferred.
Primary Supervisor:	Dr Alison White
Further info:	Please contact a.tasker@uq.edu.au for further information

SCHOOL OF CHEMICAL ENGINEERING

UQ Summer Research Project Description

Project title:	Decoupling the effect of pH, NO_2^- and FNA concentrations on N_2O production by mainstream nitrifiers
Project duration:	10 weeks
Description:	Nitrous oxide (N_2O) is a potent greenhouse gas with a global warming potential about 300 times than that of CO_2. Wastewater treatment plants (WWTPs) are noneligible sources for N_2O emissions. It is of vital importance to mitigate N_2O emissions for the energy and carbon neutral development of WWTPs. To study the effect of different environmental conditions on N_2O production is, therefore, necessary for N_2O mitigation. Different environmental conditions including dissolved oxygen, pH, NO_2^- concentrations, free ammonia (FA), free nitrous acid (FNA) concentrations and salinity were found to influence N_2O production. Among these factors, the individual or combined effect of pH, NO_2^- and FNA concentrations was not clear, since FNA is determined by both pH and NO_2^- concentrations. Therefore, this project aims to decouple the effect of pH, NO_2^- and FNA concentrations on N_2O production. We will set up a membrane biofilm reactor to enrich nitrifiers. This reactor will be operated under continuous flow mode in order to get high biomass concentration. After the biomass are enriched, we will conduct batch tests at different pH, NO_2^- and FNA concentrations to study the N_2O production dynamics. N_2O production pathways will be investigated by site-preference isotope technology. The findings will provide some insights on the individual or combined effect of pH, NO_2^- and FNA concentrations on N_2O production mechanisms, which will be further add the knowledge to N_2O mitigation strategies.
Expected outcomes and deliverables:	Scholars may gain skills in wastewater treatment process design, biological reactor setup and maintenance, data collection and processing, and have an opportunity to generate publications from their research. Students will be expected to gain more vivid and practical knowledge on wastewater treatment process, and to produce a report and oral presentation at the end of their project.
Suitable for:	This project is open to applications from students with a background in environmental engineering, UQ enrolled students only.
Primary Supervisor:	A/Prof. Liu YE
Further info:	Email: l.ye@uq.edu.au The supervisor wishes to be contacted by students prior to submitting an application.