# Advanced Manufacturing

PARTNER ECONOMY: **CHINA**
ORGANISATION: **EDITH COWAN UNIVERSITY**

**INNOVATION STORY**

2016 PRIMING GRANTS

## PROFESSOR KAMAL ALAMEH

Microphotonics – the science of manipulating light on a microscopic scale – can be applied to a spectrum of scientific disciplines. As a field in its infancy, microphotonics research is often the backbone of new and exciting inventions.

One pioneer of microphotonics is Professor Kamal Alameh from Edith Cowan University. As the Director of the Electron Science Institute, his research projects span a variety of disciplines from fibre-optics, biomedical engineering and defence to agriculture and green energy.

"If you have a background in electronics, optics and material sciences, then you have the chance to really be involved in a diverse range of projects, and that's what we're actually doing," Professor Alameh says.

His focus, however, is on getting micro- and nano- photonics from theory to practice, and he works closely with several industrial partners.

The Priming Grant was a useful way to explore industrial and commercial options for one of his latest projects – clear energy-harvesting glass.

This glass is peppered with nanoparticles that draw UV and infrared radiation to the glass frame when sunlight hits it.

On the frame are solar panels, turning this unwanted radiation into electricity and allowing most of the visible light to pass through unobstructed.

"It's always important to have the key technology and then adding to it some other electronic software and hardware in order to make it a user-friendly product," Professor Alameh says.

The Priming Grant helped set up the collaboration with Qingdao Rocky Development Co., a glass manufacturing company in China. While visiting, Professor Alameh says he helped train the Chinese employees on packaging and testing the energy-harvesting solar glass windows.

Despite being high-tech, the glass is completely transparent and looks like any other window.

Other companies, Professor Alameh says, are trying to achieve similar, clear results, but many use solar panels within the glass, for instance.

"This is the advantage of our technology compared to others around the world. Nobody can do the same as what we do," he says.

This technology is currently being trialled in a self-sufficient bus stop in Melbourne. But perhaps more exciting is its potential for agriculture.

The energy-harvesting glass, which was created alongside the company ClearVue Technologies, is being developed for greenhouses, since it can block unwanted and harmful radiations and let in the visible components of sunlight necessary for photosynthesis.

The electricity converted from the unwanted radiation, Professor Alameh adds, can be used for heating and cooling, making the greenhouse self-sufficient.

Professor Alameh has worked at Edith Cowan University since 2002. In that time, he and his colleagues have created world-class infrastructure supporting photonics research and photonics laboratories.

# Advanced Manufacturing

PARTNER ECONOMY: **CHINA**
ORGANISATION: **UNIVERSITY OF ADELAIDE**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR PEIPEI JIA

Predictably, photographs of molecules tend to have poor resolution. While cryo-electron microscopy (a microscope that uses a beam of electrons to image frozen specimens) opened the molecular world up to scientists, the images aren't as clear as photographing at the macro-scale.

The University of Adelaide biomedical engineer Dr Peipei Jia has come up with a way to boost the resolution of imaging specimens in the molecular scale – substituting carbon with gold.

Dr Jia's working on plasmonic optical sensors in the ARC Centre for Nanoscale BioPhotonics. These are sensors that consist of nano-scale holes dotted on gold film, called a gold membrane.

And Dr Jia says a major factor causing poor resolution is the instability of the carbon-based support mechanism that the sample sits on.

By switching the carbon support with similar gold membrane from the plasmonic optical sensors, Dr Jia made the system more stable.

"If you want to image something and the object is moving, you won't get a clear image. But if you hold it and don't let it move, you can get a higher resolution. The same principle is applied here," Dr Jia says.

A gold membrane substitute prevents a sample from heating, as much as one that's carbon-based when the cryo-electron microscope is switched on. When molecules are heated, they move faster and therefore are harder to capture.

Gold, which is more conductive and better reflects heat away, can effectively hold the sample in place and let scientists take a better image, Dr Jian explains.

Thanks to the Priming Grant, Dr Jia presented this substitution to a company in China, Topmembranes Ltd. There, he says, they have a technique to produce these gold membranes on a large scale.

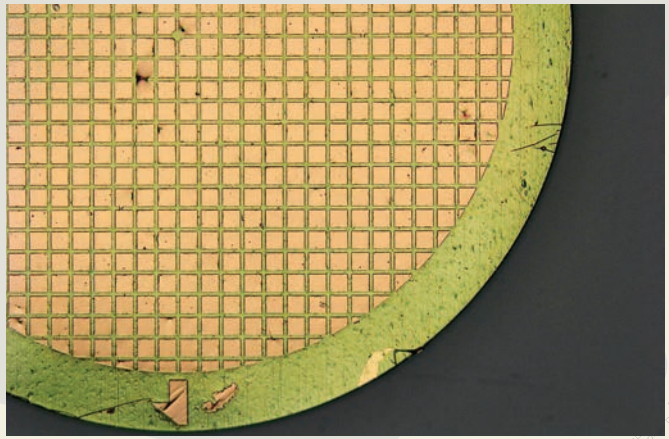
"From the preliminary results, we think it's very promising," he says.

"Hopefully it can help this field to get more detail about even smaller biomolecules."

While substituting carbon for gold may sound expensive, Dr Jia explains that their technique is cost effective as they produce reusable silicon templates to make the gold sample supports.

"Our technique is repetitive; the structure is very regular and periodic and doesn't require expensive equipment to make," he says.

While the technique is still in its early stages, Dr Jia envisions a future of nano-photonics to one day be effective in vivo – inside the body. He says this kind of technology would be useful to spot cancer biomarkers when other cancer signs escape detection.



# Advanced Manufacturing

PARTNER ECONOMY: **CHINA**
ORGANISATION: **UNIVERSITY OF NEWCASTLE**

**INNOVATION STORY**

2016 PRIMING GRANTS

## ASSOCIATE PROFESSOR ZHIYONG CHEN

When we strip back the latest technology to its bare bones, an algorithm emerges. It's The University of Newcastle control engineer Associate Professor Zhiyong Chen's job to create the core mathematics that eventually transform into sophisticated technology, such as robots.

"We tell the fundamental theory and lots of other people work on the top of that to build a robot," Dr Chen says.

And he doesn't discriminate – his mathematical prowess applies to robots of various sizes.

"If you want to build robots you have specific requirements. But I'm doing the brain part, and that can be applied to both small and large scales," Dr Chen says.

"Of course, the structure will be different, but the intelligence will share some common theories."

Dr Chen has been involved in building a soccer team of autonomous robots for the international annual RoboCup. He says building a complete robot involves many different scientific disciplines to work on different aspects of the technology.

As a control engineer, he worked on their brain and specifically, their stability and movement.

But you wouldn't want a robot playing on a human soccer team just yet. Dr Chen predicts it might take around two decades before soccer robots can reach that skill level.

"We've improved a lot over the last years, but it's at a very early stage. It's not as smart as you might see in the movies."

When Dr Chen was awarded the Priming Grant, however, it was to build a commercial network for his research on nano- to micro-scaled robots. He travelled to China and met with an SME in Shanghai.

The company develops nanopositioning products – devices that can deliver motion at increments in the nanoscale.

But one re-emerging issue in this field is getting the right speed and precision of the nano-robots.

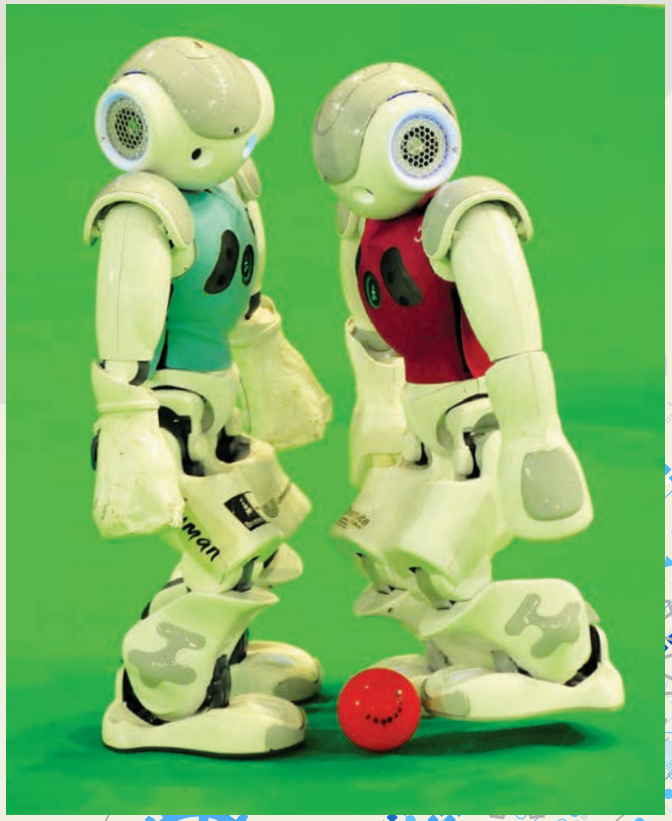
Dr Chen, who says The University of Newcastle have the most advanced techniques, updates the technology to make the robots more exact.

"There's no limit for how fast you can get, and we always want to push that forward and be more precise," he says.

Last year, the China-born 40-year-old engineer was a winner of the highest academic award issued to a person in higher education, becoming one of the Chang Jiang Distinguished Professors.

He says that it's the precision of mathematics that makes him passionate about this scientific field and ultimately drives his success.

"I'm a very mathematical guy, and I can describe lots of different things using mathematical language," he says.



# Advanced Manufacturing

PARTNER ECONOMY: UNITED STATES OF AMERICA
ORGANISATION: INSTITUTE FOR PHOTONICS AND ADVANCED SENSING (IPAS) AND THE UNIVERSITY OF ADELAIDE

INNOVATION STORY

2016 PRIMING GRANTS

## PROFESSOR HEIKE EBENDORFF-HEIDEPRIEM

For some scientists, a failed experiment can be a crushing disappointment. Perhaps the solution was slightly contaminated, or perhaps they just forgot to 'carry the one'.

For University of Adelaide glass scientist Professor Heike Ebendorff-Heidepriem, however, failures in the lab translate to unique works of art. Her research focuses on developing optical glasses and fibres, which means she experiments with the way light travels through glass.

When something goes wrong, the light still creates vivid patterns in the glass.

"Everything about glass is exciting to me," Professor Ebendorff-Heidepriem says.

"And particularly optical fibres. It's about creating new structures, manipulating the light that's travelling along these fibres and then interacting with the environment."

For fun, the German scientist has been involved in the marriage of science and art – six years ago she was involved in an exhibition with glass artist, coordinated by her previous supervisor.

The exhibition, called "A Fine Line", put failed glass science experiments on display.

"They couldn't really be used for light to travel along the glass, but they looked beautiful," Professor Ebendorff-Heidepriem says.

And she's currently working on another project, this time involving glass peppered with gold nanoparticles.

But at its core, working with optical fibres requires a sound scientific mind.

Optical fibres are usually associated with telecommunications, but Professor Ebendorff-Heidepriem's research focuses on developing new light sources such as novel lasers, and new sensing tools that use light for measurements.

For instance, she's currently working with Defence Science and Technology Group to make glasses and fibres that transmit light outside of the visible spectrum, such as infrared radiation.

"Defence are interested in developing glasses with new transmission windows."

For the project around her Priming Grant, Professor Ebendorff-Heidepriem worked with the cutting-edge technology provided by IRflex, which specialises in unique mid-infrared glass technology and production.

She brought her expertise in micro-structured fibre design and together they collaborated to create a new mid-infrared transmitting fibre for high power light.

"I'm very happy with the collaboration," she says. "It was one of those chance encounters." Professor Ebendorff-Heidepriem had met the CEO at a conference in the Bahamas.

After completing her PhD in Germany, Professor Ebendorff-Heidepriem moved to the UK for four years before flying to Australia.

And throughout her scientific career she has received a cache of awards, such as Women's Research Excellence Mid-Career Award (2015) and the International Zwick Science Award (2009) for the most innovative use of a Zwick machine, turning it from a metal testing machine to a glass extrusion machine.

# Advanced Manufacturing

PARTNER ECONOMY: **SPAIN**
ORGANISATION: **CIRCA GROUP**

**INNOVATION STORY**

2016 PRIMING GRANTS

## MR TONY DUNCAN

For Tony Duncan, who used to work in the paper industry, the "writing was on the wall" when digitisation became popular in the early 2000s and the fine paper industry began to plummet.

So he decided to co-found the business Circa to take the paper industry in a new and innovative direction.

First emerging in 2006, Circa is an SME that diverts cellulose waste by turning it into useful chemical products, such as solvents and pharmaceutical products.

Cellulose is an enormously abundant type of carbohydrate found in plant material and is used to make paper.

"Once used, paper fibre has really only three options - either landfill, recovery for recycled paper or burnt for energy. Our view was that there must be better ways to use the cellulose molecule," Mr Duncan says.

"We're now effectively using the paper industry's waste to make something that's twenty times more valuable."

One of their most recent ventures is using cellulose waste to create Cyrene – a solvent that can produce a valuable form of carbon with layered sheets only one atom thick, graphene.

The Priming Grant enabled Circa to collaborate with researchers in Spain and the UK to develop the potential of Cyrene, Mr Duncan says.

Currently, most other solvents with the same purpose are toxic, and are being phased out of the one million tonne global market.

"At the moment, the market has very few alternatives to the traditional, more toxic solvents. And when you're a small Australian-based company trying to access these global supply chains, it can be a considerable challenge," Mr Duncan says.

"So having this access to application expertise from researchers is important."

He cited one example when the international researchers tested Cyrene, they found it was ten times more effective than the solvents traditionally used in the production of graphene, as well as being a safer alternative.

"Publication of this work is now driving other inquiries from the market and other researchers," he says.

"What came out of it was a nice piece of work which was good, if not better than what's currently available."

As a company born from modernisation, Circa recently won the BioBased Chemical Innovation award in Amsterdam in early 2017.

Mr Duncan says it's one of his career highlights because it was validation for the Circa team and their manufacturing partner that they "have something the world is interested in".

"To gain this award was a genuine highlight and recognition for the small group of Circa people – employees and shareholders who've worked against the odds to get us to where we are."

# Advanced Manufacturing

PARTNER ECONOMY: **INDIA**
ORGANISATION: **DEAKIN UNIVERSITY**

**INNOVATION STORY**

2016 PRIMING GRANTS

## PROFESSOR RANGAM RAJKHOWA

With more than half a million tonnes of textile and leather waste filling Australian landfills each year, scientists are scrambling to come up with ways to incorporate sustainability in fast fashion.

Deakin University's Senior Research Fellow Dr Rangam Rajkhowa is one such scientist taking on the industry with innovative ways to keep textile waste down and find new applications for the fibre.

The 51-year-old textile fibre expert, who predominately works with natural fibres like cotton and wool, says there are still many opportunities for the fashion industry to become less wasteful.

Even natural fibres are a strain on the environment, he says. Cotton, for instance, uses vast amounts of water, energy and chemicals to process.

"It's a huge, multibillion dollar industry," Dr Rajkhowa says. "If you have a change in the process, it's massive in terms of impact."

He also widens the range of applications for natural fibres, turning our perception of fabric inside-out.

Recently, he was involved in a study that will trial the use of a silk membrane implant in the human ear to help people with ear drum problems avoid multiple surgeries.

"We only know silk as a fabric, but if we can use the proteins for new applications like medical implants it will be quite impactful," he says.

The Indian-born scientist says one of his greatest achievements, however, is being shortlisted for a competition launched by Swedish fashion chain H&M to boost recycling efforts.

Their idea is to extract colour particles from an old pair of denim jeans and use it to create a new pair, saving vast amounts of water from the process. And the research team ranks in the top five out of 3,000 entries from 130 different countries.

Currently, Dr Rajkhowa is determined to make more high-end products from wool, and the Priming Grant has helped him achieve important preliminary results.

We normally associate wool with winter, and generally only wear the fibre on the outer layers of clothing. But Dr Rajkhowa says wool has untapped potential, particularly in Australia, which produces some of the finest quality of wool in the world.

So he combined Australian animal fibres such as cashmere, alpaca and merino wool with Indian eri silk – a type of silk with wool-like properties – to develop new products.

"We have a lot of different products because we're always coming up with ideas, and we're always looking for new grants to keep us going," Dr Rajkhowa says.

# Advanced Manufacturing

PARTNER ECONOMY: **THE NETHERLANDS**
ORGANISATION: **AUSTRALIAN SYNCHROTRON**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR MARK BOLAND

While the synchrotron sounds more like it belongs in the realm of science fiction than reality, the particle accelerator still has ways to go. Physicist Dr Mark Boland is working on miniaturising the synchrotron, thanks to help from the Priming Grant.

He says part of the reason why compacting the synchrotron is necessary is to make it cheaper and more readily available.

"On the face of it, it's why you would miniaturise everything. Why aren't we walking around with giant blunderbuss satellite phones anymore? Because we came up with a compact solution."

But in terms of the scientific benefits, a smaller synchrotron can give scientists a clearer insight into particles.

Our perspective of nature largely depends on how we experience it – smaller ways of viewing, such as through microscope, reveal finer details. Compact accelerators would produce more coherent beams of X-rays, clumped together more slightly, and finer details emerge.

If it sounds confusing, you're not alone. Dr Boland says his research keeps him perpetually confused.

"But that's one of the interesting challenges, you never stop learning. There are so many things we have yet to understand, but that's also part of the fun and the challenge," he says.

The Priming Grant allowed Dr Boland, who was then working for The University of Melbourne and the Australian Synchrotron, to form a relationship with his European counterparts and create new opportunities for Australian students and researchers.

"It's a cultural experience that you get as a scientist. No one country can contain all the science in most fields," he says.

"But it still is work. It's not a leisurely pursuit – travelling is interesting and privileged, but it's not glamorous."

Dr Boland comes from a family of academics and achieved a Fulbright scholarship to Stanford University.

And after working for the Australian Synchrotron since its first inception (he was employee number five), Dr Boland recently moved to a new position at the University of Saskatchewan in Canada.

But his greatest achievement, he says, is the education and training he can provide for the next generation of physicists.

"That extended family of students who I've trained and inspired, that's the body of work I'm most proud of," he says.

"And that's one of the reasons I'm going to Canada is because part of the job is to lecture and give more opportunities to students - more than I can in my honorary role in Australia."

# Advanced Manufacturing

PARTNER ECONOMY: **UNITED STATES OF AMERICA**
ORGANISATION: **SABER ASTRONAUTICS AUSTRALIA, PTY LTD**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR JASON HELD

For many children growing up, watching Star Wars for the first time brought about a deep fascination with space. For co-founder and CEO of Saber Astronautics Dr Jason Held, this fascination never went away.

"Science fiction is what got me into doing what I'm doing now. It's a labour of love really," Dr Held says.

"Since I was six years old seeing Star Wars for the first time, it does make an impression on your life."

Dr Held began his career in the US army – a move he says was partly due to having poor grades in high school. But while stationed in Bosnia for a year, he would draw designs of technologies he envisioned building.

"In Bosnia we had a lot of free time to think and sketch things out – if there's no fighting what else are you going to do? You can only pause your life so many times."

When the opportunity to join the space command revealed itself, he asked to join, but was denied by his colonel. So, he resigned, working and studying his way into the space industry from the ground up, getting his first "space job" at 28.

For students who might not have adequate grades, he offers this advice:

"Everybody is going to tell you 'no, you can't', and you have to have the strength of will to ignore that," he says.

"In my personal experience, not everybody grows intellectually at the same rate. I didn't start to bloom until later in my life.

"If academia isn't working so well, it's okay - it's okay to make mistakes, or take a year or two off."

The Sydney-based scientist and businessman says his leadership experience in the US army boosted his ability to create and lead Saber Astronautics.

Located in Sydney and the US, the company's mission is to make the next generation of space control software.

The Priming Grant allowed Saber Astronautics to establish a relationship with a top US aeronautic school, Embry-Riddle Aeronautical University, which is building a commercial space operations research program.

The Saber Astronautics team took their mission control software up to the Florida-based university to discuss ways to modernise their technology.

"We're trying to move away from large rooms of people to something more compatible and automated," Dr Held says.

He adds the Priming Grant came at the right time. "It's a good time for it, a lot of people are trying to launch satellites."

# Advanced Manufacturing

PARTNER ECONOMY: **GERMANY**
ORGANISATION: **BIOFABRICATION DESIGN SOLUTIONS PTY LTD**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR MOHIT CHHAYA

Since it was first developed, 3D printing has struck a dent in many scientific fields, particularly in the health care sector. The tool is predominately used for prototypes – surgeons, for instance, can 3D print a body part model to help explore anatomy and better plan their surgeries.

Co-founder of Biofabrication Design Solutions (BDS) Dr Mohit Chhaya calls this the "low hanging fruit" for 3D printing's potential uses.

He says his company is devoted to taking 3D printing a step further and customise bone models to be implanted into the body of a patient.

"This is where there's a lot of movement and growth in the industry. You can use MRI or CT scans and make a custom implant," Dr Chhaya says.

Titanium and steel bone implants are made this way, but Dr Chhaya says they're too stiff and carry the bulk of the load, causing bone density to deteriorate in a similar way to astronauts' bones after a stint in space.

Instead, the Brisbane-based scientist and businessman makes intricate, porous and durable plastic implants that can be integrated into the body.

Their aim is to give bioengineers in hospitals the ability to design these structures using software that BDS is developing.

"We make not just a customised shape, but a customised architecture. We discovered this is something that the surgeons really need," Dr Chhaya says.

BDS was spawned from the labs of Dr Chhaya's PhD supervisor at the Queensland University of Technology, Professor Dietmar Hutmacher – a bioengineer who helped pioneer these 3D plastic structures.

Dr Chhaya started making his business a reality during his PhD and Post Doc, which was focussed on breast cancer implants.

Now at only 29 years old, Dr Chhaya is recognising where 3D printing is lacking and is using his Priming Grant to patch the holes in the technology.

He says because 3D printing is still a relatively new technology when it comes to biomedical research, it's hard to be exact when looking at what you can hold, compared with what was designed on the computer.

"If it's for a patient's implant, then you really want to be sure. The tolerances are really tight."

BDS have paired with a research group at the Technical University of Munich who use x-rays to analyse the printed part, comparing it to the model.

"We have a process that we can now very soon bring to Australia, and this would be one of the first ways we can control the quality of the print," Dr Chhaya says.

# Advanced Manufacturing

PARTNER ECONOMY: **UNITED KINGDOM**
ORGANISATION: **SIMPLEXITY COMMUNICATIONS PTY LTD**

**INNOVATION STORY**

2016 PRIMING GRANTS

## MR PAUL BURNS

Wires are quickly becoming a thing of the past – and Simplexity CEO and radio communications engineer Paul Burns is there to make sure that happens soon in hospitals.

Hospital patients are typically monitored by being hooked up to a machine next to their bed. This mechanism means patients' vital signs are being recorded every six to eight hours, making it possible for deteriorating conditions to go unnoticed until it's too late.

Mr Burns – whose company's primary focus is to deliver niche technologies – says this process is inefficient, particularly since Australia has an ageing population which will boost the number of hospital visits.

"The machine sits next to your bed, the information will come up on the display and you're wired to that machine, and nursing staff will come around based on your schedule to check the equipment," Mr Burns says.

Collaborating with a researcher from the UK thanks to funding from a Priming Grant, Mr Burns aims to have vital signs connected wirelessly.

"What we're looking to do is have the information go back to a central nurses' station wirelessly, and if something goes wrong, they'll know there's an issue – basically having real-time monitoring of people."

He adds a wireless system like this would also reduce the number of days a person spends in hospital as information could be transferred remotely, perhaps through a mobile phone.

Mr Burns has been working in this field for more than three decades, but he says he's kept intrigued.

"The pace of change is exponential, in fact. It's much harder to get bored with things now because they're changing so quickly."

"The applications for wireless technology today is so enormous," he says, and uses driverless cars as the latest example of what's soon to become wireless.

The Adelaide-based businessman has always been business-minded – when he was around 26 years old he was made a company director.

"As a young engineer, I didn't have any real training so I had to learn that stuff by doing it. I had a capability to look at the big picture as well as to deep dive into the technology."

But perhaps most notable is that Mr Burns is a bestselling author of the technical book, Software Defined Radio for 3G. It was lauded by former NASA computer security official John Vacca, and Mr Burns says it was one of the major highlights in his professional career.

# Advanced Manufacturing

PARTNER ECONOMY: **SWITZERLAND**
ORGANISATION: **BIOFUEL INNOVATIONS**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR REBECCA YEE

Waste generation often happens behind the scenes. When we're out to dinner at restaurants or at functions, we might finish the food on our plate, but enormous amounts of oil and grease are being thrown away.

To Dr Rebecca Yee, who is the co-founder of the SME Biofuel Innovations, this oil and grease is valuable. Not only can she transform them into a replacement for diesel, she can redirect masses of waste.

"Australia consumes phenomenal amounts of liquid fuel and the majority is fossil fuel. It just doesn't make sense, we should not be using fossil fuels," Dr Yee says.

Unlike European countries, Australia's supply chains rely on trucks due to its large landmass.

Since this system isn't likely to change, using biofuels rather than fossil fuels is essential to lowering Australia's carbon emissions and waste.

"On the other side, the actual oil molecule is fairly useable and it can be used to make something more valuable. And the fossil fuel industry has always been a concern for me, for my whole life."

In the beginning, the 31-year-old businesswoman and her business partner would source used oil from fish and chip shops and restaurants, but she says it was a labour-intensive process.

Now, the pair purchase oil from low-grade trap grease – a catchment for oil and grime that gets separated from waste water in industrial kitchens.

"Waste is really interesting, that's probably another reason I got into this space. Growing up seeing the garbage truck out of my window, as a kid I would wonder where they would go," Dr Yee says.

Ten per cent of biodiesel is a by-product called glycerol, a non-toxic chemical found in a variety of household products.

With funding from the Priming Grant, Dr Yee helped set up a collaboration between Biofuel Innovations and a researcher from ETHZ – a leading European STEM university in Zurich – to process the by-product into other valuable chemicals.

"There are a couple of different items glycerine can be made into, because it's quite a basic molecule, so it's easy to convert into other useful things," Dr Yee says.

"We're in a position now where we're communicating the details of the legalities of a joint venture, looking at the market and working out a business case of the development."

Biofuel Innovations isn't the only thing keeping Dr Yee busy. She's also worked as a swimming teacher and a tutor for science communication students at Monash University.

"Swimming makes people a bit more appreciative of our water environment, and hopefully our ocean environment," she says.

And science communication, she says, is "a real issue with some of the scientific work that comes out. It might be brilliant, but getting it across to a wider audience is an enormous challenge."

# Advanced Manufacturing

PARTNER ECONOMY: **ITALY**
ORGANISATION: **UNIVERSITY OF NEW SOUTH WALES**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR FRANCESCO FIORITO

For those who live in or near the city, climate change doesn't necessarily feel like an immediate threat. But urban environments play a critical role ensuring a habitable future for our planet.

University of New South Wales' high-performance architecture expert Associate Professor Francesco Fiorito is one scientist keeping building sustainability – or lack thereof – a topic in climate change talks.

His work focuses on façade engineering and design – the science behind resolving environmental and structural issues of a building's exterior. Dr Fiorito predominately works with smart materials that adapt to different environmental conditions, such as glass that changes colour depending on its exposure to different levels of radiation.

"We currently use a very low percentage of the energy that is naturally provided," Dr Fiorito says.

"If we can make changes automatic, we can save a lot of energy and improve indoor and outdoor comfort conditions."

He says just like the human body adapts to different environments, the first characteristic of a natural system is adaptation.

"Adaptation is one of the major strategies to climate change, especially to local climate change," he says.

"There is need of research in this area, we have to make all efforts to cope. And funding is urgent, we cannot delay finding real solutions."

Dr Fiorito moved to Australia from Bari, Italy, in 2011, first working at the University of Sydney and then transferring to the University of New South Wales in 2016.

"My passion for my research is the highlight of my career, and my passion for teaching, transmitting my research to a new generation of students, is another."

He says his ideal urban environment would be one with tall buildings – they have a lower environmental impact in terms of density and transport needs – and an integration of functions.

"I think integration is one of the key words for the future," he says.

"As an ideal development, commercial activity, offices, schools, but also primary activities like food production and production of energy would be integrated into buildings."

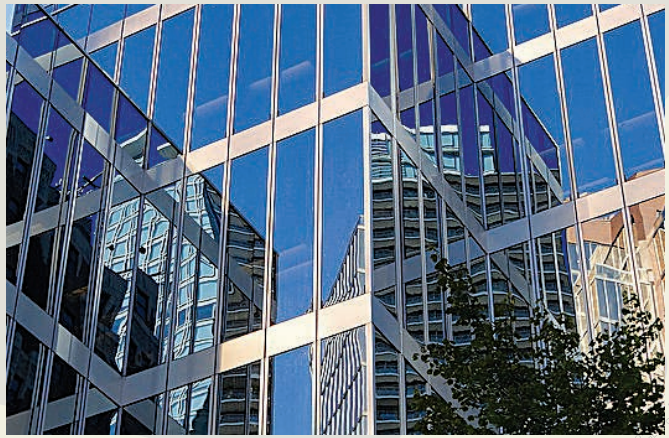
But integrating sustainability into urban environments isn't easily comparable to other industries, as buildings must be customised depending on who use them.

Consequently, Dr Fiorito also works in the prefabrication industry as a Chief Investigator of the Centre for Advanced Manufacturing of Prefabricated Housing. And this is where the Priming Grant comes in.

The 39-year-old Associate Professor worked in collaboration with a start-up in Italy, Easy House s.r.l.s., to develop a range of eco-friendly prefabricated buildings.

Dr Fiorito says prefabricated buildings are not only cheap and quick to make, but they can be flexible when exposed to various environmental conditions.

Their collaboration is envisaged to foster further research and development in Australia's manufacturing industry.



# Advanced Manufacturing

PARTNER ECONOMY: **UNITED STATES OF AMERICA**
ORGANISATION: **UNIVERSITY OF SOUTHERN QUEENSLAND**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR ALLAN MANALO

Australian rural and regional infrastructure still often relies on timber for support, but civil engineer from The University of Southern Queensland Dr Allan Manalo says managing timber has a few drawbacks.

"Managing road bridge decks made of timber is challenging and expensive, particularly since it's difficult to get high quality hardwood to keep up with demand," he says.

Steel, too, may wear away and weaken over time. So Dr Manalo and his colleagues focus their research on future materials like fibre composites designed to last and act as an alternative to timber.

The fibre-reinforced polymer (FRP) composite material typically consists of fibres such as carbon or glass. They're lightweight, so only minimal transport and manpower are needed to install FRP composite components.

"We try to find the most effective and innovative application of composites in civil engineering. We don't want to replace everything with composites, what we want is to identify the problem with existing materials and determine if composites can solve that particular problem," Dr Manalo says.

FRP composite material is an effective timber substitute, compared to concrete or steel, because it can be designed and manufactured to behave the same way as timber, but without being prone to deterioration.

And Dr Manalo is using them to replace timber in bridges, railway sleepers and to wrap composite material around degrading concrete columns.

"Civil engineers work more on applied research. We want the outcome of our research to be applied in actual structures, and then we feel that we've accomplished something," Dr Manalo says.

He was a successful Priming Grant recipient and used the funding to help bring composite bridge decking manufacturing to Australia.

The Philippine-born scientist, who moved to Australia in 2008 to start his PhD after living in Japan for two years, set up a relationship with a US company called Composite Advantage. This SME manufactures bridge decks from composite materials.

He says he first heard about them while on a sabbatical in Canada in 2015, and took the opportunity to develop the relationship when he received the Priming Grant.

The primary motivation, he adds, was to see if their technology could be introduced in Australia.

"I thought I could try to understand more on how this company produced composite decks and try to fit with the existing manufacturing process and available technology," he says.

"I visited their company, saw how they produced the product, and I was able to see some of the bridges installed using their product."

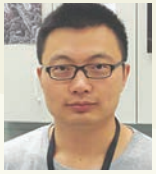
Now, a marketing study is being conducted to assess Australia's need for these kinds of bridge decks.

# Advanced Manufacturing

PARTNER ECONOMY: **UNITED STATES OF AMERICA**
ORGANISATION: **CSIRO**

**INNOVATION STORY**

2016 PRIMING GRANTS



## DR ZHAOJUN HAN

One of the major challenges that prevents renewable energy from overtaking the fossil fuel industry: what happens when the sun isn't shining and the wind is still?

How can we store this energy to use in the future? Dr Zhaojun Han from CSIRO believes the solution is in nanomaterials, particularly in graphene – a form of carbon with latticed sheets only one atom thick.

Dr Han, who develops electrodes using nanomaterials, says graphene is important because it has a large surface area, and because of its electroconductive and mechanical properties.

"I have been working on nanotechnology since my PhD and I was most interested studying the energy sector because I see energy has become a very important problem in our society, especially if we want to try and minimise greenhouse gas emissions," Dr Han says.

But nanotechnology for energy storage, he adds, isn't quite up to the required standards, and new materials and engineering methods are necessary to improve its performance.

"That's why I study this, to step into the research using graphene. It's a material that has a lot of promise to revolutionise this device," Dr Han says.

Already Dr Han is making incredible progress. He was recently part of a team that invented a way to create graphene – which is 200 times the strength of steel – from soybean oil.

This method, published in Nature Communications, cuts the cost to make graphene by five to ten-fold, and many scientists are confident it will allow the material to be produced on a commercial scale.

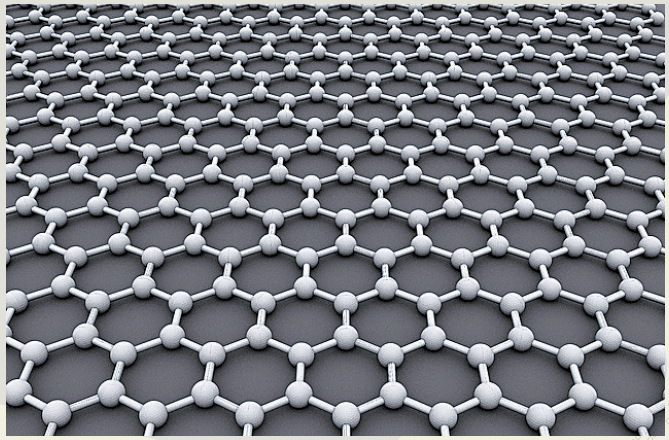
"Being a scientist is particularly self-rewarding in the sense that when you make new discoveries or publish new results, it gives you the feeling that you made some impact on society," he says.

"Even if you don't see an immediate impact, you're adding some knowledge to society in general."

But it was "vertical" graphene that saw Dr Han travel to China on Priming Grant funds and visit one of the largest graphene producers in the country – Sixth Element Materials Technology Co. Ltd.

Vertical graphene is when graphene flakes are aligned vertically on a surface. Dr Han presented it to the company CEO and a senior research team, who he says were interested because they couldn't produce vertical graphene themselves.

"We discussed some opportunities for the future, especially to do some research together as well as to apply for a joint grant for further research," he says.



# Advanced Manufacturing

PARTNER ECONOMY: **UNITED STATES OF AMERICA**
ORGANISATION: **CLARITY PHARMACEUTICALS**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR MATTHEW HARRIS

We are in a war on cancer and some treatments, such as chemotherapy, are like setting a bomb off in the body – the tumour may be destroyed, but the rest of the body becomes debilitated.

But what if there was a way to target cancer and kill a tumour without any collateral damage?

Sydney-based SME Clarity Pharmaceuticals are developing a way to do just that with nuclear medicine.

By labelling a drug with a radioactive tag, doctors can watch the drug through imaging as it travels through the body and seeks its target.

Managing Director of Clarity Pharmaceuticals Dr Matthew Harris says being able to see the drug infiltrate the body allows doctors to treat the patient more accurately.

Clarity uses a specific form of copper, called copper-64, to enable this targeted treatment. Copper-64, together with PET imaging, help confirm targeting.

"Once we have confirmation that, yes, the drug actually goes to the tumour and is safe, we use another form of copper, copper-67, which kills cancer in a localised manner, making the treatment safer and more efficient," Dr Harris says.

"It gives you a lot of confidence to treat the patient. This is opposed to getting a diagnosis, taking chemotherapy and then hoping the drug goes to the tumours. We actually visualise it."

Clarity Pharmaceuticals is a development company – they don't presently have any products on the market but they're currently in clinical trials, testing their radio-tagged drugs on humans.

Soon, they'll trial the drug on children suffering from cancer.

"That's something that also drives us, we're all focused and passionate about hopefully helping a child with cancer," Dr Harris said.

Using funds from the Priming Grant, Clarity Pharmaceuticals set up a working relationship with Idaho State University's Idaho Accelerator Centre in the US.

There, a research team pioneered a production method for a coveted but rare form of copper that isn't available in Australia, copper-67.

This form of copper is a core part of Clarity Pharmaceutical's radio-tagging technology.

"It's very important to work out whether we could actually use that in Australia in our trials, as well as the potential to make copper-67 in Australia in the future," Dr Harris says.

Copper-67 is at the "cutting-edge", Dr Harris says, and adds that up until now the production of it didn't result in high enough yields.

"The benefits of using copper for targeted therapy is nothing new in science, but it's only now coming of age, thanks to Clarity's team and technology, and the efforts of our colleagues in Idaho who ensure regular and commercially viable supply of copper-67."

# Advanced Manufacturing

PARTNER ECONOMY: **UNITED STATES OF AMERICA**
ORGANISATION: **AUSTRALIAN NATIONAL UNIVERSITY ADVANCED INSTRUMENTATION AND TECHNOLOGY CENTRE**

**INNOVATION STORY**

2016 PRIMING GRANTS

## DR NAOMI MATHERS

The only way is up for Australia's space sector, and one of the people spurring it on is Dr Naomi Mathers.

As a board member of the Space Industry Association of Australia, and until recently an industry liaison engineer at ANU's Advanced Instrumentation and Technology Centre, Dr Mathers is embedded in Australia's space industry.

"Pretty much everything I do has been, and probably will continue to be, related to this: how do we take the fantastic research that's being done in Australia and turn that into capability for industry?" Dr Mathers says.

"Really what I do is connect the dots and make sure that research gets out of the university and to companies and governments, and gives people jobs."

She adds that it's the innovative nature of the space industry that inspires her work.

The space sector is extremely collaborative and inclusive with a variety of disciplines necessary, it's "constantly cutting-edge", and the area Dr Mathers is involved in is very practical, which suits her engineering side.

"It measurably makes our life better. I don't sit well in areas that are too theoretical and esoteric," she says.

The space industry, however, has a reputation for having a lack of women involved. And Dr Mathers says they're still moving towards equity.

"Things are improving, but even in recent years I have experienced being the only female speaker at a conference or the only woman on a project."

But the industry has a lot more women starting to take part than in some other areas, she adds.

"I think that's because it has to be an integrated approach, there's a real strength in women who can connect the dots," she says.

"You need diversity, full stop. It has to be global, so you need a geographic diversity. It has to be innovative, you need a future workforce, so it has to generationally diverse. And you need all the best minds you can get, so it better be gender diverse."

Dr Mathers was a recipient of the Priming Grant, and used the funds to create a strategic partnership between ANU and Tyvak – a US company that provides nanosatellite and microsatellite vehicles and services.

With ANU's instrumentation design expertise and Tyvak's highly sophisticated satellite bus that opened up a global market, the partnership will link the two capabilities and produce instrumentation for a market.

"The Priming Grant was an opportunity to really get serious talking about how that would happen," Dr Mathers says.

"It was a good connection for a research group with instrumentation expertise who really hadn't commercialised anything before, and a company with a good research culture who needed expertise in instrumentation."

# GLOBAL CONNECTIONS FUND

*The Global Connections Fund (GCF) is a component of the Global Innovation Strategy under the Australian Government's National Innovation and Science Agenda. The GCS enables Australian SMEs to link with international researchers and Australian researchers to collaborate with international SMEs to seize opportunities in priority areas of importance to the strategic growth sectors of Australia.*

*The GCF is comprised of two types of grants: Priming Grants and Bridging Grants. Priming Grants are small grants of $7,000 to enable Australian SMEs and Australian researchers to physically meet with their international partners and develop their collaborative ideas. Bridging Grants are larger grants (up to $50,000) designed as seed funding capital to enable viable projects to grow in scope and scale, to test commercialisation and proof of concept activities.*

www.globalconnectionsfund.org.au

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NATIONAL INNOVATION & SCIENCE AGENDA

The Global Connections Fund is a project of the Australian Academy of Technology and Engineering (ATSE) and is supported by the Australian Government.
This program forms part of the Global Innovation Strategy under the Australian Government's National Innovation and Science Agenda.