Industry Issue

More value for the Australian rice industry

Unlocking the potential of sodium borohydride as a reversible hydrogen store

A/Prof Mike Manefield joins UNSW Chemical Engineering

Polymer nanoparticles improving paint coatings

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Welcome to our newsletter, Winter 2017

Welcome to our new research newsletter with this edition focusing on our industry collaborations. Chemical Engineering at UNSW has an enormous range of multi- and interdisciplinary research which has impacted many Australian and international industries. Working with external partners helps drive the application and impact of our research expertise and supports the relevance of our learning and teaching programs across industry.

In the food arena, Associate Professor Alice Lee looks at food labeling issues for the consumer. Ph.D. student Shirin Dabestani, working with Associate Professor Jayashree Arcot and I, explored the recovery of valuable plant proteins from potato processing water with a major food processor, Simplot. One of the highlights of that collaboration was watching the massive production of frozen chips from truckloads of locally grown potatoes in their Tasmanian factory. Sponsored by SunRice and Rural Industries Research and Development Corporation, Associate Professor Jian Zhao looks at the potential benefits of rice bran proteins as a valuable by-product for Australian farmers.

In another important worldwide industry, Dr Yansong Shen’s multiphase modelling research drives advanced manufacturing improvements for steel and iron. Professor Per Zetterlund is also leading the way by using interfacial engineering with nanoparticles to produce environmentally friendly coatings for Allnex. Advanced materials for hydrogen storage are developed for a growing new energy market by Associate Professor Kondo-Francois Aguey-Zinsou. And finally, a recent addition to our staff, Associate Professor Mike Manefield, tames microbes to remediate wastewater and improve conversion of biogas.

We also showcase our young alumni in industry and government roles, Lei Wang and Mega Ng respectively. We hope that this issue gives you the multifaceted view of the school’s research and its people, and we look forward to expanding our horizons further.

Professor Vicki Chen
Head of School, UNSW Chemical Engineering
Warning, this article may contain controversy

Associate Professor Alice Lee explains what the precautionary words “may contain” really mean and how she believes the Australian food industry can improve its allergen information product labelling.

Associate Professor Alice Lee explains what the precautionary words “may contain” really mean

Have you noticed the proliferation of “may contain” warnings on the most incongruous of products? Could there really be nuts in your dried pasta? Unfortunately, the answer is far from simple.

Most food allergies are caused by peanuts, tree nuts, milk, eggs, sesame seeds, fish and shellfish, and soy and wheat. Exposure to these allergens causes anything from mild discomfort to potentially life-threatening anaphylaxis. To protect sufferers, Food Standards Australia and New Zealand (FZANZ) states that these ingredients or components thereof must be declared on the food label. That’s straightforward enough. So far, so good.

Where it gets murky is that allergenic ingredients are often not separated from non-allergenic ingredients in manufacturing facilities. Formulations that contain allergenic ingredients may be processed on the same facilities and processing lines as those with non-allergenic ingredients.

“In today’s food manufacturing environment, it is virtually impossible to ensure zero chance of cross-contamination because production lines are used for a huge variety of products,” says allergen expert Associate Professor Alice Lee from UNSW Chemical Engineering.

“This obviously has important implications for people with severe allergies, where even a speck of a peanut can kill them.”

This has led to many food producers (the majority of which are small- to medium-sized businesses in Australia) opting for the safest, and cheapest, route of over-labelling their products with allergen warnings to protect against potential litigation, even if the chance of contamination is tiny. While this might seem sensible, it dramatically reduces the number of safe products available for allergy sufferers and is incredibly misleading, Lee says.

“In 2008, we checked the Precautionary Allergen Labelling (PAL) statements for the home-brand products of major Australian supermarkets and most of them contained all eight allergens on the list,” she says. “In 2011-2012, we did a survey on confectionary products with and without the ‘may contain nuts or peanuts’ warning. We found positive peanut residue in 5-10 per cent of all cases, regardless of whether they had the warning on the label or not. The real problem with the ‘may contain’ statement is that there is absolutely no way of knowing whether [food] has or doesn’t have allergen residues from cross-contamination.”

With growing confusion and frustration among allergy sufferers, the Allergy and Anaphylaxis Association, a patient support organisation, is pushing for risk-based assessment and labelling. This idea is also at the heart of Lee’s ongoing research and activities.

Although the situation is complex, Lee believes she has a solution. “I believe the next step is to use PAL to effectively communicate the risk,” she says. “This can be done by setting threshold levels for each of the major allergens (that is, the maximum dose patients can consume without it causing an allergic reaction) and the action levels (the maximum amount of an allergen that can exist in a product) accordingly.

“The Allergen Bureau (which advises the food industry on the management of food allergens through the Voluntary Incidental Trace Allergen Labelling, or VITAL, program) has worked hard to identify these levels scientifically with the ARC Training Centre for Advanced Technologies in Food Manufacture, but we’re currently at an impasse because FSANZ has not endorsed them. They are concerned about the uncertainty and accuracy of the analytical techniques used to measure allergenic residues in food, particularly in processed food.”

While she recognises this is a concern and is working on allergen-testing methodologies to improve these results, Lee believes the stalemate needs to end. This is why she has organised and will chair the upcoming Food Allergy Management Symposium – FAMS2017.

“The symposium is about improving communications between different stakeholders including food regulators, food manufacturers, consumer groups, clinical allergists, dieticians and food scientists,” Lee says. “I’m conscious that there is still an issue with the analytical methods, but I think we need to push for action levels.”

“Japan is a great example of a country, where food allergy is prevalent, that is managing allergy information well using action and threshold levels. So why are we hesitating?”

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Alice Lee is Associate Professor and Food Program Authority in UNSW’s School of Chemical Engineering, Food Science and Technology group. She is also co-director of the ARC Training Centre for Advanced Technologies in Food Manufacture and leads a highly active research program concerning food biochemistry, food analysis/immunodiagnosics and food safety, including the area of food.

“I believe that food is our best medicine,” Lee says. “Our immune system in health and disease is very much dependent on the types and conditions of food that we eat. My food-allergy research aims to find practical solutions for primary and secondary prevention via food processing and dietary intervention, and developing better diagnostic tools for allergy management.”
A researcher, teacher, inventor, collaborator, entrepreneur and author of children's books on the environment, Associate Professor Michael Manefield holds a continuing appointment between the Schools of Chemical Engineering and Civil and Environmental Engineering at UNSW.

Through his expertise in microbiology, environmental biotechnology and ecosystem engineering Manefield strives to extend the research and knowledge base through academic work and this knowledge of microorganisms is being applied to solve environmental and industrial problems in bioremediation and biogas generation.

He grew up on various properties in country NSW and credits his parents (both teachers) as the inspiration for his curiosity and pursuit of knowledge. “I’ve always been curious to know how things worked and very curious as to how animals worked from the inside” Manefield says.

Manefield confesses to be an individual who marches to the beat of a different drum. “Years ago, my parents gave me a poster with a picture of a photo of this massive rock spire - this guy standing on top of it. It said down the bottom “I’m not an ordinary person” and I don’t know if I took that to heart, if it was predictive or if it was just something that they’d observed of me. But I’ve always been more tempted to do unusual things I think than follow the norm.”

Armed with this philosophy, his approach is to “…motivate people by encouragement; for them to think outside the box. I encourage people to go their way and to try things, no matter how crazy an idea might seem.”

After completing his PhD at UNSW in 2000, Manefield left Australia. “It is a rite of passage for an Australian researcher to go overseas and spend a year or two as a postdoc in a laboratory.” He enjoyed stints at Oxford and Cambridge (UK), Copenhagen (Denmark) and Kamaichi (Japan) where he observed and interacted with “…a lot of really brilliant people and tried to absorb as much of their genius as I possibly could, to learn how they were doing things, what they were motivated by, what they were interested in. So that had a big influence as well.”
It was in the UK that Manefield experienced his first interaction with industry. “My job was to identify phenol degrading bacteria in a waste water treatment plant that was treating coking effluent from steel manufacturing. I spent lots of time taking samples and then using the commercial partner’s lab to set up experiments because they had to be done with fresh sludge.”

At an important stage of the experiment and with time pressures to deliver results, Manefield and his colleagues needed to vacate the laboratory. “We had to restart the experiment. So we took this whole experiment and set it up in a cupboard in a B&B. We set an alarm and took turns during the night to take samples with this thing bubbling away. This was my first industry interaction. Lesson: Innovate.” (Note: Manefield does not recommend that anyone should try this method at home or in a B&B!).

He returned to UNSW in 2004.

Manefield believes that developing relationships with industry is crucial. “Ideas are great. To make them work you have to take on society as a whole - academia, industry, government and community. Researchers have to facilitate application through relationships with industry to affect positive change. Nobody else will do it.”

John Giltrap, Managing Director of Enretech is into his third bioremediation research project with Manefield. “From my very first meeting with Mike about three years ago, I was impressed that here was somebody who had a real intent to do research and actually commercialize it. In subsequent meetings, I learned that he had incubated a small company at the University. As time went on we realized there were common interests in the commercialization of Mike’s work.”

To this end, Manefield says: “Enretech Australasia has become a vehicle for commercialising our research and expertise.”

Giltrap says he is pleased to have formed the company “Novorem” (Novo – New; Rem – Remediation) a joint venture between Enretech and Micronovo (the company Manefield established), which will “…continue with the research and discovery of new technologies that we could market jointly.” Giltrap continues, “While it is early days for Novorem, we are seeing positive cash flow. We also see very lucrative opportunities for Novorem in the remediation of crude oil sludges which are very difficult to degrade and dispose of particularly in view of environmental legislation.” Giltrap estimates the problem to be in the billions of dollars globally. “Mike’s research and technologies are the key elements to moving forward.”

“I follow Novorem very closely” Manefield says. “I have former students who are full time employed there which is nice. In addition, as a consequence of our research and commercialisation, the Australian remediation community now considers biological remediation as a viable option. It’s a great option for remediating contaminated sites because it’s very low energy and low cost. You’re basically trying to encourage the microorganisms to play their role as the liver of the planet.”

READ MORE ONLINE
In collaboration with SunRice, one of the largest rice companies in the world, UNSW School of Chemical Engineering researchers have discovered that rice bran protein contains peptides that exhibit significant antioxidant, antidiabetic and antihypertensive effects. Although more research is needed, this discovery has the potential to add significant value to the Australian rice industry.

The Australian rice industry faces a number of challenges including rising production costs, fluctuating water availability, climate change and competition from low-cost production countries. There is a growing recognition that to remain internationally competitive and be able to provide a reasonable return to rice farmers, the industry needs to innovate.

Jian Zhao’s team presented an innovative and commercially-relevant research proposal that offered alternative and creative uses for value-added products from rice bran, a major by-product of the Australian industry. The benefit of a collaboration like this, between researchers and commercial businesses within the food industry, is the development of innovative and cost-effective solutions that will deliver significant nutritional benefit. As a result of this research, RIRDC was able to better define the scope of the proposed work and validate the potential outcomes through collaborative discussions with Sunrice.

According to Associate Professor Jian Zhao, expert in food science and technology from UNSW School of Chemical Engineering, value-adding should be given top priority as it increases the value of the crop without requiring additional farmland, water and other agricultural resources. But where does he anticipate getting this added-value from?

“Rice bran makes up approximately 10 – 12% of the rice grain and the Australian rice industry generates around 100,000 tonnes of it per year. Most of this bran is used as stockfeed, which provides a low return to companies like SunRice. Now, we know that rice bran comprises 12–16% protein which we hypothesised could be transformed into health-benefiting properties with antioxidant, antidiabetic, blood pressure and cholesterol-lowering and anticancer effects,” explains Zhao.

PARTNERSHIP OVERVIEW

Partner: SunRice

Type of partnership: Ongoing since 2000

Funding: For this specific project: $64,000 over three years from the Rural Industries Research and Development Corporation. Previous funding sources have included ARC Linkage funding and contract research.

Purpose: Transforming a low-valued by-product of rice milling into a potentially high-valued ingredient for health products and helping the Australian rice industry have a better return to farmers.

Outcomes: Laboratory tests have shown that rice bran proteins possess significant antioxidant activities and have the capacity to block physiologically important enzymes which could be used to treat conditions such as diabetes and hypertension.

Michael Beer
Program Manager Research and Innovation, Rural Industries Research and Development Corporation (RIRDC).
“The idea is based on research on dairy, legume and other cereal proteins which shows that controlled hydrolysis can produce certain health-benefiting hydrolysates which are increasingly used in products for preventing a number of chronic diseases prevalent in modern society.”

Globally, the functional food and nutraceutical market is estimated to be worth $168 billion and is projected to grow to $305 billion by the year 2020. Zhao believes that the unique composition of rice bran protein, coupled with its low allergenicity, compared with many other cereal and legume proteins, represents a unique opportunity for the rice industry.

Against this backdrop, Zhao and his collaborators at SunRice applied for, and received, Rural Industries Research and Development Corporation (RIRDC) funding for their project. “In 2016, we finished the “blue sky” research phase and the results are very positive,” says Zhao. “Laboratory tests showed that rice bran proteins possess significant antioxidant activities and have the capacity to block physiologically important enzymes, which could be used to treat conditions such as diabetes and hypertension.

The findings of the research have several important implications. For the rice industry, they imply a significant opportunity to develop rice bran-based functional food and nutraceutical products. For the general public, the findings could help improve their knowledge on the health benefits of rice. For the scientific community, this project points to several major directions for further research, and for policy makers, these results demonstrate a strong case to allocate further funding opportunities so researchers can continue to investigate this opportunity.

Zhao believes that although it will depend on significant investment, future commercialisation prospects are very good and he is in the process of applying for more funding from RIRDC, with SunRice, to continue to investigate rice bran. “In this next phase we’re interested in extracting the fibre from rice bran, which we think has many potential applications and various health properties,” continues Zhao.

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“The commercial and practical importance of coatings, such as paints, in today’s society can hardly be overstated,” says Professor Per Zetterlund who is the Co-Director of UNSW’s Centre for Advanced Macromolecular Design.

According to Zetterlund, coatings can either be solvent-based or waterborne, but he says that with the ongoing drive towards more environmentally friendly coatings, there is a strong need to replace traditional solvent-based coatings with entirely waterborne systems. “Waterborne coatings are a key measure by which the coating industry is able to meet legislative and environmental requirements to reduce their emissions of anthropogenic Volatile Organic Compounds (VOCs), which have been identified as key agents in long-term health impacts,” he explains.

Although the industry is facing increased regulation in an effort to improve interior and exterior air quality, there are still hurdles to overcome because without the use of VOCs, current waterborne coatings exhibit crucial shortcomings related to film formation. This includes poor gloss, cracking, and poor moisture and chemical resistance. Moreover, extensive use of VOC additives is not only undesirable from an environmental perspective, but also compromises properties such as drying rate, hardness build-up, and in some cases chemical resistance.

In order to address these shortcomings, Zetterlund and his team joined forces with partner organisation Allnex Industries (who do a lot of work on different types of polymer resins, paints and coatings) on a project to develop clean and effective waterborne coatings. “Current practice in industry has been to mainly rely on a trial-and-error approach, which can be time-consuming, expensive and may not lead to optimum products. This project is looking to develop a quantitative understanding of the relationship between the method of polymer particle synthesis, the morphology of composite polymer particles, and the properties of the final polymer film,” continues Zetterlund.

They have made great progress as Zetterlund explains: “The biggest outcome so far is that we have developed a completely new way to characterise the internal morphology of these so-called gradient nanoparticles based on a method called XPS [X-ray photoelectron spectroscopy]. The other important thing we’ve achieved is a good understanding on a mechanistic level of how to design a process in order to obtain polymeric nanoparticles with a specific internal structure. The remaining task is to link these two with the properties of the final films.”

Zetterlund says the four-year Linkage grant ends in March 2018, but he is very hopeful the research will continue with a second Linkage grant and will soon be travelling to Allnex headquarters in The Netherlands to discuss future steps.

**PARTNERSHIP OVERVIEW**

**Partner:** Allnex Industries (formerly Nuplex Industries)

**Type of partnership:** Initially, contract research; then continued with an Australian Research Council (ARC) Linkage Project grant

**Funding:** $300,000 from ARC and $200,000 from Allnex, plus in-kind provisions.

**Purpose:** Develop environmentally friendly high-performance waterborne coatings that will enable the replacement of currently employed solvent-based systems.

**Outcomes:** 1: A completely new way to characterise the internal morphology of gradient nanoparticles using a method based on X-ray photoelectron spectroscopy. 2: Mechanistic understanding of how to design a process in order to obtain polymeric nanoparticles with a specific internal structure.

**Fundamental research to make paint more environmentally sound**

In collaboration with Allnex Industries, a team from the Centre for Advanced Macromolecular Design (CAMD) in the School of Chemical Engineering at UNSW is well on the way to developing environmentally friendly high-performance waterborne coatings to replace the more toxic solvent-based alternatives.

"For Allnex Industries, working with Per Zetterlund’s group has provided a great platform for in-depth scientific discussions on complex issues related to real-life production processes. The collaboration has provided us with new methods to answer questions that we only had assumptions on before, leading to adaptations of some of them, and triggering new ideas on how to improve our products."

Dr Richard Brinkhuis, Allnex Industries

This includes poor gloss, cracking, and poor moisture and chemical resistance. Moreover, extensive use of VOC additives is not only undesirable from an environmental perspective, but also compromises properties such as drying rate, hardness build-up, and in some cases chemical resistance.

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**Featured expert: Professor Per Zetterlund**

Per Zetterlund is the Co-Director of CAMD a world-renowned centre for polymer synthesis and characterisation. His research is concerned with the synthesis of polymer, polymeric nanoparticles, as well as hybrid polymeric materials with a variety of applications ranging from materials science to nanomedicine. An important aspect of his research is the use of environmentally friendly carbon dioxide in polymer (nanoparticle) synthesis.
INDUSTRY PARTNERSHIP

Protein recovery from potato processing stream waste using membrane technology

Wastewater effluent from the food processing industries contains high concentrations of potassium, COD and BOD (chemical and biochemical oxygen demand) caused by the presence of starch, proteins, amino acids and sugars, imposing expensive treatment processes to the companies before discharge to the sewage system.

The waste stream from the potato processing industry particularly contains considerable amounts of these valuable by-products. Starch is recovered using simple separation systems including hydro-cyclones. However, commercially valuable proteins are still wasted. This led to collaboration between Jocelyn Midgley (Simplot Australia) and UNSW School of Chemical Engineering Professor Vicki Chen, Associate Professor Jayashree Arcot and PhD student Shirin Dabestani, to find a solution to extract valuable high quality proteins from wastewater.

For Simplot Australia, the project was a combination of the Value Engineering approach (ie. what is in their waste streams that were not being utilised?), and marrying that with food trends. Protein, particularly plant proteins, is a food trend that has been gathering increasing momentum with consumers. Although the level of protein in this wastewater is low, large volumes of potatoes are processed, thus for Simplot Australia it was an investigation of opportunities.

“We were invited to become an Industry Partner of the ATFM, it was an easy choice. First was the quality and capability in membrane science, but also the centre’s ability to marry food (food science and nutrition) with engineering. When it comes to commercial food manufacturing, a product flows through a mechanical/chemical process. It makes sense to develop candidates with skill sets from both departments. Secondly was the ease we had with Intellectual Property negotiations – it was clear and simple.”

Dr Jocelyn Midgley, R&D Manager Simplot Australia Pty Ltd

Membrane technology has been successfully used to recover proteins from dilute waste streams such as cheese whey, utilizing a combination of concentration and diafiltration steps. Using UNSW Sydney expertise, this research project focused on vegetable protein recovery and processing. Novel membrane configurations to handle high solid concentrations were explored in addition to conventional membrane processes. Characterization of protein fractions/functionality, membrane fouling, and recovery was incorporated.

The plant protein extracted in this project can play a major role in food manufacturing due to its foaming, emulsifying and solubility properties. With a relatively high amino acid index (89%), potato protein can replace animal protein in processed food products due to the associated health benefits.

A membrane rig on a pilot scale including the proposed pre-treatment set-up was designed and built which underwent successful testing and will be used for future trials by the industry.

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PARTNERSHIP OVERVIEW

Partner: Simplot Australia
Type of partnership: Industry Partner, ARC Training Centre for Advanced Technologies in Food Manufacture (ATFM) ARC Linkage Project grant
Funding: >$150K in cash and in-kind
Purpose: Explore membrane configurations and conventional membrane processes for protein recovery from potato processing waste streams
Outcomes: Once lost vegetable proteins can be reintroduced into new foods

Featured expert: Associate Professor Jayashree Arcot

Jayashree Arcot’s expertise is in food composition, food chemistry, micronutrient bioavailability in humans, resistant starch and probiotics in animals and humans and biodiversity. She was instrumental in setting up an exclusive cell culture facility for studying the bioaccessibility of micronutrients and bioactives in foods. These analytical and research facilities have put UNSW in the spotlight as the only reputed food analytical laboratory in the Oceania region with both analytical and research capability for method development, analysis and bioavailability of vitamins and minerals in foods.

Featured expert: Professor Vicki Chen

Vicki Chen is the Head of School of Chemical Engineering at UNSW and past director of the UNESCO Centre for Membrane Science and Technology. Vicki has a broad expertise in liquid and gas phase membrane separation and has led fundamental and applied projects on membrane fabrication, characterisation and process optimisation in water, gas and food applications. Vicki’s current research is focussed on the use of membranes in carbon dioxide capture and sequestration projects and the development of advance desalination processes for zero liquid discharge systems.
Multiscale study of raceway operations for low cost and stable ironmaking. Interview with researcher Dr Yansong Shen

FAST FACTS
RESEARCH OUTPUTS - UNSW School of Chemical Engineering

11 RESEARCH CENTRES
588 PUBLICATIONS IN 2015/2016
$11,987,193 EXTERNAL FUNDING 2014/2015
Dr Yansong Shen, who joined UNSW School of Chemical Engineering in 2016, applies his knowledge of engineering and computer modeling to boost the competitiveness of industry partners, largely in the energy and resources sectors. We sat down with Dr Shen to learn more about him and his work.

Q. Where were you born?
A. In China, close to the Russian border.

Q. Who were your earliest influences?
A. My parents and my uncle who is a University Professor in China.

Q. Who are your academic / professional mentors?
A. My PhD supervisor, Professor Yu. He is the reason I came to UNSW, Sydney. In 2003, he was visiting China and I attended a seminar he gave when I was an undergraduate at Northeastern University. I was impressed. So that's why I pursued my PhD with him and then worked with him for a couple years after that.

Q. What is your research about?
A. Basically my research area is process modeling and optimization. I gave a name to my research team: PROMO. “Pro” = process; “M” = modeling, “O” = optimization. It's about mathematical modeling of reactive flow systems with applications to a range of complex processes and reactors especially in resource and energy industries, including process metallurgy, solid fuel preparation/utilization, and renewable energy processes like solar cell, biomass, hydrogen, and batteries. My research interests range from understanding fundamentals to optimising and developing new, cleaner and more efficient technologies, powered by advanced numerical and experimental approaches. The market opportunity exists for my group because the industry processes we work with are usually very complex, involving massive multiphase flow, heat transfer and mass transfer. And industrial processes have to be optimized to be competitive and sustainable which requires innovative research and development to achieve this goal. Our expertise in process optimization modeling is a practical option for industry because testing inside an industry reactor is very risky and very costly and you can't charge something to test it because it might damage the reactor, which could be catastrophic.

For example, pulverised coal combustion in iron making blast furnaces involves a deep knowledge of metallurgy and engineering as applied to new research techniques. We deliver our computation model to the industry partner and upgrade our model based on their feedback.

Q. How did ARC Linkage projects with Baosteel and Coal Energy Australia come about?
A. We formed a collaboration with Baosteel and Coal Energy Australia under a $1.1M ARC Linkage Grant in 2015 (the objective being to optimize raceway operations in blast furnaces and to assess the performance of pulverised Australian brown coals in the steel industry).

The background to this is we approached Baosteel when they started operating a research centre in Queensland. We then went to Shanghai to understand their industry needs and subsequently met with them on a number of occasions, explored the collaboration opportunities and were able to form a partnership by highlighting our successful track record with different industries.

In the case of Coal Energy Australia, they approached us because we had the reputation of how to simulate coal combustion in a blast furnace and how to design the coal products.

So it’s a perfect match. Coal Energy Australia is a coal provider and Baosteel is a coal end user. We are in the middle. We can advise Baosteel how to inject their brown coal and advise Coal Energy Australia how to design their brown coal products.

We also have a project with Coal Energy Australia to develop a step-changing raw material for ironmaking based on improved brown coal upgrading technology. There are two parts to this project. The first one is how to cost effectively upgrade brown coal and make a composite into briquettes for domestic and export markets. To do this, we need to devise a new numerical method regarding how to make a suitable briquette for blast furnace charging materials. As value-added products, briquettes could replace brown coal as exports to China, which provides more than 60 percent of the steel output globally. So it’s a significant opportunity.

Second, once we make it, how can we evaluate if it works well or not in the real blast furnace? We model the experiment because we cannot test our methods in the real blast furnace. A blast furnace testing inside an industry reactor is very risky and very costly and you can't charge something to test it because it might damage the blast furnace and to restart again can cost a billion dollars.

Q. How do you transfer your technology to industry?
A. Every time we deliver some code to industry, we spend time with the industry partner to demonstrate how to use it, fine tune the model in case they have additional requirements and generally ensure they gain the confidence to use it.

Q. What are the elements of a successful partnership?
A. I think communication is the most important thing, followed by flexibility in terms of all parties being open to a change in direction of a project if deemed necessary. Finally, set up commercial arrangements very carefully to ensure the issues around background intellectual property and new intellectual property is well defined and understood.

READ MORE ONLINE
“Yield stress” probably isn’t top of your mind when you reach for your shampoo, shaving gel or mascara, but this property is absolutely critical for the integrity of these types of products.

The majority of formulated fluid products (including cosmetics, foods and pharmaceutical preparations), remain physically stable during their shelf-life as a result of yield stress, which makes it solid-like at rest, but fluid-like when sufficiently disturbed.

As a result, robustly manufacturing and controlling yield stress fluids is a central goal of formulated product design; but according to P&G the biggest technical delay in moving a product from concept to market is the experimental time required to test the long-term stability of product suspensions. Because the failure of yield stress suspensions cannot be predicted, it typically requires from two to 12 months to test each new formulation’s stability.

Considering the costs associated with this testing period, not to mention the competitive advantage that may be lost during this time, Associate Professor Patrick Spicer says it is highly surprising that there is no theoretical or empirical model that can predict whether a given formulation’s bulk physical properties will stabilise a known load of suspended particles, or for how long. “This kind of capability would vastly accelerate new product development,” says Spicer who is a co-founder of UNSW’s Complex Fluids Group.

“Jie made such ready progress at the beginning of the project that we were soon able to think more broadly about what we could do with the insights gained. She has developed an innovative small-scale testing unit which has shown such fascinating results that P&G have invited her to their headquarters in the United States for several months, at their expense, to continue the work. I think this recognises both her capability and just how important the project has been to them.”

Spicer says the most satisfying part of working on this type of project is being linked to the newest developments in industry while still being able to ask really interesting, fundamental questions. “These two systems feed back into one another nicely and I love sitting in the middle of that,” continues Spicer who says the research has generated many more ideas for projects with P&G in the future.

“Development and testing of a new means to evaluate fluid rheology and be more predictive about our product and material stability is a great outcome. We’re also delighted to be able to bring the PhD student on the project, Jie Song, to our Research Centre in the US for a six-month project with our group. Projects like this are an excellent way to expose talented technologists to applied problems. They also enable us to learn from, and sometimes recruit, top talent.”

Marco Caggioni, Senior Engineer at Procter & Gamble

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PARTNERSHIP OVERVIEW

Partner: Procter & Gamble

Type of partnership: Contract research

Funding: $80,000 (funded by P&G plus in-kind support)

Purpose: Close an important knowledge gap by linking the processing history of a fluid to its microstructural length scale distribution, its yield stress and its stability.

Outcomes: An innovative small-scale rheometer that can test very fragile structures in products that might not normally be resolved by currently available equipment.

FEATURED EXPERT: ASSOCIATE PROFESSOR PATRICK SPICER

Patrick Spicer heads the UNSW School of Chemical Engineering's Complex Fluids Group, a diverse team of researchers studying the interactions of microstructure and flow in formulated foods and other materials. The group works with industry and academic partners to design smart fluids with unique response and flow behaviour linked directly to product and material performance.

FAST FACTS

RANKING - UNSW School of Chemical Engineering

#1
CHEMICAL ENGINEERING SCHOOL IN AUSTRALIA®

TOP 15
CHEMICAL ENGINEERING SCHOOL WORLDWIDE®

* 2016 National Taiwan University Rankings
Much can be said of Associate Professor Kondo-François Aguey-Zinsou’s ground-breaking work on hydrogen as a source of clean energy. But one of the most fascinating projects he is currently working on is a collaboration with the US Navy on unlocking the potential of sodium borohydride to solve the hydrogen energy storage problem.

With a high chemical energy density and zero emissions when produced from renewable resources, Associate Professor Kondo-François Aguey-Zinsou believes that hydrogen is set to become a major fuel of the future, and one which “bridges the gap” between intermittent renewable and rapidly depleting fossil fuels. However, key to this effort is working out a way to effectively store and release hydrogen on demand.

His team have already developed a material capable of storing hydrogen at a low storage capacity, and what he is seeking to do in this project with the US Navy is design a material with a much higher storage capacity. “I can make an analogy with computers,” explains Aguey-Zinsou who leads the team at Merlin – the Materials Energy Research Laboratory in Nanoscale at UNSW School of Chemical Engineering.

“First generation computers were only able to do simple operations, but nowadays we have computers capable of doing billions of operations at the same time. That’s the kind of “step-change” we’re working on right now with hydrogen storage.”

Specifically, his team are working on a way to control or “unlock the potential” of the properties of components called borohydrides by working at the nanoscale. Says Aguey-Zinsou, “At Merlin our approach to solving this storage problem is to engineer hydride materials “atoms by atoms” so we can accurately tailor their properties for given applications. We think that if we can make nanoparticles of those materials then we will be able to control the way they absorb and desorb hydrogen.”

Having proved this idea in concept, Aguey-Zinsou says the next stage, and indeed the motivation for this project, is to design a practical material that can store 5-10 times the hydrogen storage capacity of their current material.

With a fruitful relationship with UNSW Engineering going back many years, the US Navy heard about the work of Aguey-Zinsou and expressed an interest in funding this fundamental research.

“For Aguey-Zinsou, the most satisfying part of the project is the free reign he’s been given to develop new and exciting ideas. “The US Navy are after really profound fundamental research. For obvious reasons, they want to be at the edge of this technology, so are pushing us to come up with things that are really innovative, which is hugely enjoyable.”

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**Featured expert: Associate Professor Kondo-François Aguey-Zinsou**

Kondo-François Aguey-Zinsou has a Master in Surface and Interface Sciences and a PhD in Heterogeneous Catalysis. He has worked at the University of Queensland, the GKSS Research Centre in Hamburg, Queen Mary University London, and University College London. Since joining the School of Chemical Engineering in 2009, he has received AU$3 million in grant funding, founded the Materials Energy Research Laboratory in Nanoscale (Merlin) and focused on the properties of light metals and their hydrides at the nanoscale for hydrogen storage application.
UNSW Chemical Engineering PhD graduate Dr Mega Ng is applying her expertise as a Scientist in the Environmental Forensics Team of the NSW Office of Environment and Heritage. Dr Ng is part of a multidisciplinary team and uses her skills and knowledge in the areas of analytical chemistry, ecotoxicology and environmental forensics.

Dr Ng graduated in 2014 under the supervision of Professor Rose Amal and Dr May Lim. Her PhD research examined the impact of variability in water characteristics on water treatment processes. She also developed strategic and integrated approaches on organic matters removal. As part of the forensics team she provides chemical analysis for a range of toxic and dangerous chemicals that caused significant harm to the environment. She specialises in trace metal analysis by ICP-AES/ICP-MS methods and water quality analysis.

However it is not just the scientific skills that Dr Ng brings to her role. “Apart from the ability to use scientific equipment, I also bring analytical, problem-solving, adaptability, communication, and interpersonal skills. My PhD really equipped me with the ability to think laterally and come up with creative solutions.”

She adds “It is my ability to analyse ambiguous problems, understand and derive conclusions from these problems, and communicate the findings from my analysis that help me carry out the tasks in my current role.” Dr Ng believes that young researchers wishing to establish a career outside of academia need to acknowledge and communicate their broad set of skills. Dr Ng still collaborates with UNSW research projects and honours student supervision.

He further adds that the countless presentations given during his PhD provided a wonderful training ground for his current role, where he is calm and confident presenting in front of a large crowd and has learned to be mindful about the background of the audience, adjusting the level of scientific language accordingly.

For young PhD graduates wishing to enter industry, Dr Wang advises that the most important factor is to not underestimate your value and to learn to communicate this. A research higher degree requires resource allocation, process optimisation, and effective communication. These skills combined with research expertise can go a long way in an industry career.

“PhD studies are not about receiving and understanding, but creating, and innovating. Innovation is extremely valuable in industry. Also, PhD graduates can often learn faster and better than anyone else because they have been trained in learning at an expert level. PhDs are not quitters.”

Dr Lei Wang commenced his PhD at the UNSW School of Chemical Engineering in mid-2012 inspired by his curiosity to seek a deeper understanding of engineering processes. His passion for hydrogen energy led him to complete his research on developing nanomaterials of metal hydrides for hydrogen storage. Since completing his PhD, he has utilised his project management skills in his current role as Project Manager for Coregas.

Dr Wang believes undertaking a PhD was the best preparation for his current role in the largest Australian owned industrial, medical and specialty gas company.

“As a PhD student I was essentially the project manager for my own research project over four years. I needed to constantly remind myself to take charge, take control, take initiative - no one else was responsible for my project,” Dr Wang said.

Dr Wang asserts that this responsibility taught him a sense of accountability and provided vital management skills that he uses every day as a project manager.

“I know how to chase the right people the right way to get things done and make new things happen. This is crucial to getting large projects finished on time and on budget,” Dr Wang says.

UNSW Partcat researchers make it into FameLab Semi-finals

Two UNSW Partcat researchers, Rahman Daiyan and Dr Emma Lovell, competed in the FameLab NSW semi-finals on 5 April 2017. FameLab, a science communication competition run since 2005 by British Council in collaboration with the Times Cheltenham Science Festival, see contestants explain the science behind their research to the audience and judges in just three minutes.

Rahman Daiyan, a second year PhD student shared his research and passion in tackling climate change issue by converting CO\textsubscript{2} into valued added chemicals. Dr Emma Lovell, who recently completed her PhD thesis on ‘Closing the carbon loop: activating Ni-based catalysts for CO\textsubscript{2} reforming of methane’, convinced the audience about the importance of making a fine (stable, effective and cheap) catalyst to use CO\textsubscript{2} and methane (renown greenhouse gases) to produce diesel, which is a stepping stone to a sustainable future.

Well done to both on their efforts!
RESEARCH FACILITIES

The School of Chemical Engineering at UNSW Sydney is a powerhouse of innovative engineering research. The School has a plethora of advanced research infrastructures that bring experts from our School together with leading researchers from other areas of UNSW, other universities, business and government.

Some of the facilities that are available at the School include membrane fabrication, catalysis and particle characterisation, polymer modelling and synthesis, complex fluid microstructure and rheology, fruit and legume drying facilities and many more.

For more information on the research facilities at the school, please visit: engineering.unsw.edu.au/chemical-engineering/about-us/facilities

Cyclone L-1000M/D Force spinning: A cost effective method to produce composite nanofibers for applications including spacers in batteries, solar cell devices, membranes for water treatment and gas separation.

Langmuir-Blodgett Troughs: Used to fabricate monomolecular films with precise control of lateral packing density for application in battery and coatings.

Flame spray pyrolysis reactor: An advanced synthetic method for producing any type of nanomaterials at scale. Currently, this technique is used to design materials for carbon dioxide conversion and water treatment.

Bench-top NMR: Used to measure changes in the surface chemistry of particles within complex formulations, in particular to optimise surfactants for pigments including titania, silica, alumina, iron oxide and carbon black.

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