TEACHING AND RESEARCH NEWS
DEPARTMENT OF CHEMICAL ENGINEERING
MONASH UNIVERSITY

ChemEng focus

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Inside this issue:

ARC Research Hub for BioProcessing Advanced Manufacturing

The Bioprocessing Advanced Manufacturing initiative (BAMI), led by Prof Gil Garnier and Dr. Warren Batchelor, Director and Deputy Director of BioPRIA/APPI at Monash University, is one of only three successful industry transformation research hubs (ITRH) to drive innovation in manufacturing industries strategic to Australia. This announcement of late December 2013 is a significant recognition of the importance played by the Pulp and Paper industry in Australia and a commitment from the government to support its migration into a sustainable industry.

The aim of the BAMI Research Hub is to develop both functional materials to maximize the value of forest resources and green chemistry and energy solutions for bioprocessing industries. Lignocellulosic streams will be converted into a series of marketable materials, chemicals and energy products. Examples include new polymers and composites, smart packaging, chemical intermediates, fuel, green energy and nanocellulose and cellulosic fibre applications. These will drive advances in chemical engineering, materials and green chemistry for the full conversion of lignocellulosics. The Hub will augment research developments with short courses and a problem-based Masters in BioProcess Engineering to keep industry workers up to date with evolving science and technology.

The Australian Research Council (ARC) will contribute over three years $1,633,553 to BAMI, co-matching cash contributions of $1,275,000 from the Australasian Pulp and Paper Industry and $600,000 from Monash University, for a total of $3,508,553. The industrial partners are Amcor, Australian Paper, Carter Holt Harvey, Circa, Norske Skog and Visy. Each industrial partner also provides a technical leader to assist and guide the research consortium. Technical expertise will be provided by nine experienced investigators and 11 research associates from Monash University delivering multidisciplinary expertise in Chemical Engineering, Green Chemistry and Material Engineering.

The scientific aims of the BAMI research hub are twofold:

1. To develop new **functional materials** complementary to those produced by the industry. The BAMI will process all lignocellulosics streams into a complementary array of products for market. This will include:

   a. New polymers and chemicals from cellulose, lignin, and hemicellulose for food, chemical and energy application.

ARC Research Hub for BioProcessing Advanced Manufacturing continued….

b. Nanocellulose and cellulosic fibre applications in membrane, filters, agriculture covers, thermoplastic composites for automotive and construction.
c. New and better packaging.

2. To develop **green chemistry and energy solutions** for the pulp and paper industry including catalytic reaction engineering, material engineering and sustainable processes for the conversion of lignocellulosics into a complementary array of marketable chemicals, materials and energy products.

The BAMI will also deliver a problem-based Masters program in BioProcessing Engineering and industry short courses in order to ensure the skills base of workers in the industry are kept up to speed with the evolving science and technology. The skills development element of the BAMI will be essential for the transfer of knowledge directly back into industry.

The main economic, environmental and social benefits of the BAMI will be to:

- Sustain current jobs in the industry, especially in regional areas
- Develop new sustainable employment opportunities in bioprocessing
- Stimulate the growth of SMEs in the sector leading to employment growth
- Create new revenue streams and bring new technology to evolve the industry
- Identify complementary bioprocessing opportunities for each of the industry partners and the broader Australian industry to improve profitability and sustainability
- Transform a traditionally natural resource dependent industry into a technology driven industry
- Develop and expand the skill levels of workers in direct and complementary industries.
- Train a new generation of engineering and science students in emerging technologies

The proposal consists of 11 interlinked projects grouped into **functional materials** and **green chemical and energy solutions** platforms. Figure 1 shows the linkages between the projects and how this Hub will transform the existing industry by creating new high value products from existing fibres or by transforming biomass into new products.

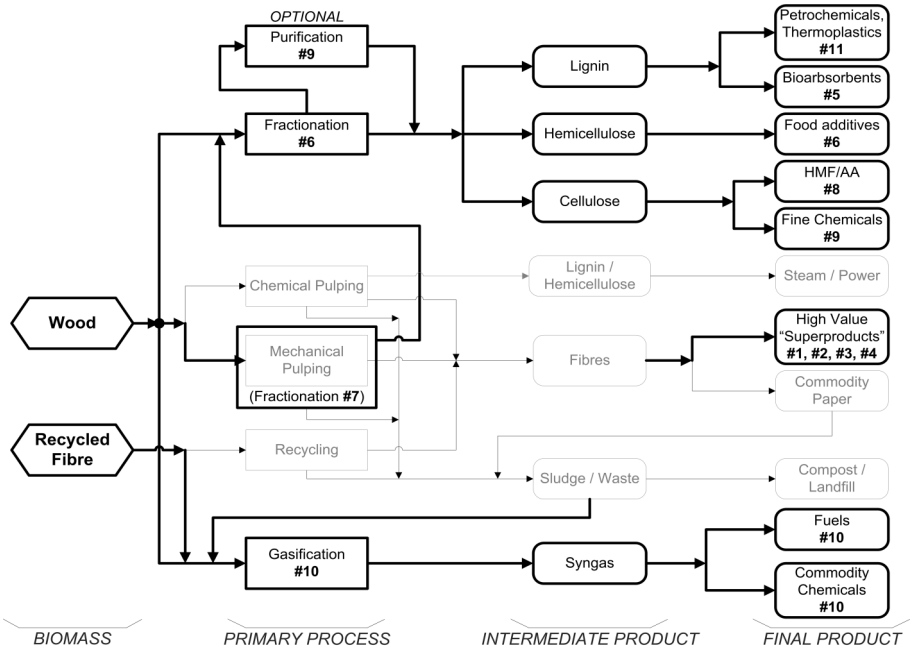


Figure 1:
BAMI process diagram for the integration of new products with the current processes.

Powder power

Technological advances are delivering new ways to produce dried milk: a homely ingredient that helps drive a multibillion-dollar dairy export industry.

It is a simple concept developed more than a century ago. Feed a wet product, such as milk, into a machine that vaporises it. The vapour then descends through a cylinder of hot air that evaporates the liquid to leave just the dry, powdery particles – in this instance, milk powder.

It is called spray drying and it is also used to produce pharmaceuticals, chemicals and laundry powders. But this process has been one of the reasons why a very traditional industry – dairy manufacturing – is also at the leading edge of food technology.

In Australia, about 40 per cent of fresh milk is spray dried to create products such as milk powders, whey powders and milk protein concentrates, which are the basis of a multibillion -dollar dairy export industry.

The latest research to further these technologies involves Monash University chemical engineers, who are taking spray-drying technology to a whole new level of efficiency and product quality.

Spray-dried dairy products do not need refrigeration, have storage stability and can be transported efficiently to distant markets. But their production is much more energy-intensive than that of fresh liquid milk products, says Dr Mike Weeks of Dairy Innovation Australia Limited, an industry-funded research body.

"And if you're in the commodity business, being able to reduce your operating cost, especially energy costs, is important," says Dr Weeks, co-investigator on an Australian Research Council (ARC) Linkage Project focused on the spray-drying process.

"We're also interested in the functionality of the finished product, and are trying to understand how different drying conditions can affect the powder when it is later rehydrated and dissolved."

The main concern is to avoid particles that are not dry enough, or that have been ruined or discoloured through overheating.

Addressing this challenge is Monash chemical engineer Associate Professor Cordelia Selomulya (pictured above), who is using a pilot-scale spray dryer with special features that include a unique microfluidic nozzle developed by her former Monash colleague Professor Xiao Dong Chen.

"Our microfluidic nozzle allows us to handle liquids with varying viscosity, including those containing high solids or even nanoparticle suspension, and generate uniform droplets," Associate Professor Selomulya said.

The uniformity is significant. Usually, spray-drying studies use commercial dryers, so when researchers analyse how the particles function, for example in the controlled release of active ingredients, the wide range of particle size and shape becomes a problem. "It is difficult to distinguish whether the results are due to the conditions you impose or to this variance," Associate Professor Selomulya said.

"But because particles produced from our microfluidic spray drier are highly uniform in size and shape, and are dried under well-defined drying conditions, we can confidently say that any phenomenon we observe is due to drying or material properties."

Drying analysis

In the dairy research, the microfluidic spray dryer helps researchers understand how the properties of the precursor (the liquid fed into the nozzle) affect the final powder properties when subjected to different processing parameters.

With particle uniformity assured, the ARC Linkage Project is now exploring the degree to which moisture content of the liquid milk can be reduced further before it is fed into the dryer, because a more solid precursor has less moisture to remove and therefore requires less energy to dry.

Evaporative processes are already applied to milk before spray drying to lift the solid content, but increasing this further becomes a delicate balance. "When you dry at the higher solid content, the particle might still remain wet inside, or it could be over-dried on the outside, with poorer surface properties if the solids form a shell earlier in the drying stage," Professor Selomulya explains.

"So we need to find a different way of drying at a high solid content, or try to understand what's going on in that high solid condition, in terms of the effects of changing drying temperature on the properties of that particle."

Words: Alexandra Roginski
First appeared in Monash Magazine - October 30

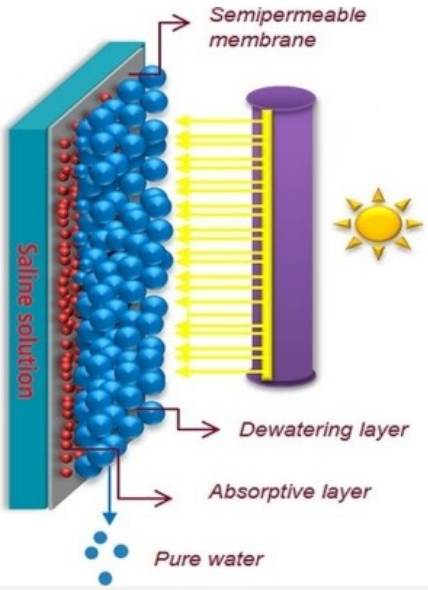
Sunlight Helps Turn Salty Water Fresh

Water Purification: Solar-powered forward osmosis desalinates brackish water using a temperature-responsive hydrogel

By Deirdre Lockwood

With energy-efficient desalination techniques, water-starved communities could produce fresh water from salty sources such as seawater and industrial wastewater. But common methods like reverse osmosis require pumping the water, which uses a substantial amount of energy. So some researchers have turned to forward osmosis, because in theory it should use less energy. Now a team has demonstrated a forward osmosis system that desalinates salty water with the help of sunlight (Environ. Sci. Technol. 2013, DOI: 10.1021/es403266y).

Like reverse osmosis, forward osmosis removes solutes from water via a semipermeable membrane. But instead of pumping the water through the membrane, forward osmosis methods rely on osmotic pressure to drive water across it. To create this osmotic pressure, researchers place so-called draw agents, such as solutions of other salts or absorbent hydrogels, on the other side of the membrane. Once these materials draw fresh water across the membrane, researchers have to find a way to extract the water from them. Developing an energy-efficient way to do this last step has been a challenge for researchers.



Desalting Sponge
In a new forward osmosis method, a saline solution (far left) sits on one side of a semipermeable membrane (gray). Fresh water passes through the membrane and is absorbed by a hydrogel (red spheres). Next, a second gel (blue spheres) absorbs the fresh water. When a solar concentrator focuses sunlight onto this second gel, the material shrinks and releases the trapped pure water.

A team led by Huanting Wang and George P. Simon at Monash University, in Australia, created a forward osmosis device that extracts the fresh water via a dual-layered hydrogel. In their device, fresh water is pulled through the semipermeable membrane into a hydrogel made from N-isopropylacrylamide (NIPAM) and sodium acrylate. The gel swells 10 to 20 times in volume. Next, a second, temperature-sensitive hydrogel made from just NIPAM absorbs the water from the first gel. When the researchers heat the second layer to 32 °C, the gel collapses and squeezes out the fresh water. The team's device uses focused sunlight to heat up the gel.

The team tested the dual-layer device with a solution of 2,000 ppm sodium chloride, a standard concentration for brackish water. Once the hydrogel was primed with water, the module could produce fresh water at a rate of 20 L/m2 h. This is similar to the rate of forward osmosis using other draw agents, such as a solution of ammonium bicarbonate. To extract fresh water from that agent, researchers must heat the solution to about 60 °C to convert the ammonium bicarbonate salt to gases that can be removed by distillation at a lower temperature.

Although the flow rate of extracted fresh water was encouraging, the first step in the process—the hydrogel absorbing water—was an order of magnitude slower than that of other draw agents, Wang says. To improve the performance of the system, the group envisions running many hydrogel modules in parallel.

The team's concept is truly novel, says Jeffrey R. McCutcheon, a chemical engineering professor at the University of Connecticut. "It's essentially an osmotic sponge that squeezes itself out when heated," he says. And the method requires minimal energy compared to other draw agents, because the device extracts the fresh water at a relatively low temperature. He cautions, however, that the system's rate of freshwater production must improve by an order of magnitude to be competitive with other osmotic methods.

The device also struggles with desalinating seawater, which has a salt concentration about 17 times greater than the team's test solution, Wang says. As a result, he says the current method would be most useful for purifying industrial wastewater streams that have a lower salt concentration. What's more, waste heat from industrial processes could be used to power the freshwater extraction. "It would be a perfect combination," Wang says.

The team is now working with Shanghai-based steel company Baosteel to scale up the system for industrial use.

Chemical & Engineering News, American Chemical Society [ISSN 0009-2347]

Sharmen Rajendran talks at the Shell Global Energy Forum [2013]

It is a well-known fact that over 60% of the world's energy is generated through the use of fossil fuels and this proportion increases to over 95% here in Australia. Such a heavy dependency on fossil fuels for power generation has made the energy sector the principal source of anthropogenic greenhouse gas emissions in Australia and most countries around the world.

CO2, the main greenhouse gas produced from fossil fuels, is extremely hazardous to the environment. Over the years, there has been a significant increase in the CO2 levels in the atmosphere, from 280ppm in the 18th century to over 390ppm today signifying a 40% increase. The effect of the increased CO2 levels is global warming which in turn leads to extreme weather changes, degradation of the ecosystems as well as increased sea levels to name a few.

The adverse effects of high greenhouse gas levels in the atmosphere have been studied in great detail by both governmental and non-governmental bodies around the world. The general consensus agreed upon by all involved in these studies is the need for CO2 emissions to be halved within the next four decades to avoid irreversible damages to the environment which could include the melting of the Arctic ice.

Having said all of the above, the fact remains that fossil fuels will continue to be the main source of power around the globe for the foreseeable future. Replacing the current energy generation regime with renewable technologies will not be easy. Alternative technologies presently available within the market have a high capital input and associated operational costs. Carbon Capture and Storage (CCS) technologies allow for the generated CO2 to be separated and then stored in reservoirs such as underground geological foundations, deep saline aquifers, depleted oil reservoirs and bacterial ponds. This prevents the release of CO2 into the atmosphere hence mitigating its harmful effect on the environment. Recently, a breakthrough has been made with the inception of a process termed Chemical Looping Combustion (CLC). CLC has been reported to be one of the most promising CCS options to date due to its high carbon capture efficiency while only marginally increasing the cost of electricity.

Sharmen Rajendran presenting his winning paper at the 2013 Shell Global Energy Forum

CLC works on the principle of oxygen transfer from an oxygen carrier, typically a transition element metal oxide, to the fuel for combustion. The reactor configuration typically used in CLC is dual circulating fluidized beds of which one is termed the Air Reactor (AR) and the other Fuel Reactor (FR). The oxygen carrier is first introduced into the FR where it reacts with the fuel and oxidizes it while itself being reduced. Once the oxygen carrier is depleted of its oxygen, it then enters the AR where it reacts with air to return to its initial oxidation state and is then returned to the FR ready for another reaction cycle. The gases exiting the FR are CO2 and steam which can be removed upon condensation to generate a highly concentrated stream of CO2 which can then be sequestered.

My research project, supervised by Professor Sankar Bhattacharya and sponsored by both Brown Coal Innovation Australia (BCIA) as well as Energy Australia focusses on the continued use of fossil fuels while utilizing carbon capture technologies. Specifically, my research project deals with Chemical Looping Combustion of Victorian brown coal looking particularly at potential operational issues which may be encountered from utilization of such a coal.

My research covers both experimental and modelling aspects. Experimental investigation covers a variety of aspects from fundamental research into the kinetics of the process to advanced study relating to the evolution of pollutant gases from the CLC with Victorian brown coal. Modelling in this project involves both kinetic and process simulation. The former is done to the study the effect of operating conditions on the reaction kinetics of the oxygen carrier in presence of coal while the latter delves into fine tuning the process to obtain the best outputs in terms of fuel conversion and concentration of CO2 in the flue gas. My project to date shows that due to its high reactivity and low ash content, Victorian brown coal is a suitable fuel for CLC.

Professor Wei Shen finalist in "The Australian Innovation Challenge—Innovation for People in the Health" category

"The Australian Innovation Challenge" has seen **Professor Wei Shen's research group** listed as a 2013 finalist in the Health category of the awards.

A new biosensor featured at the awards is a result of the collaboration by the students within Professor Wei Shen's research group. Ms Misosi Li, Mr David Ballerini, Dr Xu Li, Ms Lizi Li and Dr Junfei Tian have all had a hand the biosensor's inception and overall creation.

The biosensor has been so well received that it could soon be deployed in developing countries for fast, cheap blood typing tests. Professor Wei Shen says the test gives clearer results than existing technology, making it appropriate in places where medical personnel and infrastructure are scarce. The test reduces the risk of potentially fatal errors when patients are given blood transfusions.

Antibodies specific to blood types are printed out on paper in the form of letters, such as A and B, denoting the blood types.

"Reactions between the antibodies and the patient's blood sample lead to the clumping of the red cells, which forms a red letter," he says.

Professor Wei Shen says existing tests are based on colour or phase changes that can be difficult for untrained people to interpret.

The Australian Innovation Challenge awards are helping drive some of the nation's best ideas to commercialisation or adoption. Now in its third year, The Australian Innovation Challenge is run by The Australian, in association with Shell, and are supported by Innovation Australia, the federal government's leading statutory body supporting industry innovation.

The Challenge has attracted entries from researchers in laboratories and start-up companies around the country.

The Australian Innovation Challenge not only offers prestige and publicity for the winner but also prize money. The Challenge offers nine cash prizes awards. The overall winner receives a further $25,000.

The judging panel of The Australian Innovation Challenge was lead by policy expert and former CSIRO deputy chairman Dr Terry Cutler.

Finalists were featured in The Australian and The Weekend Australian over several weeks. They were showcased on The Australian website and in a dedicated magazine.

The Awards Ceremony was held on 28 November 2013 at the National Library of Australia, Canberra. Guests included Chris Mitchell, editor-in-chief of The Australian, Andrew Smith, Country Chair, Shell Australia, and The Hon Ian Macfarlane MP, Minister for Industry.

The Mollie Holman Medal for Excellence in a PhD Thesis has been awarded to Dr Aditya Putranto

The Mollie Holman Medal is awarded to PhD students who have fulfilled all requirements for the degree and are judged to have presented the best doctoral theses of the year.

Dr Aditya Putranto's doctoral thesis "Theoretical Extension and Innovative Applications of Reaction Engineering Approach to Modeling Drying and Other Transport Processes" focused on drying modeling, in particular on the development and expansion of the, by now well-known, model of the reaction engineering approach.

During his candidature Dr Putranto produced a large number of excellent journal articles; 18 first-authored peer-reviewed journal papers, and one co-authored peer-reviewed journal papers, seven first-authored peer-reviewed conference papers as well as being the major contributor to the book "Modeling Drying Processes, A Reaction Engineering Approach", published by Cambridge University Press. Dr Putranto has a H-index of 19; total citation of his journal papers published during his PhD is 95 total citations by 35 documents.

Dr Aditya Putranto is an Associate Editor of the International Journal of Food Engineering (IJFE) and he has been invited to give a keynote talk at the International Drying Symposium (IDS 2014), Lyon, France on "Reaction Engineering Approach (REA) to Modeling Drying Problems: Ideology versus Reality".

Dr Putranto will be presented the medal at the Graduation ceremony to be held in May 2014.

Congratulations goes to Dr Putranto on his wonderful achievement.

Highlights of Dr Junfei Tian research achievements

Dr Junfei Tian's doctoral thesis "Bioanalysis through Patterning Low-cost Substrates" documented a pioneer study of using printing as a patterning technique to fabricate sensors on low-cost substrates for bioanalysis and diagnostics. This work established a platform to develop technologies for disease screening and healthcare in developing regions of the world. Dr Tian's work addresses an important global issue of our time; his PhD thesis was not only a novel study in an immerging field, but also a study that has a strong impact to our society.

During his candidature, Dr Tian applied himself creatively and diligently in his PhD research and generated an amazing amount of high quality research outcome; this includes nine first-authored (including two co-first authored) peer-reviewed journal papers, Ten co-authored peer-reviewed journal papers, two first-authored peer-reviewed conference papers, seven co-authored peer-reviewed conference paper as well as six patents. Dr Tian's has a H-index of 11; total citation of his journal papers published during his PhD is 427 and the average impact factor of his first-authored papers is 5.951 which represents a very high achievement for a recently graduated PhD student.

Dr Tian's achievements do not end there! He is a member of the Monash Bioactive Paper Group and the Monash Surface Engineering Group that have won the 2012 Australian Museum Eureka Prize (Innovative use of Technology Category) and the 2012 IChemE "Dhirubhai Ambani Chemical Engineering Innovation for Resource-Poor People Award". He is also one of the students who has been involved in the breakthrough research of the text-reporting blood typing paper sensor and shared the co-first authorship of the paper published in Angewandte Chemie.

Dr Tian's PhD work has made a substantial contribution to the international reputation of the Monash Bioactive Paper Group. Professor Robert Pelton, the founding leader of the Canadian Bioactive Paper Program has commented: "In the last few years, Monash University's modest bioactive paper group has proven to be one of the powerhouses in this new, rapidly developing field. Their publications and innovation record compares very favorable with Whiteside's efforts at Harvard and the large Canadian SENTINEL Bioactive Paper network that I lead. Indeed, with far fewer people and less funding, the Monash group productivity is amazing."

Congratulations goes to Dr Tian on his wonderful achievements during his HDR candidature.

IChemE's Young Chemical Engineer of the Year Award (Singapore) awarded to Ardi Sastrohartoyo (BE Chem [2005])

The IChemE Awards recognise innovation and excellence in chemical engineering across the world. The Awards are organised by the Institution of Chemical Engineers, which organises events each year in North America, UK, Malaysia and Singapore.

The Singapore Young Chemical Engineer of the Year Award recognises the individual who best demonstrates his or her achievements and tangible application of chemical, biochemical, process or engineering skills to address important economic, environmental or social issues. All entrants must have been born, on or after 1 January 1983.

The judges were impressed with Ardi's diverse international experience and extensive knowledge and expertise in the complex chemical manufacturing of ammonium nitrate, explosives and blasting services.

Ardi has also impressed the judges in leading on cost savings opportunities as part of Orica Business Improvement projects in the Asia region which include plant productivity improvements, variable cost reduction, new product development, differentiation and technology up sell.

Ardi Sastrohartoyo graduated from Monash University with a Bachelor of Chemical Engineering in 2005 and is now working with Orica Mining Services as a Senior Technical Superintendent.

Based in Singapore and responsible for 50+ site operations in Asia including Malaysia, China, Hong Kong, India, Indonesia, Mongolia and the Philippines; Ardi exemplifies the notion that an Engineering degree can take you anywhere.

Following his graduation, Ardi worked for four years with Orica in Newcastle, NSW. He was fortunate enough to experience a broad array of jobs, working as a Process Risk Specialist Australia/Asia, HS&E Advisor, Technical Superintendent South East Australia and Process Engineer at an Ammonium Nitrate Manufacturing Plant in Kooragang Island.

Left to Right:

Justin Blades (IChemE Deputy CEO), Ardi Sastrohartoyo and Terence Tan (Technology Manager of Shell Eastern Petroleum Pte Ltd)

Orica is a global market leader of chemical manufacturing and provider of commercial blasting explosives & blasting services with 15,000 employees across six continents in 50+ countries.

Whilst working, Ardi has also gained his Chartered Professional Engineer status with IEAust, IChemE and RACI.

Ardi believes his career has already been rewarding, as he has had the opportunity to work as a Chemical Engineer across many industries such as chemical manufacturing, mining and explosives with global international opportunities.

The award that Ardi won was sponsored by Shell.

Student guide to the HDR journey

A new complete Library guide for research students is now available online.

The Higher Degrees by Research (HDR) Library guide has been compiled by librarians and learning skills advisers to help HDR candidates during their research degree journey.

The guide is designed as a gateway with links to all Library services, research training and opportunities for HDRs:

- Quality resources for each stage of candidature
- Finding, reviewing and managing the literature in any discipline
- Managing research data and communicating research
- Getting published

Feedback from the Monash Institute of Graduate Research and some HDR candidates has helped shape the guide and will continue to do so.

The Library is interested in you and in your research so visit the HDR guide and contact a specialist librarian or learning skills adviser.

Australia – China Oxy-Fuel Combustion Workshop Hosted by the Department on February 6-7, 2014

On February 6-7 2014, Dr Lian Zhang and his research group successfully hosted a two-day workshop entitled 'Australia – China Oxy-Fuel Combustion Workshop" in Hotel Bruce County, Mount Waverley. The workshop was supported by Australian Academy of Technological Science and Engineering (ATSE) under its Joint Co-ordination Group (JCG) program, and Brown Coal Innovation Australia (BCIA).

The workshop invited a total of fifty attendees, with a great mix of local and international participants. The international participants are internationally renowned oxy-fuel combustion researchers and came from the USA, Europe, Japan and China. Their presentations covered the oxy-fuel combustion progress and demonstration projects in their own countries, and the fundamental issues regarding the mechanisms underpinning this low-emission clean coal technology. The Australian participants are also widely diverse, including Monash's industrial partners from Callide A oxy-fuel project in Central Queensland, Energy Australia in the Latrobe Valley, and academics from the University of Queensland, the University of New South Wales and the University of South Australia.

From left:
Dr Lian Zhang and Mr Anthony De Girolamo [HDR student] during closing of the workshop

From left:
Dr Lian Zhang and Dr Xueyuan Xu [Shanghai Boiler Works] giving workshop welcome speeches

The workshop provided an opportunity for Monash to showcase our research progress on the oxy-fuel combustion of Victorian brown coal, and the other research activities relevant to low-emission clean coal technologies. The workshop provided a good opportunity for the Department's postgraduate students to learn from the internationally renowned coal researchers, as well as building their own networks within the research area.

Monash has been a leader on the R&D of low-rank coal oxy-fuel combustion. Since 2007, a variety of funding resources have been sought to promote the deployment of this low-emission clean coal technology in the Latrobe Valley. As a continuation of the completion of a variety of national projects, we will be working continuously on this area by examining the ash slagging/fouling propensity and air pollutant emission reduction. Monash will also be assisting our industrial partner, Shanghai Boiler Works to carry out engineering design through the extra funding support from the Department of Primary Industry. Through these existing and future efforts, Monash has established a strong collaboration with national and international industries to develop new generation clean coal technologies.

Iron Oxide as an Ultralightweight—Iron oxide frameworks with hierarchical pore structure from pyrolysis of Prussian blue nanocrystals

Adsorption, catalysis, or substrates for tissue growth: porous materials have many potential applications. In the journal Angewandte Chemie, a team of Chinese and Australian researchers has now introduced a method for the synthesis of ultralight three-dimensional (3D) iron oxide frameworks with two different types of nanoscopic pores and tunable surface properties. This superparamagnetic material can be cut into arbitrary shapes and is suitable for applications such as multiphase catalysis and the removal of heavy metal ions and oil from water.

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Materials with hierarchically organized pore systems—meaning that the walls of macropores with diameters in the micrometer range contain mesopores of just a few nanometers—are high on the wish lists of materials researchers. The advantages of these materials include their high surface area and the easy accessibility of the small pores through the larger ones. The great desirability of these materials is matched by the degree of difficulty in producing them on an industrial scale.

Scientists at Fudan University (China) and Monash University (Australia) have now successfully produced an ultralight iron oxide framework with 250 µm and 18 nm pores in a process that can be used on an industrial scale. A team led by Gengfeng Zheng and Dongyuan Zhao used highly porous polyurethane sponges as a "matrix", which were soaked with yellow potassium hexacyanoferrate ($K_4[Fe(CN)_6]$). Subsequent hydrolysis resulted in cubic nanocrystals of Prussian blue (iron hexacyanoferrate), a dark blue pigment, which were deposited all over the surfaces of the sponge. The polyurethane sponge was then fully burned away through pyroloysis and the Prussian blue was converted to iron oxide. The result is a 3D framework of iron oxide cubes that are in turn made of iron oxide nanoparticles and contain mesopores. The material is so light that the researchers were able to balance a 240 cm^3 piece on an oleander blossom.

Simple modifications allow the surface of the 3D framework to be varied from strongly hydrophilic to strongly hydrophobic for different applications. The researchers demonstrated this by removing arsenic ions from contaminated water and by separating water from gasoline. In the latter experiment, the resol-coated iron oxide framework absorbed more than 150 times of its own weight in gasoline.

The resol-coated frameworks are also suitable for use as nanoreactors for catalytic multiphase reactions between hydrophilic and hydrophobic reactants, which can normally only be made miscible through addition of various phase-transfer reagents and cosolvents. With the resol-coated iron oxide framework, the reaction runs much faster and more selectively without these additives, giving high yields. This is because of the tunable hydrophilic/hydrophobic surfaces of the mesopores, which take in both reagents and bring them into contact with each other. The catalyst can be retrieved magnetically, because the iron oxide nanoparticles of the 3D frameworks are superparamagnetic.

Taken from Press Release at Angewandte Chemie International Edition, Nr. 06/2014, February 25, 2014 from Biao Kong's journal article "**Ultralight Mesoporous Magnetic Frameworks by Interfacial Assembly of Prussian Blue Nanocubes"**

Biao Kong, Jing Tang, Zhangxiong Wu, Jing Wei, Hao Wu, Yongcheng Wang, Prof. Gengfeng Zheng, Prof. Dongyuan Zhao [doi: 10.1002/anie.201308625]

2013 IChemE Macnab-Lacey prize awarded to Monash 4th year Chemical Engineering students

The Institution of Chemical Engineers (IChemE) has announced the winners of its medals and prizes for 2013.

Over 20 individuals and organisations are being honoured for their achievements and exceptional work across all aspects of chemical, process and biochemical engineering.

The Institution has been awarding medals since 1928 when the Osborne Reynolds medal (now known as the Arnold Greene medal) was presented to former IChemE president Sir Alexander Gibb.

Up to 20 medals and prizes are now awarded each year by IChemE to celebrate the outstanding contribution being made by chemical engineers worldwide – to advance the profession and society in general.

IChemE chief executive, David Brown, said: "Announcing the IChemE medal and prize winners each year is one of my great privileges. It's also a time to reflect on the excellent work that is taking place to 'advance chemical engineering worldwide'.

"2013's roll of honour includes winners from Japan, Austria, Italy, Canada, Malaysia, New Zealand, UK, France, Australia, Ireland and Germany. All have one thing in common – over the past year they have shown talent, expertise and sheer hard work to promote chemical engineering and the profession.

"I would like to congratulate them all and welcome their names to the rich and growing history of IChemE medal and prize winners."

The winner of the Macnab-Lacey prize was awared to a group of 4th year students from the Department of Chemical Engineering, Monash University for their group design project: The Gippsland PLA production facility.

Speaking on behalf of the design group, Monash's Andrew Hoadley said: "Monash University Department of Chemical Engineering is delighted that their top design project group were awarded the MacNab-Lacey prize in 2013.

"The group consisted of four chemical engineering students – Abdullah Al Harthy, Peter Harris, Yue Jiao, Jia Low, and Agnes Marcella – and one environmental engineering student – Timothy Werner.

"Not only did the group achieve a fantastic result for their PolyLactic Acid design plant, they also put together the submission for the MacNab-Lacey prize in their own time."

The McNBab-Lacey prize is awarded to the student design project that best shows how chemical engineering practice can contribute to a more sustainable world.

The objectives of the competition are to:

- Encourage students to think of sustainable development as a key element of their design projects;
- Influence chemical engineering departments to position sustainable development at the heart of the curriculum;
- Demonstrate that IChemE takes sustainable development seriously;
- Provide a showcase for student talent, and reward achievement.

Congratulations to the entire team (now alumni) and to Andrew Hoadley the design coordinator, and also to their team mentor Gil Garnier.

A full list of the IChemE 2013 honour roll can be viewed here.

From Left
Abdullah Al Harthy, Timothy Werner, Jia Low, Agnes Marcella, Yue Jiao, Peter Harris

Monash Malaysia researchers awarded 2014 Australian Endeavour Scholarships

Three Chemical Engineering researchers from Monash University Malaysia have been awarded Endeavour Executive Fellowships to study in Australia under the prestigious 2014 Australia Endeavour Awards program.

The program allows recipients to pursue postgraduate studies and professional development opportunities across a broad range of disciplines, at Australia's premier universities and research institutions.

The Australian High Commissioner to Malaysia, Rod Smith, presented recipients with their awards at a ceremony held at the Australian High Commission in Kuala Lumpur.

For Dr Nagasundara Ramanan, Senior Lecturer at the School of Engineering, and his two PhD students, Catherine Chang and Ramalakshmi Subbarayalu, the award will go a long way to help further develop a robust process for E. coli culture storage which will benefit the bio-pharmaceutical industry.

The proposed research into E. coli storage will be carried out with Professor Douglas Macfarlane, an Australian Research Council (ARC) Laureate Fellow at Monash.

Australian High Commissioner to Malaysia, Mr Rod Smith, together with the recipients of the 2014 Australia Endeavour Awards program

"It is a privilege to be selected as an Endeavour Awards recipient. I'm appreciative of the continuous support provided by Monash University, which has allowed me to conduct some really interesting research," Miss Chang said.

The Australian Endeavour Award is international, making it highly competitive. Recipients undertake part of their research in an Australian institution of their choice, from four to six months. They also receive up to $23,500 to cover their living expenses.

News in brief

- Congratulations to A/Prof Bradley Ladewig on receiving the Vice Chancellor's Award for Teaching Excellence.
- Congratulations to Sankar Bhattacharya and Karen Hapgood who have been promoted from Associate Professor to Professor.
- **Monash Chem Eng teaching space renovations - a brand new look revealed!** At the 11th hour on Friday 28th February, the bulk of the renovations for The Potter Room (36/222) and The Lawson Room (69-201) were completed. The entire project felt like a last minute scramble on a renovation show "The Block" but the rooms are now open and functional just in time for Semester 1 lectures. Thanks to Jill for managing the project.
    - The Potter Room (36/222)
    - The Lawson Room (69-201)
    - 360 degree panorama view of The Lawson Room

  To remind yourself where we started from, check out the Before photos.

2013/2014 Faculty of Engineering Summer Research Projects

1st place goes to Fatema Hasan Abdulla Abbas Husain

Undergraduate students who are in level 3 or above, have a minimum of 48 credit points remaining in their degree and have a weighted average mark greater than 80% are invited to apply to undertake a research project over a 12 week period from late November until the end of February of each year.

In 2013/14, the Faculty of Engineering offered 45 research projects, spanning across all five Faculty of Engineering Departments. A total of 28 students participated in the 2013/14 Summer Research program.

At the end of the Summer Research program, each student must present their research on a poster and present it to their peers. The Summer Research Poster presentation was held on 27 February 2014 and was the finale of many weeks of hard work toiling away in the research labs. During the Summer Research Poster presentation, each student had to describe their project to their fellow Summer Research students, as well as the Faculty's many postgraduate students and academics.

"My research project deals with quantifying the effect of polymer addition to Cellulose Nanofibers on the drainage force during sheets formation. In other words, how to use polymers to make the manufacturing process of Cellulose Nanofibers sheets, an exciting new eco-friendly material, faster and more sustainable for mass production." Fatema said describing her project.

She also said "I found the whole experience of summer research to be very enjoyable. It gave me a feel of what is research like. The topic, research and lab work was all interesting. I was also fortunate to have had a great working environment in APPI with the support from my supervisor and group."

Effect of Polymer Addition to Cellulose Nanofibers on Drainage Force During Sheet Formation—New Frontiers for Cellulose Nanofibers

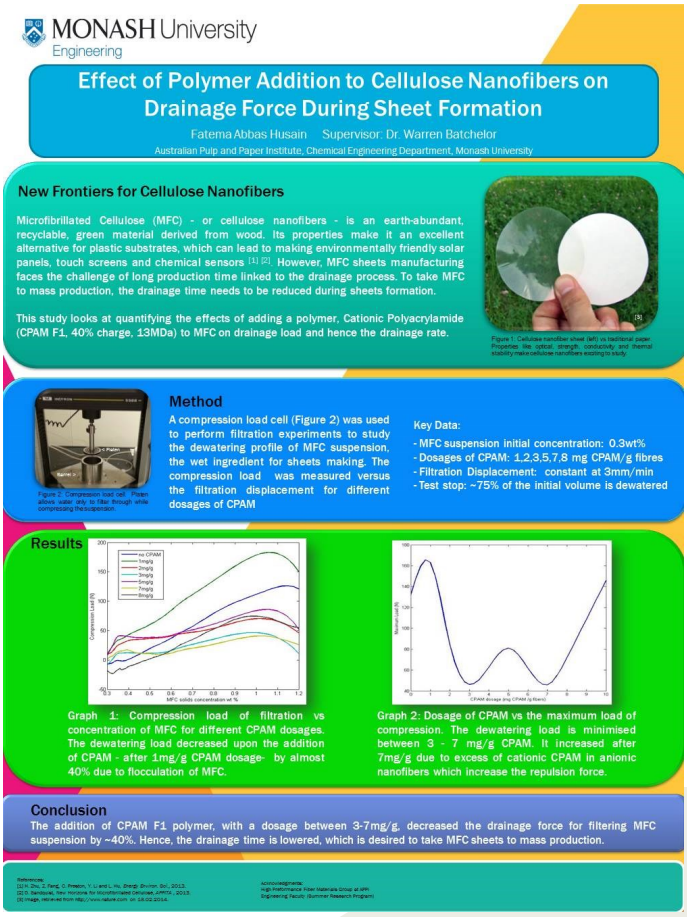
Microfibrillated Cellulose (MFC) - or cellulose nanofibers - is an earth-abundant, recyclable, green material derived from wood. Its properties make it an excellent alternative for plastic substrates, which can lead to making environmentally friendly solar panels, touch screens and chemical sensors. However, MFC sheets manufacturing faces the challenge of long production time linked to the drainage process. To take MFC to mass production, the drainage time needs to be reduced during sheets formation.

This study looks at quantifying the effects of adding a polymer, Cationic Polyacrylamide to MFC on drainage load.

A compression load cell was used to perform filtration experiments to study the dewatering profile of MFC suspension, the wet ingredient for sheets making. The compression load was measured versus the filtration displacement for different dosages of CPAM

Conclusion

The addition of CPAM F1 polymer, with a dosage between 3-7mg/g, decreased the drainage force for filtering MFC suspension by ~40%. Hence, the drainage time is lowered, which is desired to take MFC sheets to mass production.



Society of Monash University Chemical Engineers (SMUCE) President—William Huggett, 2014

The Society of Monash University Chemical Engineers (SMUCE) is a student run society aiming to help engage the chemical engineering student community. SMUCE aims to bridge the gap between the classrooms and the world outside university. It serves as a link between students, academics and industry.

This aim is achieved by the weekly Industry Seminar series, where SMUCE invites different companies to give talks, informing students about who they are and what they do. The companies are given the opportunity to showcase their employees' experiences with their company and to advertise potential employment opportunities, especially vacation and graduate positions available for our students. Moreover, there is a strong collaboration with the Department of Chemical Engineering and Monash Employment and Careers Development in order to help students in preparing themselves for the real life industry by building the skills necessary to aid them in their professional undertakings.

This year, SMUCE is also implementing a peer mentoring program for Process Systems Analysis. Additionally, study group programs for certain units from second year onwards are being looked at with the aim of facilitating networking opportunities between students of different year levels, as well as striving for the best grades possible.

We also know how to have fun as SMUCE does social events too. Aside from the always delicious barbecues, we're holding a trivia night, a pub crawl with our friends from MAMEC, an end of year lawn bowls day, and our annual SMUCE Academic Dinner.

SMUCE Membership includes:

- Weekly industry seminar with FREE Pizza Lunch throughout the academic weeks
- BBQ events and member price tickets to social events throughout the semester
- Copy of the 2014 SMUCE Careers Guide
- Invitation to the Vacation Employment Day
- Discounted Annual Academic Dinner tickets

James Cavallo

Academic Vice President [2014]

SMUCE

Society of Monash University Chemical Engineers

C/O Department of Chemical Engineering,
Building 35, Room 226
Monash University, Clayton Campus 3800

SMUCE Semester 1—Key Events Summary

EVENT NAME	WEEK	DATE AND TIME	LOCATION
SMUCE Membership Launch BBQ	1	Thursday, 06/03/14 12:00pm – 2:00pm	Kenneth Hunt Memorial Garden (behind SMUCE office)
Monash Employment and Careers Development	2	Thursday, 13/03/14 12:00pm – 2:00pm	The Lawson Room Building 69, Room 201
Careers fair	3	Thursday, 20/03/14 **Session times** 10am - 12.30pm: Arts, Business, Commerce, Economics, Law, Education. 2.30pm - 5pm: Art Design and Architecture, Computing/IT, Engineering, Science.	Campus Centre (building 10) First floor, Main Dining Room Clayton campus
SMUCE Industry Seminar **Professional Australia (formerly known as APESMA)**	4	Thursday, 27/03/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **Mondelez (formerly known as KRAFT)**	5	Thursday, 03/04/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **PwC**	6	Thursday, 10/04/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **Emerson Process Management**	7	Thursday, 17/04/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
MID SEMESTER BREAK			
SMUCE Industry Seminar **Uhde Shedden**	8	Thursday, 01/05/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **TBA**	9	Thursday, 08/05/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **TBA**	10	Thursday, 15/05/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **TBA**	11	Thursday, 22/05/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201
SMUCE Industry Seminar **Teach For Australia**	12	Thursday, 29/05/14 12:00pm – 1:00pm	The Lawson Room Building 69, Room 201

Kim Sho

Industry Vice President [2014]

SMUCE

Society of Monash University Chemical Engineers

C/O Department of Chemical Engineering,

Building 35, Room 226

Monash University, Clayton Campus 3800

OFFERS OF INDUSTRY SEMINARS WELCOMED

If your company would like to offer an Industry Seminar, please contact Kim Sho at smuce@monashclubs.org

Society of Monash University Chemical Engineers (SMUCE) 2014 Committee

President	William Huggett
Vice President (Social)	Alexandra Gummer
Vice President (Academic)	James Cavallo
Vice President (Industry)	Kim Sho
Treasurer	Ilia Lyamin
Secretary	Georgia Jaffray
4th Year Reps	Fatema Abbas Husain Monica Montanaro Timothy Cottew
3rd Year Reps	Cameron Ekins Alex Grufas Jason Wu
2nd Year Reps	Laura De Rango Michael Lam James Ng
SMUCE office	located opposite the E1-E3 lecture theatres (ground floor of Building 32)
Email	smuce@monashclubs.org
Check out SMUCE on	Facebook

Connecting Monash Chemical Engineering students with Industry

The Society of Monash University Chemical Engineers (SMUCE) is the student organisation responsible for linking together industry, the Monash Chemical Engineering Department and Monash students. Throughout the year, SMUCE invites industry members to talk to students about their company, being a chemical engineer and to inform students about possible career opportunities. There are also promotional opportunities available such as listing in the **SMUCE 2014 Careers Guide**. If your company would like to connect with SMUCE and Monash Chemical Engineering students, please contact Kim Sho, Industry Vice President.

Kim Sho

Industry Vice President [2014]

SMUCE

Society of Monash University Chemical Engineers

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The Department welcomes the following new HDR students starting their degree [2014]

PhD:

- **Mr Baiqian Dai** [Supervisors: Lian Zhang and Zhe Liu (Mech Eng)] **Research Topic:** The properties of ash deposition and fouling during oxy-fuel combustion
- **Mr Liam Powles** [Supervisors: Cordelia Selomulya and Magdalena Plebanski (Immunology, Alfred Hospital)] **Research Topic:** On developing effective nanoparticle-based vaccines against malaria
- **Mr Kahlil Desai** [Supervisors: Karen Hapgood and Peter Stewart (Pharmacy)] **Research Topic:** Analysis and Optimisation of batch mixing processes and designing of a novel two stage blending proc
- **Ms Yaoxin Hu** [Supervisors: Huanting Wang and Xinyi Zhang (School of Chemistry)] **Research Topic:** Metal Organic Framework Membranes for Highly Selective Separation
- **Ms Yan Liang** [Supervisors: Huanting Wang and Xinyi Zhang (School of Chemistry)] **Research Topic:** Facial synthesis of palladium-based alloy nanoparticles for hydrazine electrooxidation
- **Mr Martin Foerster** [Supervisors: Cordelia Selomulya and Mengwai Woo **Research Topic:** Design of Uniform Microencapsulates and Therapeutic Carrier Particles
- **Mr Zhiyong He** [Supervisors: Warren Batchelor and Xiwang Zhang] **Research Topic:** Recyclable Ultrafiltration
- **Miss Zheng Ma** [Supervisors: Wenlong Cheng, Lian Zhang and Malin Premaratne (Electrical)] **Research Topic:** Synthesis of plasmonic Au-TiO2 hybrid nanoparticles for water splitting applications
- **Mr Makarios Wey Jene Wong** [Supervisors: Sankar Bhattacharya and Srikanth Srivatsa] **Research Topic:** Feasibility of the Super-Claus process for Sulphur Recovery from Biomass-derived Synthetic Gas
- **Ms Yosef Ahmed Tigabwa** [Supervisors: Akshat Tanksale and Andrew Hoadley] **Research Topic:** Exergy and Thermoeconomic Evaluation of Supercritical Water Gasification of Biomass for Hydrogen Production

Masters:

- **Ms Uthpala Manavi Garusinghe** [Supervisors: Warren Batchelor and Gil Garnier] **Research Topic:** Nanomaterial

Congratulations to the following HDR student who completed their degree

[December 2013—March 2014]

PhD:

- **Dr Saad Hamood Mohaissn Al-Saadi** Thesis Title: "Silane coatings for mitigation of microbiologically influenced corrosion of mild steel" [Supervisor: Raman Singh]

Company participation?

Would your company like to offer any of the following?

- **Vacation Work Experience to our undergraduate students**
- **Graduate Positions (Undergraduate and Postgraduate)**
- **Speak to undergraduate students at a lunch time seminar about your company**
- **Become a corporate sponsor or donate a student prize**

***Would you like to receive future issues of ChemEng Focus?* If so, please email lilyanne.price@monash.edu and we will add you to our newsletter mailing list.**

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