MACDIARMID ANNUAL REPORT 2017

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

THE UNIVERSITY OF
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Te Whare Wananga o Tamaki Makaurau
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CHRISTCHURCH NEW ZEALAND

The MacDiarmid Institute
for Advanced Materials and Nanotechnology

MASSEY
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TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

UNIVERSITY of
OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Callaghan
Innovation

GNS
SCIENCE
TE PŪ AO

The challenges facing New Zealand and the world today – clean water, renewable energy, climate change – will be solved by tomorrow's scientists and engineers, sitting in our classrooms right now, ready to be inspired. They'll need new materials and the new technology based on those materials that hasn't been discovered yet. That's what the MacDiarmid Institute does. We're New Zealand's investment in our future – a team of New Zealand's best scientists, engineers and educators unified for a common goal – to make, understand and use new materials to improve people's lives.

624 PhD graduates

190 postdoctoral fellow graduates

814 alumni

3000+ attendees

14 start-ups

Introduction

Out of the lab

Into the market-place

Into the community

Into the future

Into the metrics

Director's report

Professor Thomas Nann
Director

Nature Science Index ranked us 4th amongst New Zealand's top 10 research institutions

2017 has been another exceptional year for the MacDiarmid Institute; from our AMN8 international conference in February, and our expanding industry collaborations, through to our growing engagement with schools and communities.

Excellent science has always been the bedrock of everything we do. This is continually endorsed externally, for example by the Nature Science Index 2016, who ranked us 4th amongst New Zealand's top 10 research institutions. Again, our researchers have been outstandingly successful in competitive research grant schemes, securing in excess of $54M, giving testimony for the quality of our science.

The AMN8 conference is increasingly international, with 69 percent of the more than 500 delegates coming from overseas and including world-renowned researchers in Materials Science. The event was much more than a typical Materials Science conference; plenary speaker David Leigh spoke to over 600 school children and the 'Women in Science' panel attracted great interest from the public, conference delegates and the media.

The 'Women in Science' event at the AMN8 was so successful we based our Regional Lecture Series 2017 on this theme. Our female nanoscientists travelled the country to speak about their personal science journeys, inspiring hundreds of New Zealanders across seven regional centres.

The mid-term review was an important milestone for the MacDiarmid Institute - a great opportunity to reflect on our activities in the first funding term and to position ourselves for the next term and beyond 2020.

Our Industry Interface Challenge, where several New Zealand companies pitched technical problems to MacDiarmid Investigators, resulted in industry-led follow-on projects, along with lasting relationships with these companies and potential employment opportunities for our students.

I thank all of our investigators for their great work. I would particularly like to acknowledge our outgoing Board Chair, Dr Ray Thomson, whose influence and knowledge in commercialisation and entrepreneurship has had a huge impact on our success in this area. I also recognise and thank our two outgoing Deputy Directors, Nicola Gaston and Justin Hodgkiss, for their outstanding contributions and continuing support.

Chair's report

Dr Ray Thomson
Chair

The MacDiarmid Institute continues to deliver to the New Zealand science scene and to the economy

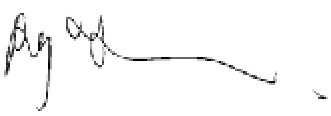
One of the main achievements in 2017 was the hosting of the Interface challenge where MacDiarmid investigators were paired up with a variety of industry challenges. Feedback from the industry participants was unbelievably positive, highlighting to me that what goes on inside our "University ivory towers" is not usually seen as very accessible by the business community. This is something the wider science community needs to work on, and could do well to follow this lead by the MacDiarmid Institute.

We have continued to make good progress on seeing the work of MacDiarmid scientists being commercialised, with Sapvax (Margaret Brimble), Silventum (Carla Meledandri) and SpotCheck Technologies (Jadranka Travas-Sejdic and David Williams) established, the latter also supported by Return on Science to take things to the next level and seek investor funding. It was also pleasing to note that two companies associated with our investigators raised second round funding: Auramer Bio (Justin Hodgkiss) and Hi Aspect (Juliet Gerrard). Engender Technologies (Cather Simpson) is currently undertaking a major capital raise.

The scientific achievements by our investigators have continued at a high level as reflected in the $50m worth of MBIE bids awarded to associated teams.

I would like to take this opportunity to thank our two retiring Deputy Directors Nicola Gaston and Justin Hodgkiss, who have both put in a lot of effort into their roles over the last two and a half years. I believe we have made good solid progress in both industry engagement and education outreach under their leadership. My own term came to an end at the end of 2017 and I therefore wish Thomas Nann and his team every success in the future. In particular the MacDiarmid rebid will be a key focus over the next three years. I firmly hope the government will continue to see the huge benefits the MacDiarmid Institute delivers to the New Zealand science scene and to the economy, both in terms of human capital and economic impact.

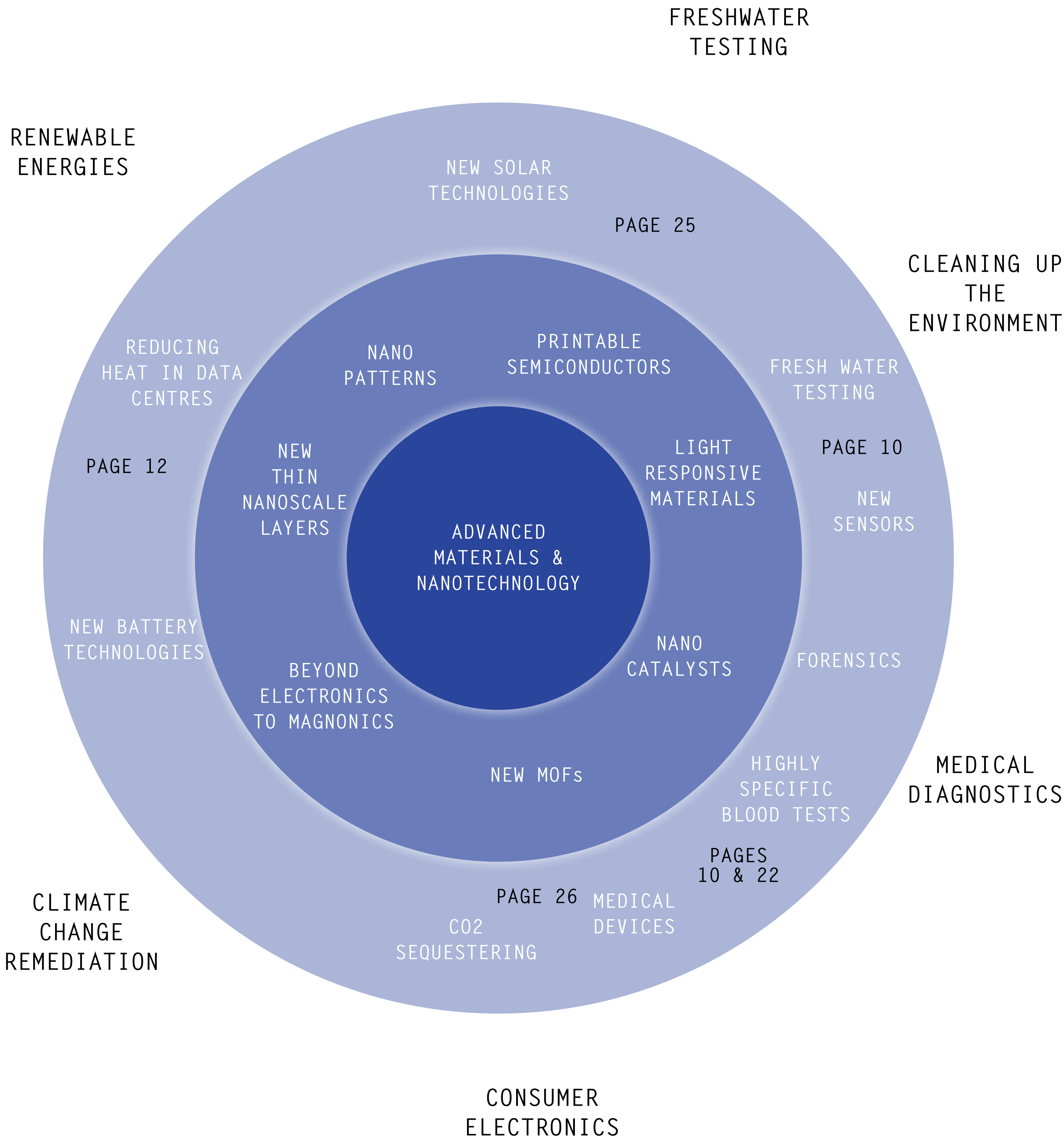
After three full and rewarding years as Chair on the MacDiarmid Board, I hand over this role to Paul Atkins. Paul brings expertise as CEO of Zealandia. He is on the boards of several other companies, and chaired the board of Boutiq Science Ltd, a MacDiarmid Institute spinout company, until the end of 2017. He brings many years' experience in marketing and business development and I am very pleased to be leaving the Chair role in such strong and capable hands.



Rakaia River, Geoff Leeming

1. Out of the lab.

The tiniest things can make a difference to our biggest problems, such as climate change.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RENEWABLE ENERGIES
NEW SOLAR TECHNOLOGIES
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NANO PATTERNS
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WATER QUALITY TESTING AND MEDICAL DIAGNOSTICS

With nearly all cancer deaths caused by metastasis – cells breaking away from the primary cancer and spreading through blood and lymph nodes to other parts of the body – hunting for metastatic cells is a priority in cancer diagnosis.

Finding metastatic cancer cells in blood is a bit like looking for a needle in a haystack – the cells are tiny and within a large volume of blood, full of many other cells and substances.

Doctors need clean, enriched cell samples and highly specific targeting technology to diagnose quickly and accurately. Electrospun fibre mats, developed by MacDiarmid Principal Investigtors and University of Auckland Professors Jadranka Travas-Sejdic and David Williams, along with Associate Professor David Barker, will provide just that. The researchers have recently developed surface-grafted mats with negatively charged 'brushes' and capture probes made of DNA strands that recognise specific genes. They will use such platform technology and develop it to selectively capture intact rare cells from complex liquids and release them into an analysis medium -concentrating disease markers for medical testing and diagnosis.

Professor Travas-Sejdic explains. "Our gene detection technology is capable of targeting a whole range of things just through changing the DNA probe, from cancer cells in blood, to bacteria and other pathogens in water and food, viruses and much more. The technology has applications in medical diagnosis, forensic science, and food and water quality testing.

"We have shown that we can use these novel polymers, that bear specific gene probes, as a thin coat on our highly porous conducting electrospun fibre mats. We can make highly sensitive and selective gene sensors."

Professor Travas-Sejdic's team this year received a Ministry of Business, Innovation and Employment (MBIE) Endeavour Smart Ideas grant, worth $900,000 over three years.

The technology has applications in medical diagnosis, forensic science and food and water quality testing.

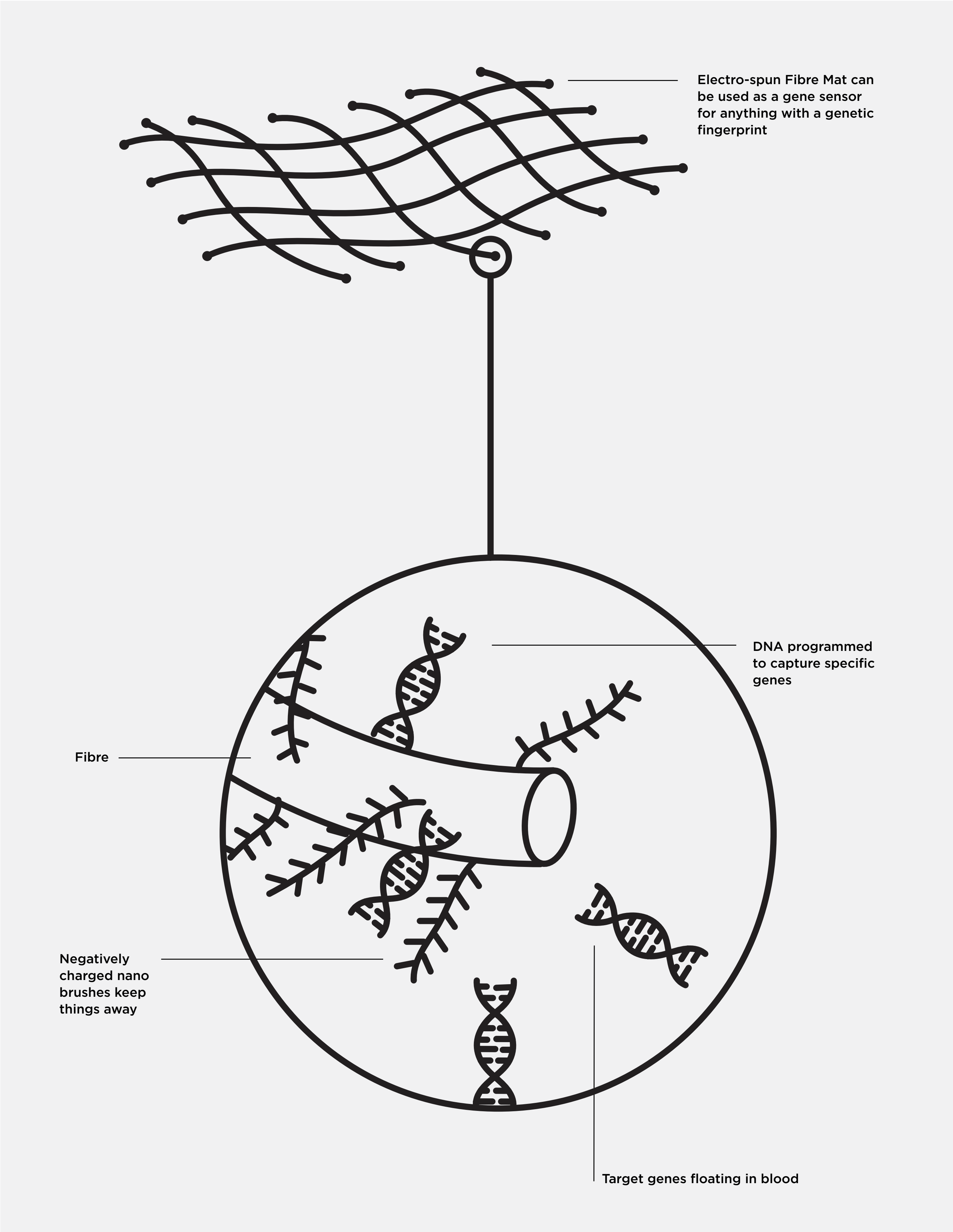
Professor Jadranka Travas-Sejdic

"We're looking to functionalise the fibres – to build a library of functional materials to capture biomolecules. This is platform technology – it can go in any direction," says Professor Travas-Sejdic.

One direction they're already heading is commercialisation, with spinout company SpotCheck Technologies registered in early 2017. SpotCheck plans to commercialise this biosensing platform technology, and the team has secured seed funding from Auckland UniServices (Return on Science) and from University of Auckland Inventors Fund. It has already attracted interest from investment groups.

The new company, which has employed three former MacDiarmid PhD students, is working to show that the technology is large-scale manufacturable, similar to the production of highly commercially successful glucose sensors. These gene sensors will be cheap and portable. For example, they could be used in GP offices for on-site bacterial tests or by local authorities to test bacterial pollutions of water.

Going forward, the group is collaborating with MacDiarmid Principal Investigator and Victoria University of Wellington Professor Thomas Nann and Postdoctoral Fellow Dr Renee Goreham to extend the application of electro-spun fibres (such as for capturing exosomes), and has recruited a MacDiarmid-funded PhD student to assist, starting in early 2018.


Electro-spun Fibre Mat can be used as a gene sensor for anything with a genetic fingerprint
DNA programmed to capture specific genes
Fibre
Negatively charged nano brushes keep things away
Target genes floating in blood

TAKING THE HEAT OFF

Each time you type into Google and hit 'search', somewhere in the world a data centre responds. This data centre – a repository for masses of information – will be one of many worldwide (there are even four in New Zealand). Globally, data centres use almost ten times as much electricity per year as the whole of New Zealand, and their collective energy use is projected to treble in the next decade.

It turns out not all electricity used by data centres goes into running your search query. A good chunk of it is used to cool down the computers.

It's this chunk that two MacDiarmid Institute teams are addressing, in quite different ways.

One of the MacDiarmid teams is a group of physicists at Victoria University of Wellington working with rare earth nitrides. The researchers have combined these rare earth nitrides with superconducting electronic materials to make new superconductors, and already have a couple of patents under their belts.

The other is a multidisciplinary team led by MacDiarmid investigators at the University of Auckland and involving our investigators at Victoria University of Wellington and the University of Canterbury. Using biology, this team is looking at new ways to assemble nanowires and nanoarrays for tiny transistors. The team brings together researchers with deep knowledge in specialist areas and is using this cross-discipline expertise to create potentially game-changing technology.

Working to reduce electricity use 100-fold

Principal Investigator and Victoria University of Wellington Associate Professor Ben Ruck says that data centres use electricity in two ways. "When you run big data centres, you pay twice for electricity. You pay to run the computer, and you pay to get rid of the heat it creates. Heat is such a big deal that they actually build data centres in Sweden, where they can just keep the doors open."

Along with the VUW MacDiarmid team, Associate Professor Ruck has found and patented materials that could cut the amount of global electricity used by data centres by 100-fold, from 3 percent to 0.03 percent.

Along with the VUW MacDiarmid team, Associate Professor Ruck has found and patented materials that could cut the amount of global electricity used by data centres by 100-fold, from 3 percent to 0.03 percent. "We've been working with rare earth nitrides like samarium or gadolinium nitride – simple compounds that act as magnetic nanomaterials – and combining these with superconducting electronics, based on materials such as niobium. To our surprise, we found that samarium nitride is a superconductor itself," explains Associate Professor Ruck.

Superconductivity in samarium nitride is unexpected because it is a magnetic semiconductor and superconductivity and magnetism are usually incompatible bedfellows.

For example, in samarium nitride the electrons organise themselves into a state where their so-called intrinsic 'spins' all point in the same direction. This makes it magnetic. By contrast, superconductors such as niobium almost always have electrons in pairs with opposite spin directions. Somehow, samarium nitride finds a way to accommodate both types of ordering.

The team (which also includes MacDiarmid Principal Investigators Dr Franck Natali, Emeritus Professor Joe Trodahl, Professor Michele Governale and Professor Uli Zuelicke, as well as Associate Investigator Dr Simon Granville, and more recently Emeritus Investigator Professor Bob Buckley) has been patenting as they go. They have two patents already and more on the way, with 2017 KiwiNet funding to help.

Associate Professor Ruck says that while they're still some way off commercialising it, there are good prospects for technology like this to one day be manufactured in New Zealand. "These components are tiny and light and high value. We could ship them anywhere." The VUW MacDiarmid team is already collaborating with a US company to develop their ideas further.

Longevity rules

Associate Professor Ruck says the project is an example of a long-term deep-research project, funded over many years by a Centre of Research Excellence, starting to show its usefulness in the practical world.

"When we started this MacDiarmid project in 2006, we were trying to understand the basic properties of the materials. From about 2012, we could then start to look at how these materials could be used to make computer memory. And from 2015, we've been able to tie it in with superconductivity, to not only make computers faster, but to reduce the heat and the big impact these data centres are making on the environment."

"Ten years into this research, our MacDiarmid team is still the world leader in this area, and because of our patents, we now have international companies wanting to work with us."

A multidisciplinary approach

Another MacDiarmid team is approaching the heat problem in a different way.

Sitting together at a MacDiarmid Institute Functional Nano-structures theme meeting in mid 2016, Victoria University of Wellington physicist and Associate Investigator Dr Simon Granville, and University of Auckland MacDiarmid Principal Investigators biochemist Professor Juliet Gerrard, chemist Professor David Williams, and materials engineer and Associate Investigator Dr Jenny Malmström were pondering this same problem – how to reduce the heat produced by computers in general, and data centres in particular. By working across their four disciplines, they've come up with an entirely new approach.

Dr Simon Granville works with magnonics – studying magnetic materials able to generate magnons, or spin waves, that could be downsized to the level of modern transistors – making devices that will be very fast while saving a lot of energy. In theory, magnonics is a good idea for a technology to replace electronics.

However, the building blocks are so tiny (much smaller than 100 nm) that assembly proves a huge challenge. The multidisciplinary MacDiarmid team put their heads together to come up with a couple of cunning ideas.

> **"This is a long-term deep-research project funded over many years by a CoRE, now starting to show its usefulness in the practical world."**
>
> Associate Professor Ben Ruck

A biological solution to an electronic problem

The first idea was to try using protein 'doughnuts' (a regular building block of a more manageable size – 15 nm diameter, with a hole in the middle of about 8 nm) to assemble nanowire and nano surfaces. This method had already been used to assemble other nanoparticles by Principal Investigator and biochemist Professor Gerrard.

MacDiarmid PhD student Sesha Manuguri – jointly supervised by Professor Williams and Dr Malmström – has since managed to restrain iron nanoparticles to the 3-4 nm dimensions of the inside of the protein doughnut, by making the particles assemble inside the doughnuts.

These protein doughnuts can stack into long tubes. Dr Malmström says the aim is for each doughnut to be a carrier for magnetic nanoparticles, and create long magnetic nanowires.

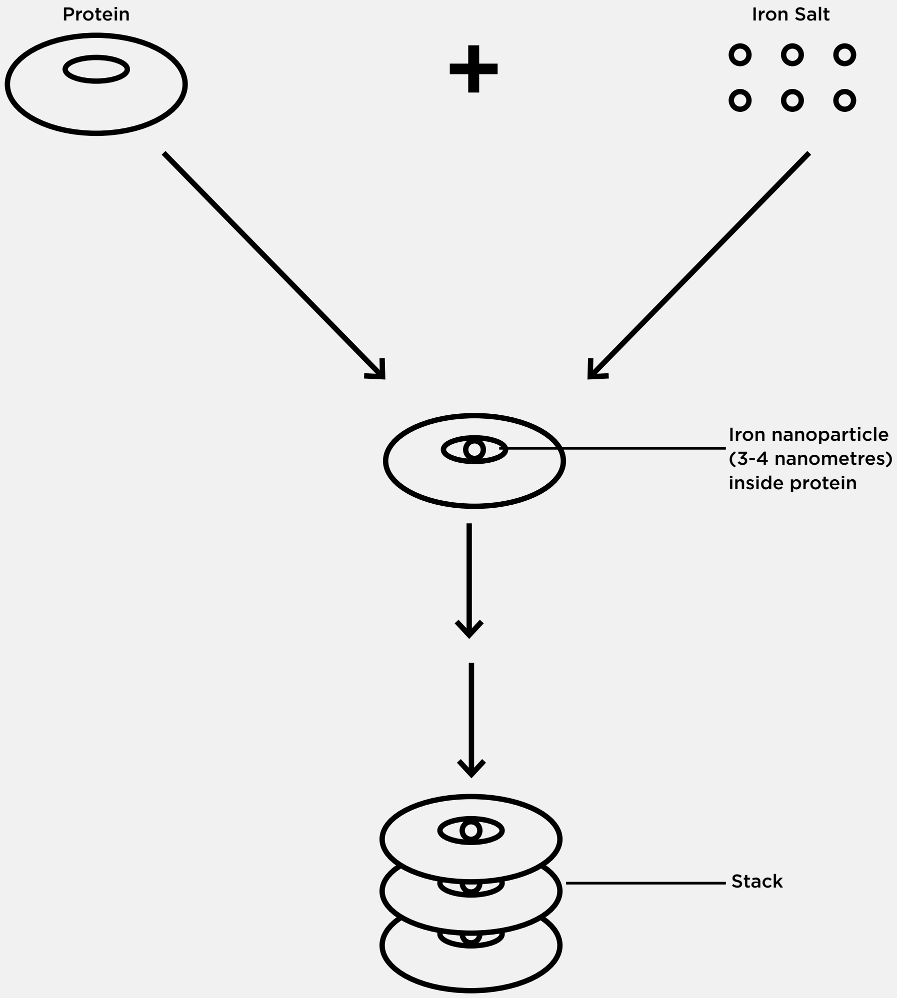
New MacDiarmid Institute Associate Investigator and University of Auckland biochemist Dr Laura Domigan (who collaborates with Professor Gerrard) is working to place single protein doughnuts in an organised pattern on a surface. If doughnuts can be placed on a surface they could be used to hold nanoparticles in an organised pattern. Dr Domigan is currently working on assembling them on surfaces.

Using polymers to assemble thin nanoscale layers

The second idea hatched at the functional nanostructures theme meeting involves using polymers (another name for plastics) to assemble nanoparticles. By using a so-called block copolymer – with two parts that don't like each other, much like oil and water – the polymer can organise itself into regular nanopatterns.

These polymer patterns can be used to make an ordered pattern of nanoparticles, although the particles that can be made in the polymers are larger than those made in the protein doughnuts. There is also the potential to use the polymers themselves to order the protein doughnuts.

It is then up to Dr Granville and his collaborators to test these materials for magnonic



Dr Malmström says the aim is for each doughnut to be a carrier for magnetic nanoparticles, and create long magnetic nanowires.

"We may have built up an entirely new science."

Dr Jenny
Malmström

properties, by measuring the wavelengths of the spin waves produced using the patterns.

"If spin waves can be excited to feature wavelengths in the nanometre range, it might allow for the downscaling of devices that work at gigahertz frequencies and can compete with the nanosized transistors of today," he says.

Uniquely MacDiarmid

Dr Granville says what excited him was connecting people across a multitude of disciplines – biochemistry, chemistry, materials engineering, and physics.

"This is exactly the sort of project MacDiarmid is good at. It's hard to see another organisation managing it.

"We're bringing together people with a deep knowledge in specialist areas and seeing how magnonics can be applied to be completely revolutionary. That's the goal of the project," says Dr Granville.

Other than potentially creating a revolutionary technology in the form of magnonic transistors, Dr Malmström says there are other valuable benefits to such a project.

"This is another thing that excites me. You are doing something so far out there, that's where the big breakthroughs come from. We may have built up an entirely new science."

Professor David Williams says this kind of research is really only possible in a Centre of Research Excellence (CoRE).

"Only a CoRE would naturally facilitate a group as diverse as this to come together to hatch ideas."

He loves the challenge. "You want your brain to hurt, to get out of your comfort zone. You attract people when you do things like this. You respond to sparks and generate your own sparks. We do the weird stuff no one else is doing."

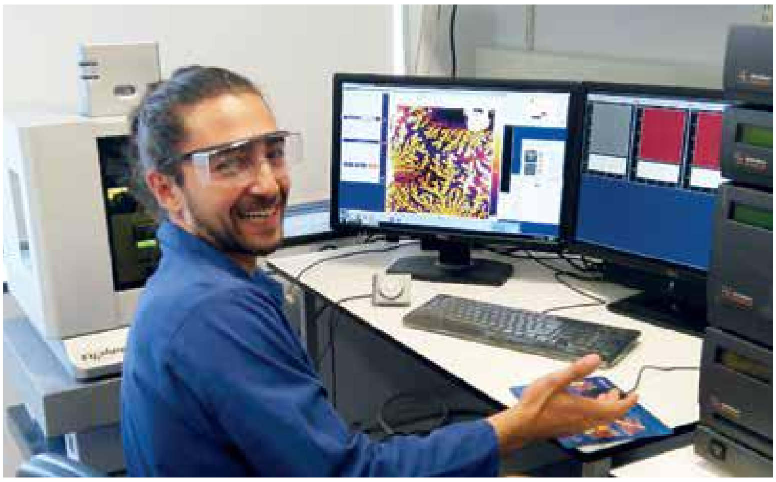
A newly created MacDiarmid postdoctoral position will slot into the middle, providing the glue between the investigators, and enabling functional measurements of the new materials.

Other MacDiarmid Institute researchers involved include Canterbury University Professor Alison Downard and University of Auckland Professor Penny Brothers and Associate Professor Duncan McGillivray (who will run various tests, including neutron scattering); a PhD student who is putting gold particles in the middle of doughnut protein; and another PhD student working with other polymers to form an organised nanoscale film.

One day, with these new technologies, perhaps we'll be able to 'like' our friend's Facebook post without collectively putting such a strain on global energy use or contributing to greenhouse gas emissions.

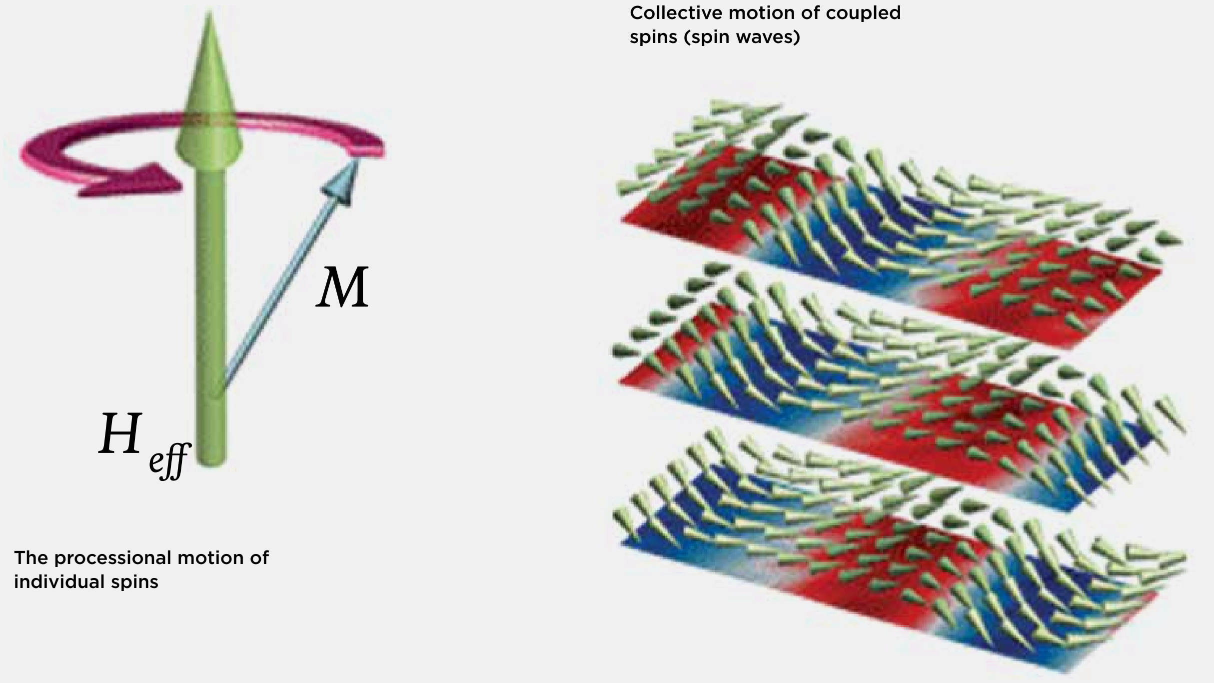
We do the weird stuff no one else is doing."

Professor David Williams

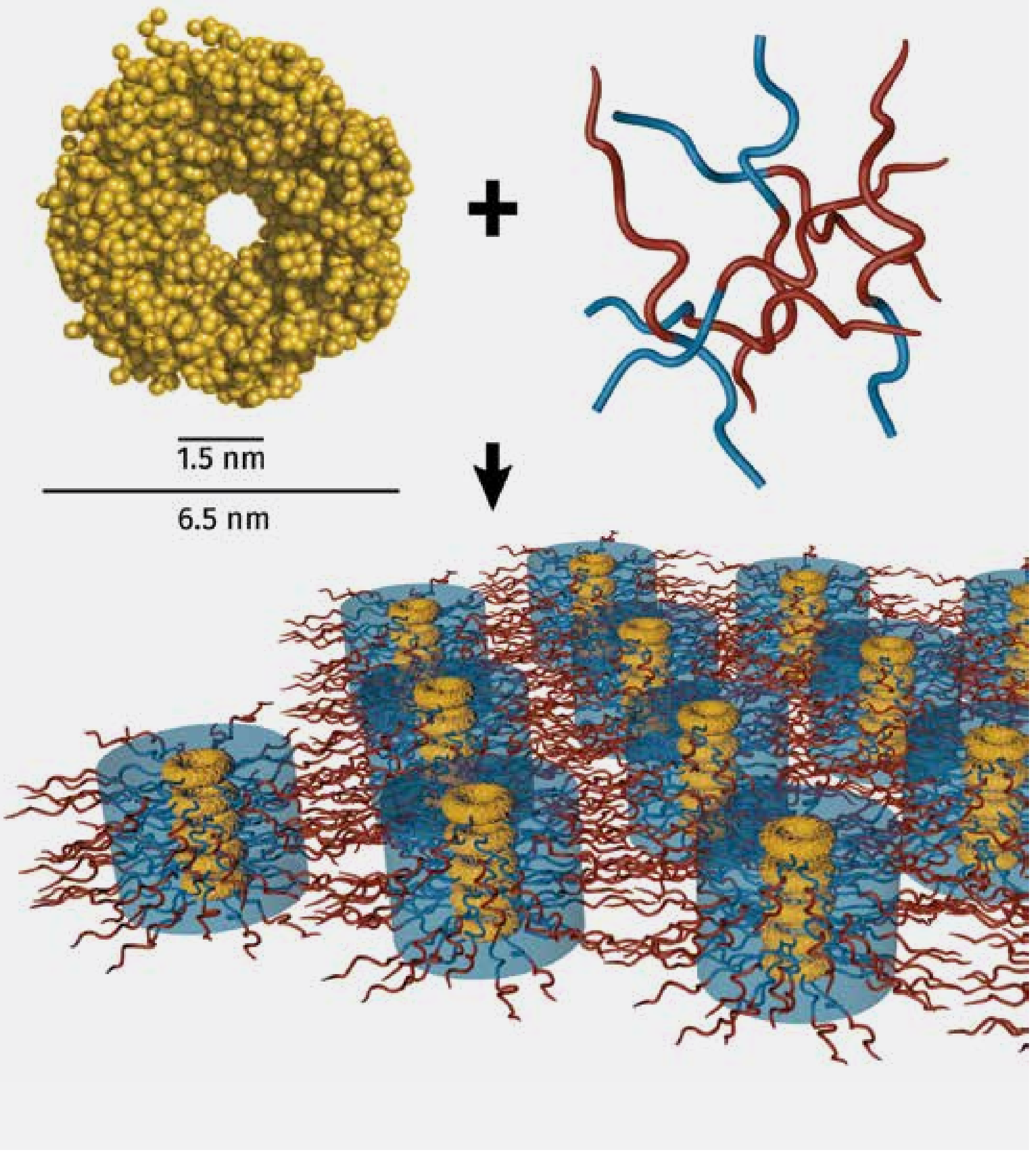


MacDiarmid PhD student and MESA Auckland rep Tarek Kollmetz measuring the electrical resistance of samarium nitride as a function of temperature

Spin waves in a magnetic layer



Restraining iron nanoparticles to the 3-4 nm dimensions of the inside of the protein doughnut, to make long magnetic nanowires



This work, if successful, would give New Zealand a significant share of the global electronics market.


THE COLLOIDAL DOMAIN


THE COLLOIDAL DOMAIN


THE COLLOIDAL DOMAIN


THE COLLOIDAL DOMAIN

Physicist Dr Simon Granville, Chemistry Professors Penny Brothers and David Williams, Physics Professor Jeff Tallon and Materials Engineer Dr Jenny Malmström

"You are doing something so far out there, that's where the big breakthroughs come from."

Dr Jenny Malmström

PAINTING SEMI-CONDUCTORS

Painting semiconductor surfaces to create sensors

Imagine a point-of-care electronic blood test that can provide an immediate result in a doctor's surgery, instead of the current tests that have to be sent away to a lab. The blood test device would plug into a mobile phone to provide a reading, and would be cheap and biofriendly. Or imagine a cheap, wearable UV sensor for SunSmart education and skin-cancer prevention programmes in schools. These are just two of the end products that Principal Investigator Associate Professor Martin Allen (University of Canterbury) and his MacDiarmid Institute collaborators are working towards.

The underlying science of these devices is based on changing the properties of metal-oxide semiconductors (such as zinc oxide or tin oxide) by chemically attaching organic molecules; for example, to make them into biological and environmental sensors.

"These are quite unusual semiconductors in that they're completely transparent, so you can make sensors which are invisible and non-intrusive," says Associate Professor Allen. "They're also cheap, nontoxic, biofriendly materials."

The metal-oxide semiconductors are grown on plastics, glass or sapphire by one of two methods. The first method uses a state-of-the-art molecular beam epitaxy facility to grow semiconductors, using beams of atoms in an ultra-pure vacuum system. "It's a bit like atomic spray-painting," says Allen. "We can virtually deposit these layers atom by atom on to sapphire substrates"

The second method is much cheaper; the equipment involved costs less than $5,000. "This method uses a non-vacuum solution-based system. Ultrasound waves are used to generate a mist of these materials and we can then easily deposit that mist onto whatever surface we want to grow them on," explains Allen.

> **"It's a bit like atomic spray-painting."**
>
> Associate Professor Martin Allen

A very unusual property of these metal-oxide semiconductors is that they're covered in free surface electrons. "They have a two-dimensional layer of mobile electrons on the surface, which makes them highly sensitive to their environment," says Allen. While this is useful for things like atmospheric sensing, it is not so good for other applications. "We get rid of that surface sensitivity using special organic layers, which enables them to sense other things like UV radiation and biological molecules, such as proteins, toxins and antibodies. The organic layers both protect the material and change its properties."

Associate Professor Allen and his MacDiarmid Institute collaborators have developed a cheap and robust way to get different organic molecules to attach to the surface of these semiconductors, for example by terminating the surface with amino groups. "This means that they're bio-active and sensor ready," says Allen.

What Associate Professor Allen likes best about this work is that it is truly multidisciplinary. "Alison Downard is a chemist. Roger Reeves is a physicist. I'm an engineer. And we're all MacDiarmid Principal Investigators at the University of Canterbury," says Allen. "And there's a whole range of multidisciplinary PhD students working together on the project, all learning new things from each other."

Support for the work has also come from MacDiarmid Deputy Director and Principal Investigator Associate Professor Nicola Gaston (University of Auckland) on the theoretical calculations needed to select the best molecules to use, and Principal Investigator Dr Natalie Plank (Victoria University of Wellington) on nanostructured metal-oxide growth. "Working as a multidisciplinary team has really supercharged the development of this," says Allen.

A lot of the key equipment that the team needs to grow and understand the materials (including the molecular beam epitaxy facility) wouldn't have been possible without the MacDiarmid Institute. "There was a big initial investment from the MacDiarmid Institute that allowed us to build a world-leading position in the growth and fabrication of oxide semiconductors," says Allen. "We also had a breakthrough in terms of how to make devices on these materials, which we patented a couple of years ago."

The team also does a lot of work at the Australian Synchrotron, a multimillion dollar x-ray facility based in Melbourne. "We use it to work out how the organic molecules attach to the surface and how they change the properties of the materials, particularly in ways in which we want them to," says Allen.

The team are currently in the proof of concept stage: they have developed a cheap, quick and robust way of painting a surface with organic layers. The next step is to test the sensing ability of the prototype sensors.

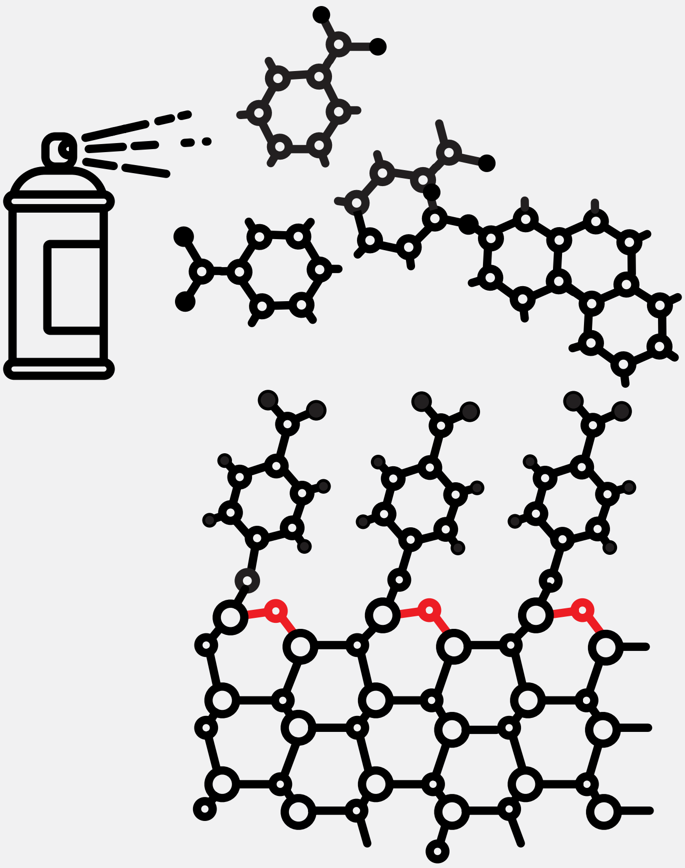
"One MacDiarmid Institute PhD student in particular, Alexandra McNeill, a Fullbright Scholar, has done a lot of the development work with the chemical attachment of organic layers," says Allen. "We also have a couple couple of new MacDiarmid students who will be taking this to the next level, testing the sensing capability of these things."

"We've had a breakthrough in terms of how to make devices on these materials, which we have patented."

Associate Professor Martin Allen

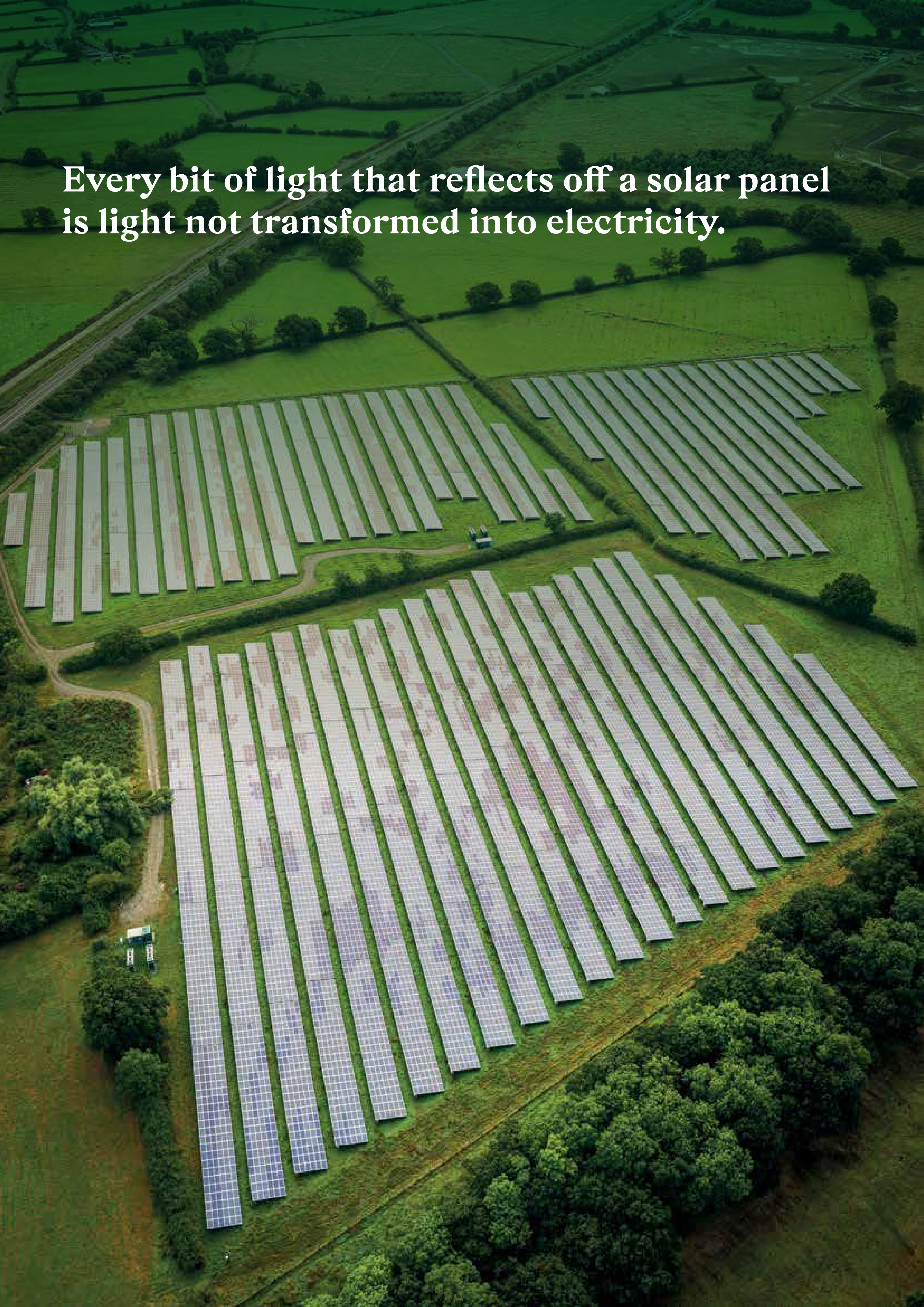
Professor Roger Reeves, Professor Alison Downard and Associate Professor Martin Allen

ATOMIC SPRAY-PAINTING



Layering atom by atom on a surface to create a new bioactive semiconductor = cheaper blood tests + skin cancer prevention

Every bit of light that reflects off a solar panel is light not transformed into electricity.



BLACK, BENDABLE, LIGHTWEIGHT AND CHEAP – THE SOLAR PANEL REVOLUTION

When we imagine solar panels, we think of hard rectangular frames sitting on roofs, or spread out across expanses of deserts.

But imagine flexible, bendy solar panels, supple enough to skim a curved roof, pliable enough to be rolled up and transported easily, lightweight enough to be a thin film for the roof of a tent, and portable enough to be rolled out to generate power for emergency relief operations or taken into remote areas.

Printable solar materials that will allow all of this are closer than we think. Lead researcher in this MacDiarmid project, Associate Professor Justin Hodgkiss, says new printable photovoltaics will be low cost and able to replace silicon as the next generation of photovoltaic materials.

"Silicon cells are getting cheaper but still require a high-temperature, high-vacuum manufacturing process. For solar energy to be really accessible it needs to be much cheaper and faster to manufacture," says Hodgkiss.

He says these printable semiconductors, including polymers and nanoparticles, can potentially be manufactured on a roll, cutting production costs.

"Their ease of transport and light weight also mean it is feasible for these to be manufactured in New Zealand and shipped anywhere in the world."

Shiny is the enemy of good

When we see photos of those bright, shiny swathes of solar farms, we don't automatically think of their shininess as a problem. But Hodgkiss says an ideal solar panel would look black. "Every bit of light that reflects off a solar panel is light not transformed into electricity. When no light bounces off, it means all visible light is getting in."

This is where nanotechnology comes in. Hodgkiss compares the idea to radio antennae on the roof of a building. "When you see large antennae on the top of buildings, their size is related to the radio frequencies they're tracking. Radio waves are of the order of metres, so the antenna discs are this size. But optical wavelengths are in the order of hundreds of nanometres."

Imagine flexible, bendy solar panels

He says the MacDiarmid team working on this (which includes University of Canterbury Professor Maan Alkaisi and Victoria University of Wellington Professor Eric Le Ru) is effectively creating tiny antennae that capture light and can direct it inside the solar panels.

"We're making nanopatterns that make sure that light gets in and is not bounced away, and that capture and focus the light waves directly where they are needed in the solar panels."

Blitzing with lasers

Figuring out which new materials are going to work best as solar panels involves a bit of trial and error, and a lot of very precise laser measurement. This has shaped the career of Hodgkiss, who switched from straight chemistry to using physics techniques to trial new solar contenders.

"When I started out as a chemist I was looking at molecular models for solar power conversion and trying to devise the best 'recipe'. But I soon realised that real devices were already way more effective at solar-energy conversion than our models were ever likely to be. So we changed our approach; instead, we tried to understand how real solar photovoltaic devices work, and when comparing lots of them, to find the perfect recipe. We study the cells by blitzing them with very short pulses of lasers – essentially doing strobe photography – and taking snapshots of the electricity being produced.

"The MacDiarmid team is using lasers to understand where the energy losses are happening, where, for example, heat is being generated instead of electricity," Hodgkiss explains.

The team also includes Professor Keith Gordon from Otago University, who is using lasers to help see the structure of materials inside a solar cell.

Hodgkiss emphasises the New Zealand-wide nature of these projects. "Each of these solar projects involves researchers from universities up and down New Zealand who wouldn't be working together if it wasn't for the MacDiarmid funding the research and collaboration, which enables them to connect."

SCIENCE IS BEAUTIFUL

Scientists don't often call the focus of their work gorgeous, but this is the exact term that Principal Investigator Professor Shane Telfer uses to describe the metal-organic frameworks (MOFs) he is creating in the lab.

"Under a microscope they look quite beautiful," says Professor Telfer. "Out of the gloop we use to produce MOFs, emerge these beautiful crystalline forms."

While they may be nice to look at, MOFs could also provide the answer for storing gases like hydrogen – an alternative to fossil fuels – in large quantities.

MOFs are like 3D sponges. When placed in cylinders they can store hydrogen in much smaller spaces and at a much lower pressure – allowing cars, or even planes, to run on hydrogen.

"MOFs are mostly free space, like an open porous net, with a metal at the corners and an organic component as the rods or linkers," explains Professor Telfer.

In another win for the environment, MOFs could also potentially be used to absorb and enrich carbon dioxide, thereby remediating climate change.

Medical applications

"One of our MacDiarmid PhD students has run calculations to show that if you pass air through a MOF, you can capture the oxygen," says Professor Telfer.

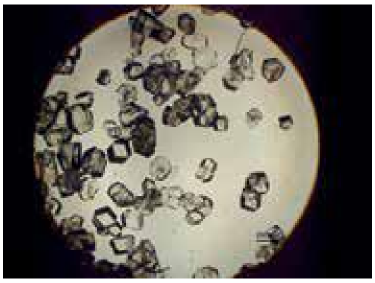
So rather than using a bulky cylinder of oxygen, a patient could have a much smaller MOF-infused device. This would be more efficient, cheaper, and have a longer life span.

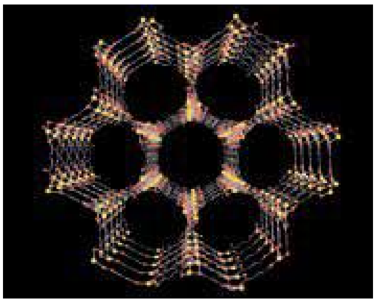
Professor Telfer has 12 years under his belt working on MOFs. His MacDiarmid Institute collaborators have now begun some blue skies exploration and have come up with new materials and a new process for creating MOFs.

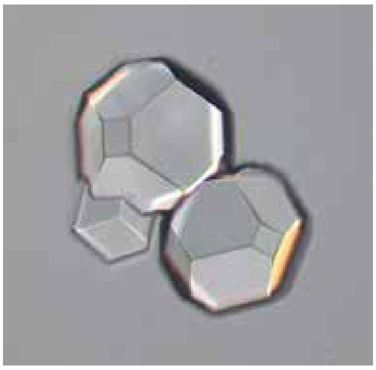
"These kinds of nanoparticles are hard to make. Two metals often don't like getting alongside each other, but using this method you end up with a nanoparticle containing two metals. And they're catalytically active."

Professor Shane Telfer

The MacDiarmid team pulls together researchers from all over New Zealand, including Principal Investigator Professor Paul Kruger from the University of Canterbury, Principal Investigator Dr Carla Meledandri from the University of Otago, and Principal Investigator Dr Geoff Waterhouse from the University of Auckland. Professor Telfer says the MacDiarmid MOF team bid successfully for 2018 MBIE Catalyst funds of $1.5 million to work with CSIRO to develop applications of their MOF







materials, including new catalysts for eliminating nitrous oxide greenhouse gas emissions.

The team is looking at more efficient ways to make MOFs, and new applications for the materials they discover. To help understand the structure of their materials, the team benefits from collaborations with the electron microscopy lab at Victoria University of Wellington, led by Principal Investigator Professor Thomas Nann.

The team recently published a report in the prestigious Journal of the American Chemical Society showcasing their discovery of a new process to create functional, bimetallic nanoparticles using MOFs as starting materials.

"These kinds of nanoparticles are hard to make," says Professor Telfer. "Two metals often don't like getting alongside each other, but using this method you end up with a nanoparticle containing two metals. And they're catalytically active."

The catalysts they created were made with very low levels of platinum, which is expensive and rare.

Such processes are important as they can make aniline – an organic compound that is the precursor for many things, including conducting polymers (for which New Zealander Alan MacDiarmid won the Nobel Prize for Chemistry for in 2000).

Professor Telfer says it was a true collaborative effort. Professor Telfer designed the project with Professor Kruger; Dr Hui Yang did the experimental work, including the catalysis studies; Associate Professor Geoff Waterhouse helped characterise the materials; and Professor Thomas Nann and his postdoctoral researcher Dr Siobhan Bradley contributed to the analysis by finding the structure and the composition on the nanoscale.

"That is something that links us. There is this beneficial collaboration that has come out of the Institute: scientists who may not have crossed paths or had the opportunity to talk much science, but valuable connections between them are forged by MacDiarmid," says Professor Telfer.

Emulsion droplets

Another MacDiarmid Principal Investigator, University of Otago senior lecturer Dr Carla Meledandri uses emulsion droplets as a way to synthesise nanoparticles.

Professor Telfer immediately saw that the idea was perfect for making MOFs.

Instead of the current method of putting the metal and organic parts of a solution in an oven, the MOFs could be fused in an emulsion.

"Dr Meledandri has two types of droplets, which she merges," says Professor Telfer. "By themselves they don't do anything, but together they do."

Dr Siobhan Bradley

FUNDING SUCCESS

USING PHYSICS TO BOOST NEW ZEALAND'S $14 BILLION MILK POWDER EXPORT INDUSTRY

Unlike most of us, when physicist Dr Geoff Willmott thinks about milk, he thinks about droplets, surfaces and heat.

And he's eager to use surface interactions to solve problems in the dairy industry.

"I'm pretty big on this type of thing – supporting New Zealand industry with our research – and often we, as university researchers, aren't doing this."

To make milk powder, heated milk is sprayed into the top of large spray dryers – silos up to 20 storeys high. The milk droplets, which are about 200°C at the top of the silo, fall through the spray dryer to form milk powder at the bottom.

However, milk droplets can stick to the side of the silo, causing fouling, and incurring losses due to cleaning costs and production downtime.

Dr Willmott is using his expertise to study drop impact and the effects of surfaces on this.

"We're looking at surfaces and spraying conditions. We'll study closely exactly how milk drops hit the surface of the silo and figure out when they stick and why.

"By altering the drop size of the milk, and the temperature, we can figure out how to improve efficiency of spraying conditions. We can also look at specific drop interactions and which products are easier to dry."

He is taking his fundamental research in microfabrication and high-speed photography (developed over the past few years while on a Marsden grant – looking at the high-speed surface interactions of water drops with PhD student Matheu Broom) and has now won a $1 million MBIE grant to apply this to the dairy industry.

"We have the engineering capability to make these giant spray dryers in New Zealand."

Dr Geoff Willmott

Dr Willmott says the aim is to help the dairy industry understand the types of surfaces they currently use, how best to tweak them, and what spray settings (such as drop size and temperature) are ideal.

At first glance, this seems a bit removed from his day job teaching physics at the University of Auckland. But it's something he's keen to do more of.

"It's great to see this flow from fundamental research to applied technology. It's also a nice opportunity to get out of the lab and talk to industry people.

"The infant formula industry is a big deal for New Zealand, with exports of infant formula growing, especially to China. It's an interesting premium foods opportunity for New Zealand."

He is now working with the dairy industry, including equipment manufacturers and producers. "We have the engineering capability to make these giant spray dryers in New Zealand."

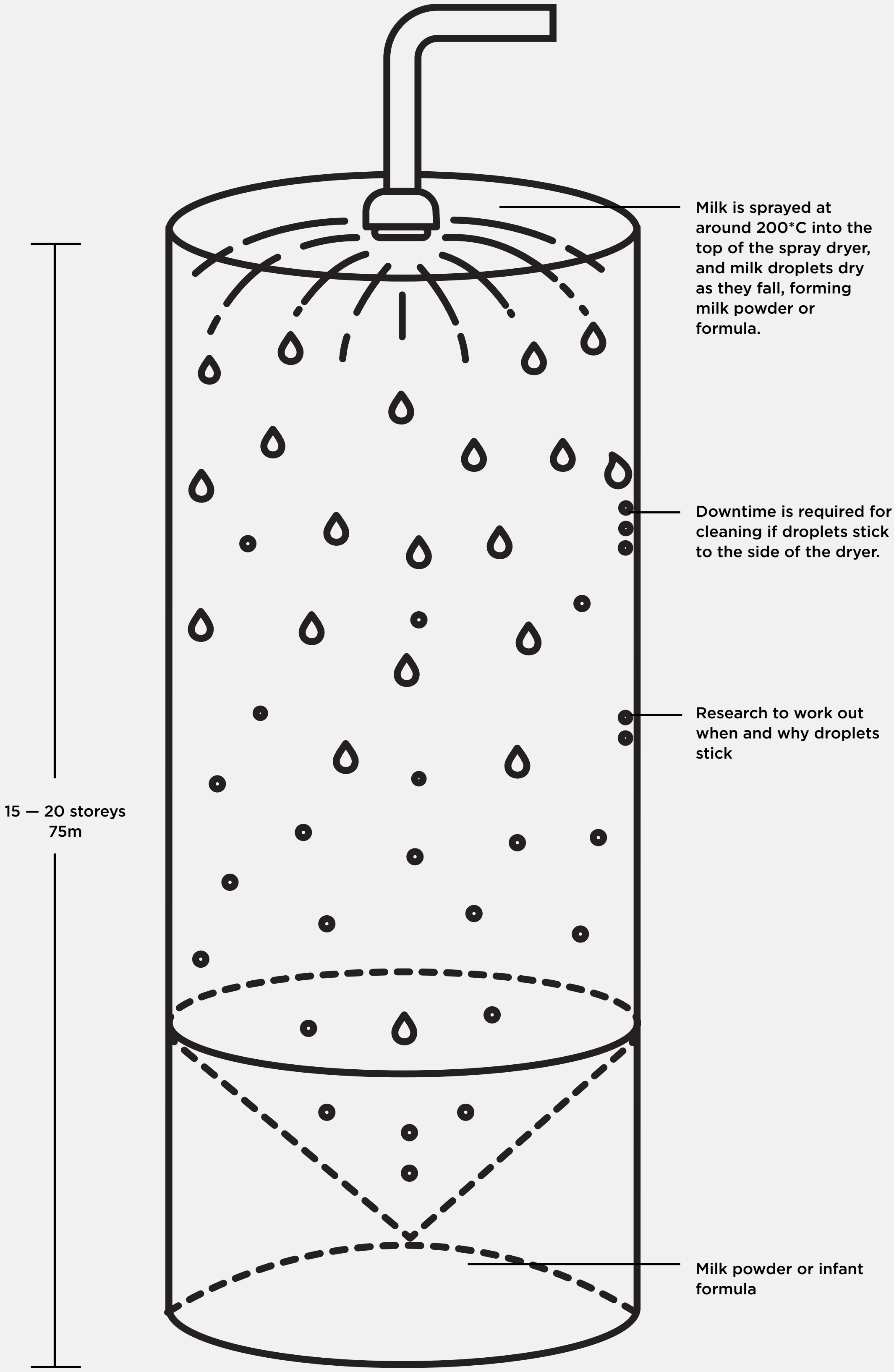
Dr Willmott says that one of the best things he did to obtain the MBIE funding was to take up MacDiarmid Institute funding to attend a GetFunded workshop – although he nearly didn't go.

"The MacDiarmid Institute had to twist my arm to get me there. I was busy and wasn't too keen, but it was there that I spent two days developing the idea and really got started on it.

"The MacDiarmid Institute supports me as an individual researcher extremely strongly. With all the collaborations – we learn from each other – this is what enables us to do high-quality fundamental research, says Dr Willmott.

"More specifically for this research, my students learn about microfabrication from people like [MacDiarmid Associate Investigator] Volker Nock at Canterbury and have access to fabrication and characterisation equipment through facilities like the Photon Factory."

SPRAY DRYER


Milk is sprayed at around 200*C into the top of the spray dryer, and milk droplets dry as they fall, forming milk powder or formula.
Downtime is required for cleaning if droplets stick to the side of the dryer.
Research to work out when and why droplets stick
15 — 20 storeys
75m
Milk powder or infant formula

2017 FUNDING SUCCESSES

2017 MacDiarmid Investigator (MI) Marsden winners

Alison Downard - University of Canterbury	"Tailored environments for highly active and stable electrocatalysts"
Volker Nock – University of Canterbury	"Using synthetic communities to visualise bacterial plant leaf community development and pathogen invasion processes at the single-cell resolution"
Natalie Plank – Victoria University of Wellington	"Training multiplexed electronic aptasensors to profile hormones in complex samples"
Catherine Whitby and **Geoff Willmott** Massey University; University of Auckland	"Encapsulation of an aqueous liquid in a drop of aqueous liquid"
Martin (Bill) Williams – Massey University	"Optical Nano-Machines to Study Single Molecules"
Uli Zuelicke and **Michele Governale** Victoria University of Wellington	"Supercharging electromagnetism: Tuneable magnetoelectricity in unconventional materials"

2017 MacDiarmid Investigator Royal Society grants

Margaret Brimble - University of Auckland	Catalyst Fund: Seedling "Short Peptide as Marine Anti-Fouling Agents"
Alison Downard - University of Canterbury	Catalyst grant: "Novel Coatings to Control the Rate of Corrosion of Magnesium Implants"
Paul Kruger - University of Canterbury	Rutherford Postdoctoral Support: "Building bigger and better cages: a novel approach to large and complex molecules"

2017 MBIE Grants awarded to MacDiarmid Investigators

2017 MBIE Smart Ideas grants

Maan Alkaisi - University of Canterbury	"Solar Energy Capture and Storage"
Petrik Galvosas - Victoria University of Wellington	"Medical device for comprehensive brain monitoring using portable magnetic resonance technology"
Juliet Gerrard with **Laura Domigan** University of Auckland	"Lens protein adhesives for use in ocular surgery"
Keith Gordon - University of Otago	"The Lake Snow Toolbox: detecting and quantifying an emerging environmental problem"
John Kennedy and **Jerome Leveneur** - GNS Science	"Novel inorganic composites for strong near infrared reflecting black coatings"

John Kennedy, Jerome Leveneur, Franck Natali and **Grant Williams** - GNS Science; Victoria University of Wellington	"Next generation ultra-high frequency acoustic wave filters for 5G networks and beyond"
Volker Nock – University of Canterbury	"Development of a simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings"
Cather Simpson - University of Auckland	"Point-of-care device for skin cancer diagnosis"
Jadranka Travas-Sejdic and **David Williams** University of Auckland	"Selective capture, selective release of cells"
Geoff Willmott – University of Auckland	"Optimized Drop Impacts for Industry"

2017 MBIE Research Programme

Bob Buckley and **James Storey** Victoria University of Wellington	"The World's Fastest Superconducting Machine"
Chris Bumby and **Simon Granville** Victoria University of Wellington	"High speed superconducting generators for future electric aircraft"
Shen Chong, John Kennedy and **Jerome Leveneur** - Victoria University of Wellington	"Development of robust IPT pavement systems for electric vehicles"
Andreas Markwitz - GNS Science	Vision Matauranga funding
Cather Simpson and **David Williams** University of Auckland	"Advanced Laser Microfabrication for NZ Industries"
Martin (Bill) Williams – Massey University	"Accelerated evolution: a step-change in food fermentation"

2017 MBIE Catalyst

Sally Brooker - University of Otago	"New complexes for photocatalytic hydrogen production"
Shane Telfer, Paul Kruger, Carla Meledandri and **Geoff Waterhouse** - Massey University, University of Canterbury, University of Otago; and University of Auckland	"Disruptive Technologies from Metal-Organic Frameworks"

2017 HRC grants

Justin Hodgkiss - Victoria University of Wellington	"Real time in situ antibiotic sensitivity testing"

2017 NSC (National Science Challenges)

Cather Simpson and **David Williams** University of Auckland	"Precision farming for aquaculture"

2017 Domestic grants – Government Funding

Margaret Brimble - University of Auckland	MPI - The NZ Fund for Global Partnerships in Livestock Emission Research "Discovery of New Nitrification Inhibitor – Phase II"
Sally Brooker - University of Otago	"Surface attached catalysts for hydrogen production"
Simon Brown - University of Canterbury	Pre-Seed Accelerator Fund "Neuromorphic Computing Chips"
Geoff Willmott – University of Auckland	Catalyst: Seeding Grant "Development of Nanoscale Pipetting for Nanomechanical Applications"

2017 Domestic grants – Other

Margaret Brimble - University of Auckland	Pastoral Greenhouse Gas Research Limited "Carbon Monoxide Releasing Norborneone Compounds" Connovation "Invasive Pest Control"
John Evans - University of Otago	"Does aged collagen influence ovarian tumour development"
Vladimir Golovko - University of Canterbury	"Miniature electrochemical sensing elements for detection of nitrate"
Shaun Hendy - University of Auckland	"Monitoring disease with financial data"
Jadranka Travas-Sejdic - University of Auckland	Better Border Biosecurity "Novel sensor approaches to sniff out biosecurity threats" Better Border Biosecurity "Point of use plant pathogen biosensor"

2017 KiwiNet awards

Jadranka Travas-Sejdic - University of Auckland	"Sensing the opportunity: Insect odorant receptor (iOR) based biosensor"

AWARDS 2017

Margaret Brimble	IUPAC Service Award (for Outstanding Service to IUPAC in the Advancement of Chemistry Worldwide)
Sally Brooker	Awarded the 28th Inorganic Chemistry Award of the Royal Australian Chemical Institute (RACI), the Burrows Award Appointment as a Member of the New Zealand Order of Merit for services to science, MNZM Awarded the Royal Society of New Zealand (RSNZ) Hector Medal for outstanding work in chemical, physical or mathematical and information sciences
Valdimir Golovko	Royal Society of Chemistry (UK) Inspirational Committee Award
Justin Hodgkiss	New Zealand nominee for ASPIRE prize (APEC Science Prize for Innovation, Research and Education).
Guy Jameson	Elected Fellow of the New Zealand Institute of Chemistry
Jerome Leveneur	Early Career Science award 2017 - GNS Science
Jenny Malmström	University of Auckland Early Career Research Excellence Award
Carla Meledandri	2017 Prime Minister's MacDiarmid Emerging Scientist Prize
Cather Simpson	Shimadzu Prize, Applied and Industrial Chemistry, NZ Inst Chemistry (NZ) Vice Chancellor's Sponsored Research and Commercialisation Medal (NZ)
Jeff Tallon	Elected Fellow of the Institute of Physics (London)
Jadranka Travas-Sejdic	Elected Fellow of the Royal Society Te Apārangi Maurice Wilkins Centre Prize for Chemical Science (NZIC) Councillor of the Pacific Polymer Federation, representing New Zealand polymer community (2009 – current)
Geoff Waterhouse	Chinese Academy of Sciences (CAS) President's International Fellowship Chair Professorship at Shandong Agricultural University, China Guest Professorship at Guangdong Ocean University, China

NEW ASSOCIATE INVESTIGATORS

Dr Philip Brydon, University of Otago

Superconductivity is a low-temperature quantum state of matter where electricity can flow without resistance. Despite intense study, we still have a poor understanding of the many unconventional superconductors. Philip's research aims to develop a microscopic description of these enigmatic, but technologically important, superconductors that relates to their observable properties.

Dr Laura Domigan, University of Auckland

Laura's research is broadly focused on the application of fundamental knowledge underlying protein structure and function to create new materials and devices for bionanotechnology and biomedical engineering. Her current research is focused on biomimetic materials fabrication and creating protein biomaterials derived from natural products.

Dr Charles Unsworth, University of Auckland

Associate Professor Charles Unsworth's Neural Engineering Research Group, in the Department of Engineering Science and the Centre for Brain Research, specialises in neural chip platforms, advanced signal and image processing, and computational neuroscience.

Dr Guy Dubuis, Victoria University of Wellington

Guy is an experiment physicist interested in how solid matter behaves at extreme conditions, particularly at very low temperatures and under high magnetic fields. Guy currently studies high-temperature superconductors and exotic new electronic states called skyrmions. Skyrmions may hold the key to future generations of improved computer chips.

Dr Erin Leitao, University of Auckland

Erin's research aims to discover new catalytic ways to link earth-abundant main-group elements together, with the eventual aim of making long chains (polymers) – either with the same atom or two different atoms alternating along the polymer backbone. These new materials will have really interesting properties (for example, semi-conducting).

Dr Elke Pahl, Massey University Albany (Auckland)

Elke's research focuses on the modelling of material properties under normal conditions and in extreme environments characterised by ultra-high pressures or magnetic fields. In particular, she is interested in describing melting from an atomistic view using quantum-mechanical tools and understanding how solid-state properties emerge from small few-atom clusters.

Dr James Crowley, University of Otago

James' research uses 'click' methods and self-assembly to generate new functional molecules and materials. He and his group have developed a wide range of nanoscale cages through self-assembly, and they are examining if they can be used to improve cancer-drug delivery or generate new catalysts.

Dr Chris Fitchett, University of Canterbury

Chris is interested in the synthesis of new organic molecules, particularly focusing on large, flat, mostly carbon-based molecules called heterographenes. These molecules conduct electricity and absorb light, making them ideal components for organic solar cells. They are also highly coloured, making them useful as active components in OLED displays.

Dr Ben Mallett, University of Auckland

Ben is fascinated by how electrons give solids their unique properties; like their colour or conductivity. He uses light, electric and magnetic fields to study the electrons in particularly enigmatic solids. Ben uses these studies to tailor the interaction between electrons - resulting in new, potentially useful properties.

Dr Baptiste Auguié, Victoria University of Wellington

Baptiste studies the interaction of light with nanostructures. Much like how a regular antenna is used to funnel electromagnetic waves into electronic devices, a nanoparticle can act as an antenna for light on a much smaller scale, localising light beyond the resolution of optical microscopes. The scattering of light captures some information about material properties at the nanoscale, and even down to the molecular scale. This may be applied in non-intrusive optical sensors, but also in the light-harvesting design of solar cells, and novel display technologies.

Dr Michel Nieuwoudt, University of Auckland

Michel's research focuses on transforming complex spectral data and large datasets into knowledge and insight. Michel combines different forms of spectroscopy with chemometric and machine-learning approaches to interrogate materials without changing the sample matrix. This reveals their properties and behaviour in their natural place, and interactions between multiple components in complex matrices.

Dr Aaron Marshall, University of Canterbury

Aaron's research is based on electrochemical energy technologies. These technologies include the development of materials for large-scale batteries, hydrogen generation, and electrochemical conversion of carbon dioxide into fuels. The goal of his research is to enhance the rate of the relevant electrochemical reactions used in these technologies by developing electrode materials with high catalytic performance.

AMN8 – 8TH INTERNATIONAL CONFERENCE ON ADVANCED MATERIALS AND NANO-TECHNOLOGY

The biennial AMN conferences are becoming increasingly international, with 69 percent of the more than 500 delegates to AMN8 coming from overseas and including some of the best researchers in Materials Science.

AMN8 Outreach

The event was much more than a typical Materials Science conference:

- Manchester University Professor David Leigh spoke to 680 Christchurch students
- Oxford Professor Henry Snaith and Victoria University of Wellington Assoc ProfessorJustin Hodgkiss spoke to over 200 people about new solar technologies at the Royal Society in Wanaka
- Shotover Primary school kids had a science-through-soccer lesson from University of Washington Professor Albert Folch
- The Women in Science panel of Italian Institute of Technology Professor Silvia Giordani, Imperial College of London Professor Natalie Stingelin and University of Otago Senior Lecturer Dr Carla Meledandri attracted a lot of interest, both from media and from those who attended
- In Nelson, University of Auckland Professor Juliet Gerrard's talks at the Suter Gallery and then, the next day, at a school, were received with great enthusiasm.

MacDiarmid Institute International Science Advisory Board members at AMN9 – Professor Tomonobu Nakayama, Professor Matt Trau, Professor Michelle Simmons, Professor Thomas Schimmel, Professor Thomas Nann and Professor Mike Kelly

"The keynote speakers, both international and home-grown, were presenting material at the very forefront of science and technology."

MacDiarmid International Science Advisory Board Statement February 2017

AMN8 Conference Queenstown: 500 delegates 34 countries

“The MacDiarmid Institute represents international-scale excellence, producing outstanding scientists and leaders.”

MacDiarmid International Science Advisory Board
Statement February 2017


OFFICE PAPER
RECYCLING

2. Into the marketplace.

Commercialisation and industry engagement. The MacDiarmid Institute aims to transform New Zealand’s economy by catalysing the growth of new export industries.

The Institute has a proud record of spinning out new high-tech companies. MacDiarmid investigators spun out three new companies in 2017, SpotCheck, Sapvax and Silventum, while recent spinouts continued their successful trajectories – gaining new investment and a successful exit.

Here, we celebrate the other dimensions in which the MacDiarmid Institute contributes to New Zealand's high value manufacturing sector: contributing our capability to existing industry and developing business nous in our PhD graduates.

We launched 'Interface', an industry problem-solving challenge, in partnership with the Dodd-Walls Centre. We reached out to find some of the toughest materials-science problems faced by industry, and over 20 of our investigators and students teamed up to tackle these problems. These seed projects are delivering value to New Zealand industry with new intellectual property, new product development opportunities, and access to New Zealand's savviest PhD graduates.

THE BUSINESS SCIENCE INTERFACE

The science end of business meets the business end of science

New Zealand companies have finite resources to develop innovative technology for global markets. Yet right down the road from some of these local companies are scientists from the MacDiarmid Institute, leading the world in some of these very same areas. While the main research drive of the MacDiarmid Institute is not industry-led, we've found we have a great capacity to help industry solve particular problems.

The Interface Industry Challenge

We invited high-tech New Zealand companies to challenge our scientists with tough technological problems they faced – things they couldn't solve on their own. We then matched these problems with scientists from Centres of Research Excellence (CoREs).

The companies are excited about tapping into top research minds and the pipeline of talented PhD graduates.

The scientists are stimulated by the problems thrown at them, and excited about contributing to New Zealand industry and forging career paths for their graduates.

Already, these projects are moving the companies forward, generating valuable new intellectual property, and exposing researchers to the business end of science.

The companies we are working with range from early-stage start-ups such as Avertana, Aquafortus, and Lanaco, to the biggest fish in the New Zealand high-tech manufacturing sector, Fisher & Paykel Healthcare.

"MacDiarmid is really helping underpin the high-value manufacturing sector."

Dr Andrew West, Chair, Aquafortus and Chair, Lanaco

Another major benefit is that we are connecting our PhD graduates with New Zealand industry. We're giving them a taste of industrial research and development, and helping them realise what is possible in an R&D career in New Zealand. Moreover, we're giving New Zealand businesses insight into the kinds of graduates we are producing, so that they continue to look to the MacDiarmid Institute for high-tech and data-savvy PhD graduates for roles in all sorts of industry positions.

Avertana is a highly innovative company whose mission is to extract commodity materials from industrial waste. Avertana is really excited about accessing the deep expertise and capability in the MacDiarmid Institute that a small company could not simply hire to solve every problem that came along.

Fisher & Paykel Healthcare is one of New Zealand's biggest high-tech manufacturers. To maintain this position, it is constantly innovating in areas that include new materials. As well as benefitting from the deep materials capability in the MacDiarmid Institute, it is also attracted by the possibility of connecting with a pipeline of top graduates.

Aquafortus is an early-stage start-up that has developed a material for wastewater treatment that operates with unprecedented energy efficiency. Aquafortus came to us to interrogate the chemical nature of the active components – seeking new knowledge and increased insight that is critical to developing it to the next level. The tools to do this are simply not affordable for an early-stage start-up, but accessing them through the MacDiarmid Institute is transformative.

Lanaco makes air filters from New Zealand wool fibres. But there's much more to their technology than meets the eye. They run a broad science programme aimed at improving the performance and manufacturability of the air filters, so to be able to go deeply in certain areas is immensely valuable to them. Their collaboration with the MacDiarmid Institute pulls in a range of physics, chemistry and engineering expertise from all around the country.

"Working with the MacDiarmid Institute has given us access to capability we wouldn't and couldn't hire because they're deeply specialised scientific experts."

James Obern, Commercial Director, Avertana

PATENTS 2017

Details of Patent Application

Margaret Brimble

- "Quinoline Sulfonamide Compounds and their use as Antibacterial Agents"
  US Provisional Patent Application 62/608,141, 2017
- "Peptide Conjugate CGRP Receptor Antagonists and Methods of Preparation and Uses Thereof"
  NZ Patent Application 736960, 2017
- "Peptide Conjugates, Conjugation Process and Uses Thereof"
  NZ Patent Application 735008, 2017
- "Tumour-targeting Peptide Variants"
  GB Patent Application 1706472.6, 2017
- "Amino Acid and Peptide Conjugates and Conjugation Process"
  PCT International Application PCT/IB2017/051054, 2017
  TW Patent Application 106106457, 2017

Simon Brown

- "Percolating Switching Devices"
  International Patent Application Number PCT/NZ2016/050108 China; Japan; Europe; South Korea; US

Juliet Gerrard

- "Protein-Based Compositions And Uses Thereof"
  PCT Patent Application No. PCT/NZ2017/050094

Valdimir Golovko

- "Photocatalytic conversion of carbon dioxide and water into substituted or unsubstituted hydrocarbon(s)"
  WO 2017091857 A1
  International PCT Application via Australian Patent Office PCT/AU2016/051175

Justin Hodgkiss

- "Optical system for narrowing the bandwidth of radiation"
  NZ Patent Application Number 737899

Eric Le Ru

- "Absorption and scattering spectra of liquids using a spherical integrating cavity"
  PCT application

Jerome Leveneur

- "Ion beam sputtering apparatus and method"
  NZ Provisional Patent Application 738705

Carla Meledandri

- "Glass ionomer cement containing silver nanoparticles"
  Provisional Patent Application 62/510,591, 25/05/2017

Franck Natali

- "Ammonia production method and apparatus for ammonia production"
  European Patent Application Number EP17179326.8
- "Rare earth nitride structure or device and fabrication method"
  US Patent Number 15/480,406
- "Rare earth nitride and group-III- nitride structure or device"
  US Patent Number 15/480,406

Natalie Plank

- "Sensor device and methods"
  International Patent Application Number PCT/IB2017/05818
  Taiwan Application Number 106145168

Ben Ruck

- "Ammonia production method and apparatus for ammonia production"
  European Patent Application Number EP17179326.8
- "Rare earth nitride structure or device and fabrication method"
  US Patent Number 15/480,406

Cather Simpson

- "Fluid analytical device"
  PCT/US/64661US 62/430,497

Richard Tilley

- "Magnetc nanoparticles"
  European Patent Application Number 09833691.0

Jadranka Travas-Sedjic

- "Sensor Device for Odorant Sensing"
  NZ Patent Application NZ727745
- "Conducting polymers and uses thereof"
  International Patent Application Number PCT/IB2017/058181

Joe Trodahl

- "Ammonia production method and apparatus for ammonia production"
  European Patent Application Number EP17179326.8
- "Rare earth nitride structure or device and fabrication method"
  US Patent Number 15/480,406

David Williams
- "Conducting polymers and uses thereof"
  International Patent Application Number PCT/IB2017/058181
- "Fluid analytical device"
  PCT/US/64661US 62/430,497

Details of Patent Granted

Simon Hall
"Rechargeable Zinc Electrode"
Patent EP1390995 Granted in Europe: Ireland; Italy; Spain

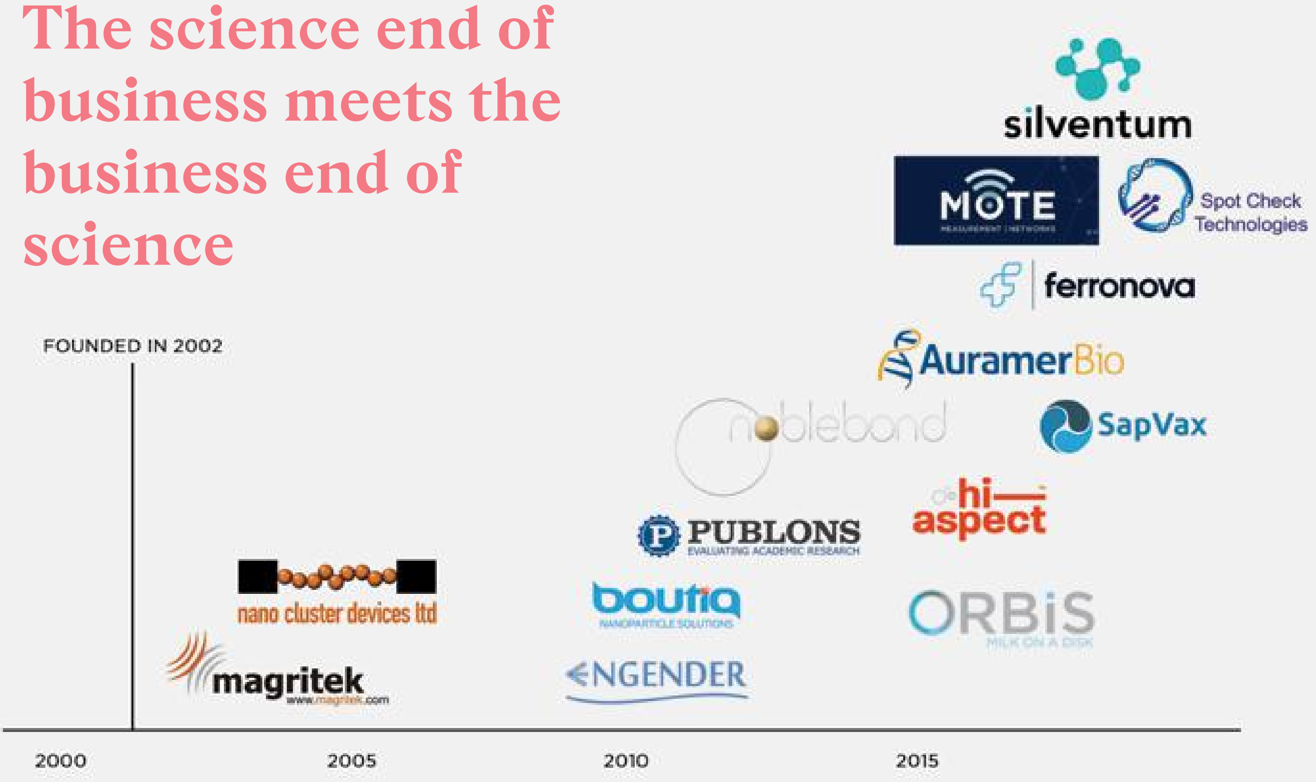
"Rechargeable Zinc Electrode"
Patent EP2434566 6 Granted in Europe; France; Germany; United Kingdom

Justin Hodgkiss
"Transient Grating Time Resolved Luminescence Measurements"
US Patent number 9,752,927

SPINOUTS FORMED IN 2017

Sapvax	Margaret Brimble — Co-Founder
Silventum Limited	Carla Meledandri
SpotCheck Technologies	Jadranka Travas-Sejdic, David Williams

The science end of business meets the business end of science



NEW COMPANIES SPUN-OUT OF THE MACDIARMID INSTITUTE BETWEEN 2002 AND 2017


HOUSE OF SCIENCE

3. Into the community. The MacDiarmid Institute has a long history of supporting sustained community engagement activities by our investigators, from the DiscoveryCamp programme for Māori and Pasifika high school students that has been running since the Institute was founded, to the physics teachers' workshops developed by Professor Michele Governale and Associate Professor Ben Ruck over the last three years.

The value of these activities is not just the impact they have on the broader New Zealand community, but the experiences they provide our investigators and students.

Our track record is so strong that, at times, it seems there is little space for innovation!

This year, however, our people have once again demonstrated how much more can still be done, particularly through our partnerships with key practitioners in outreach and science communication. Our outreach efforts are continually enhanced by our partners: NZEI Te Riu Roa (Kōrero with scientists), the House of Science (Nano-Chem box sponsorship), Lab in a Box (a mobile science laboratory, built in a 20 foot shipping container), and The Spinoff online magazine.

These experiences create valuable perspectives on the interface between science and society. It's precisely this shift in culture that enables us to support more striking, one-off initiatives, such as the Women in Nanoscience lecture series led by Carla Meledandri or the extension of the Korero with scientists programme into regional New Zealand, in cooperation with the Nanogirl Live! stage show created by Michelle Dickinson.

These activities represent a cultural change that sees our researchers acknowledging the importance of community engagement for their own research. More important than any of our individual initiatives in isolation, therefore, is that we know that community engagement is a value that all our alumni will take forward with them out of their time with the MacDiarmid Institute.

EXTENDING OUR ENGAGEMENT

House of Science

By partnering with House of Science, we enabled the Tauranga-based charity to begin their nation-wide roll-out of their science box scheme. House of Science provides science resource kits and professional development to schools and teachers. The new MacDiarmid Nano-Chem boxes are based on our longstanding Kōrero programme (and include experiments with light, acids and bases and magnets), enabling us to extend the reach of Kōrero to many more students and teachers.

The MacDiarmid Nano-Chem boxes are now available at eight branches of House of Science (West Auckland, Western BOP, Eastern BOP, Rotorua, Manawatu, Hutt Valley, Wellington and Nelson) and were used in over 60 classrooms in 2017, reaching more than 2600 students, including 774 Māori (30%) and 208 Pasifika (8%).

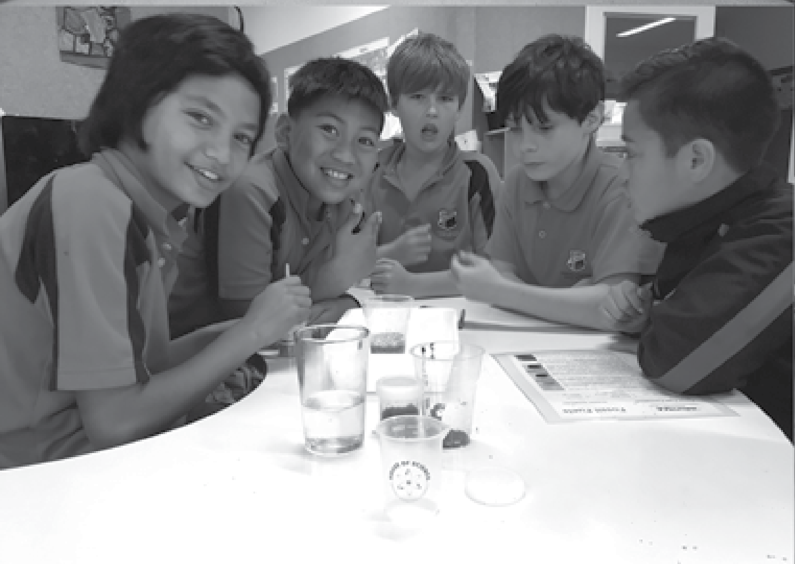
In some centres the Nano-Chem box has been booked out every week of the school year, and House of Science is seeing repeat use, with half of the schools having seen the box at least twice.

"This was an awesome box. I have never before had kids running because we were doing science."

"Total engagement and had kids wanting to know if they could buy the kit."

Teacher comments


Investigating
Sunrise Rotary

Nano-Chem
NANO-CHEM


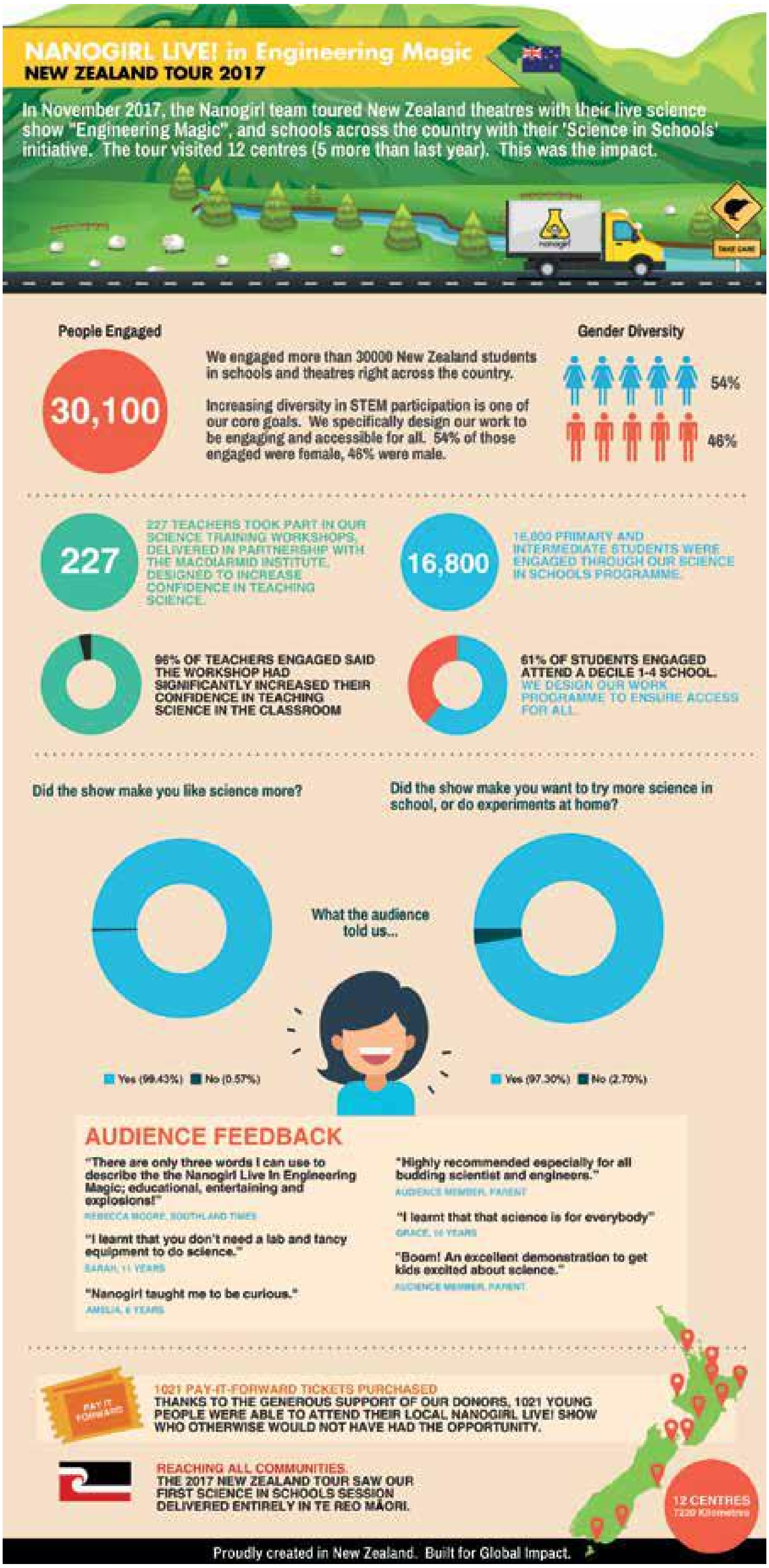
Exploring Structures – Buckyballs


Nano-Chem
NANO-CHEM
MATERIALS SCIENCE AND NANOTECHNOLOGY
TEACHER MANUAL

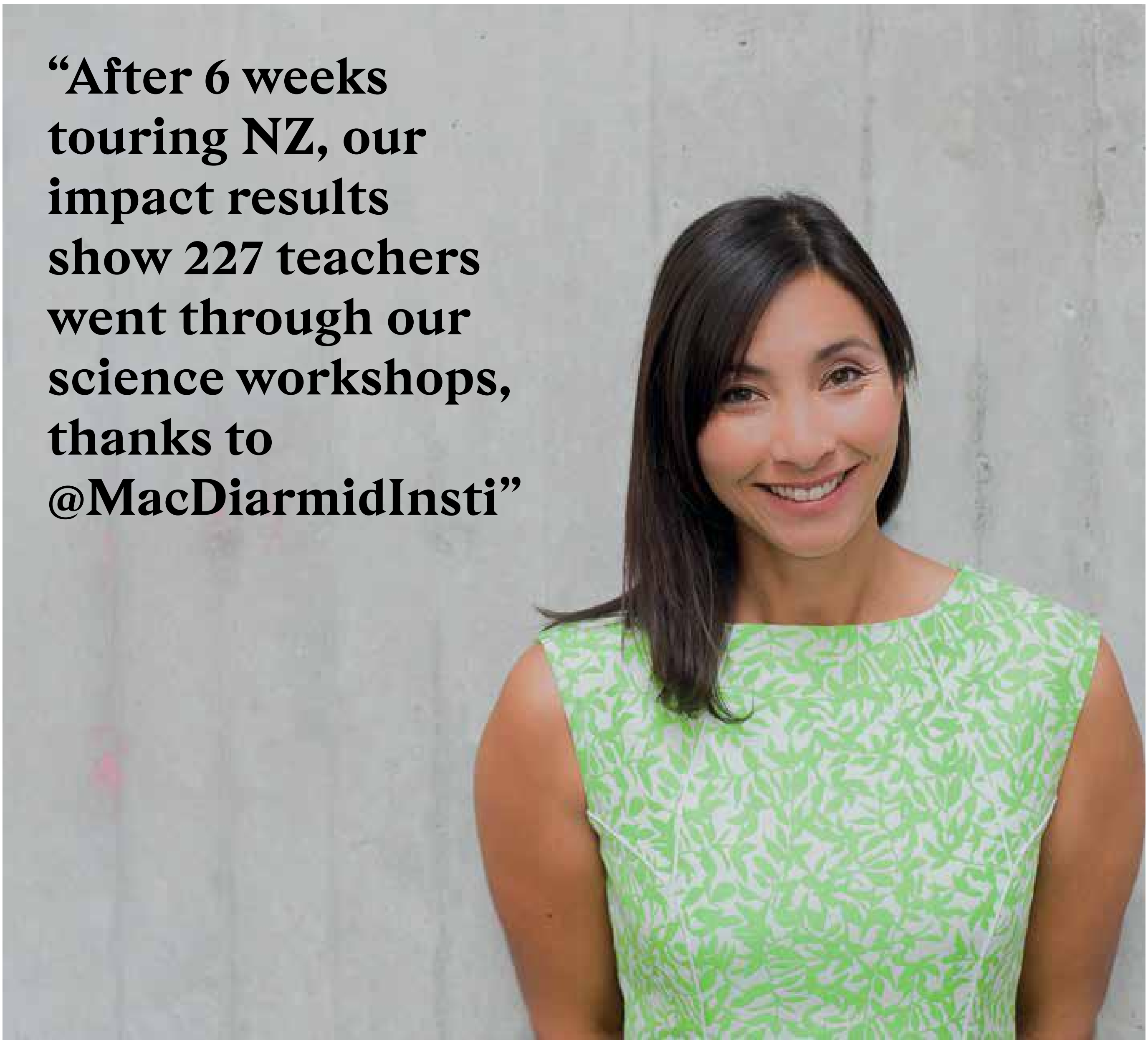

Exploring Structures – Buckyballs
Make a Buckyball Model

Nanogirl

Again we worked with MacDiarmid Investigator Dr Michelle Dickinson to extend our 'Kōrero with scientists' programme into regional New Zealand, in cooperation with her 'Nanogirl Live!' stage show.

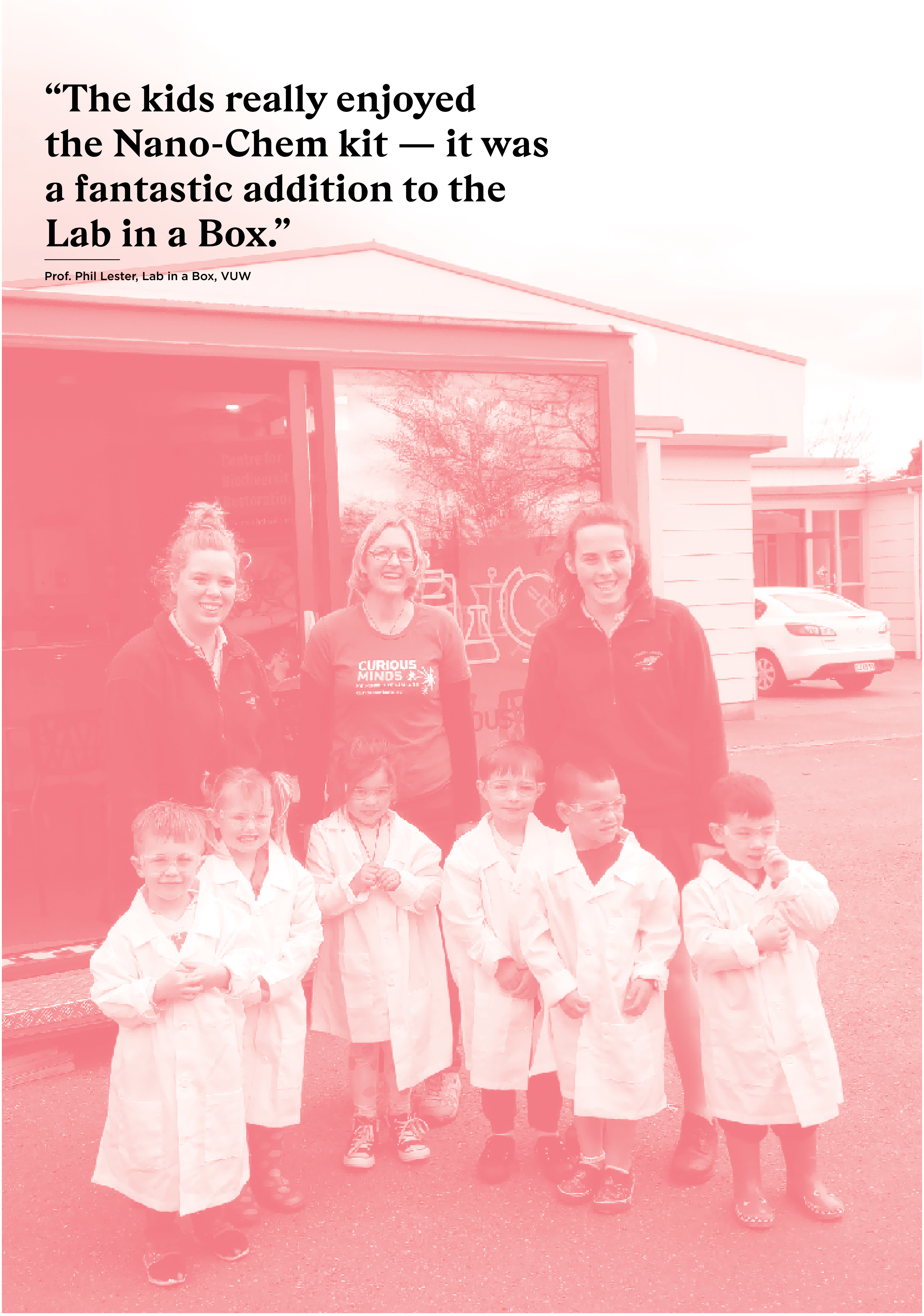


"After 6 weeks touring NZ, our impact results show 227 teachers went through our science workshops, thanks to @MacDiarmidInsti"



“The kids really enjoyed the Nano-Chem kit — it was a fantastic addition to the Lab in a Box.”

Prof. Phil Lester, Lab in a Box, VUW



Lab in a Box

With an eye to redressing the urban/rural divide in science teaching resources, University of Otago Professor Peter Dearden conceived of Lab in a Box, a mobile science laboratory inside a 20-foot shipping container. Lab in a Box can be taken anywhere in the country and comes full of science gear and is accompanied by a teacher, and is able to reach isolated rural communities and schools.

In 2017, Lab in a Box came to the North Island for the first time and we added a Nano-Chem box plus some lab coats for the kids. Lab in a Box spent time at schools in the wider Wellington area, then traveled to Rotorua, Taupo and the East Coast. 23 groups of students (401 in total) used the Nano-Chem box over this time.

WOMEN IN NANOSCIENCE: LITTLE MATERIALS, BIG STORIES

19 women, 19 stories: all paving different paths into nanoscience.

This year 19 women from the MacDiarmid Institute travelled to seven regional centres to tell their personal stories of life in science. They gave their own perspectives on what it is like being a woman in the physical sciences (physics, chemistry or engineering) – an area of science largely populated by men.

Dr Carla Meledandri, who organised the lecture series and spoke at the Dunedin event, said the feedback had been overwhelmingly positive.

“It was great to be able to tell personal stories to wide-ranging audiences. One of the young women in the audience told me afterwards that she felt incredibly relieved that there was obviously no one right way to get into science and academia – that we’d each talked about the different pathways we’d taken into research and that this made her less worried about ‘getting it right’.”

Exit surveys confirmed the positive feedback: 83 percent of attendees rated the lectures ‘excellent’; 95 percent of people said the evening’s lecture had stimulated their interest in nanoscience research; and 82 percent of participants wanted to hear more from the Institute.

Dr Meledandri said the lecture series was a follow up to the very successful Women in Science lecture at the AMN8 conference in February, and that there had been considerable interest in the lectures.

“Despite decades of government effort aimed at getting girls into science, the statistics show that women are still significantly under-represented in the academic career structure, not only in more senior ranks but also at the research student level,” says Dr Meledandri.

> **“Science rocks. Our girls need to feel they can definitely do it! Once you’re hooked, you’re on your way.”**

Audience feedback

“I’m happy to be able to say that a third of MacDiarmid Institute researchers are women – even at the most senior levels. But while that’s better than usual in these disciplines, it demonstrates the persistent representation gap.

“We know that having positive female scientist role models helps younger women see a future career for themselves as scientists, so we’re extremely pleased to be able to bring some of our female scientists to speak around the country.”

The regional lecture series delivered talks in Tauranga, Napier, Whanganui, Nelson, Oamaru, Wanaka and Dunedin. The lectures were delivered by MacDiarmid researchers Professor Margaret Brimble, Dr Jenny Malmström, Dr Laura Domigan, Dr Catherine Whitby, Dr Gemma Cotton, Professor Alison Downard, Dr Anna Garden, Dr Dagmara Jaskólska, Dr Natalie Plank, Dr Renee Goreham, Ashley Way, Professor Cather Simpson, Dr Michelle Dickinson, Professor Penny Brothers, Professor Sally Brooker and Dr Carla Meledandri.

Opposite page: Tauranga Girls College students watch Dr Jenny Malmström during the regional lecture series

The underrepresentation of women throughout the scientific career

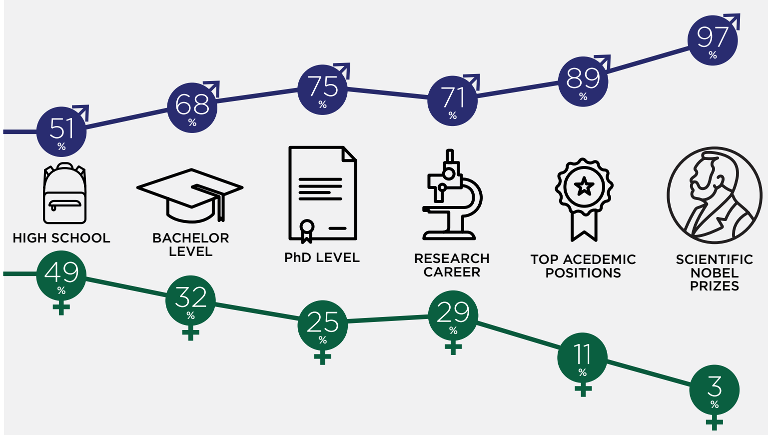


Diagram courtesy of L’Oreal and Women in Science


Athletics
Basketball
Cricket

"Great to have speakers who have wonderful humour and are capable of expressing some high-powered science in an understandable way."

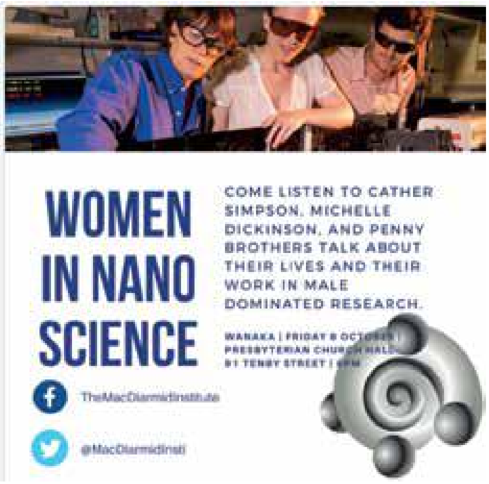
Audience feedback

The MacDiarmid regional lecture series

Tauranga
Napier
Whanganui
Nelson
Wanaka
Oamaru
Dunedin

Women in Mathematical Sciences

The MacDiarmid co-sponsored the first Mirzahkani Hui for Lower North Island Women in Mathematical Sciences Conference was in December. The meeting brought together 20 women involved in mathematics, physics, physical chemistry, statistics, and computer science in the Palmerton North and Wellington regions. These women were researchers and teachers from universities and industry, from a variety of stages of their careers from post docs through to professor.



Kōrero

The 2017 Kōrero programme was again led by MacDiarmid Principal Investigators Associate Professor Duncan Macgillivray (University of Auckland), Professor Eric Le Ru (Victoria University of Wellington) and Professor Paul Kruger (University of Canterbury). The programme, where MacDiarmid scientsts teach nanoscience directly to teachers, reached 139 primary and early childhood teachers in Auckland, Wellington, Porirua and Christchurch.

Physics Teachers Workshops

Physics Teachers Workshops Principal Investigators and Victoria University of Wellington researchers Professor Michele Governale and Associate Professor Ben Ruck continued their popular hands-on programme for high-school physics teachers. The programme, which has been running since 2015, took the workshops to physics teachers in Palmerston North and Dunedin, in collaboration with the Dodd-Walls CoRE. The workshops will expand in 2018, with support from both CoREs and from the New Zealand Institute of Physics (NZIP).

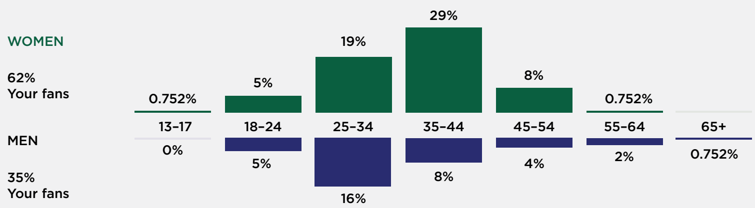
Social Media

We used social media to engage our followers about the Women In Nanoscience lecture series, on Twitter, LinkedIn and Facebook.

Tweets linking to articles about Dr Carla Meledrandi and Professor Cather Simpson, for example, had a potential reach of 9.3 thousand which shows many were interested in the work and lives of our scientists. Through the hashtag #WomeninNanoscience, people who attended and shared information about the events used the hashtag themselves, encouraging engagement and greater reach online.

We ran a Twitter Q and A for World Science Day - #AskMacDiarmid. Our followers tweeted questions for our panel of scientists. We promo-ed the event with biographical tweets about each of the scientists on our panel. Some of the posts gained a potential reach of 5.6 thousand.

Aggregated demographic data about the people who liked our Facebook page based on the age and gender information they provide in their user profiles



Twitter engagements

Partnering with The Spinoff

As Science Page Partner for The Spinoff online magazine, we've provided a platform for over 100 articles on science, in areas ranging from climate change to women in science, to nanotechnology. Our partnership has created a place where all science and articles on materials science in particular can reach the general public.

This included a series of articles on materials science around our AMN8 conference in February. Analytics show the science page averages 30k hits per month with nearly 19k unique users per month. Users spent an average of six minutes per page.

Bootcamp

Twenty MacDiarmid students and postdocs attended the annual MacDiarmid Emerging Students Association (MESA) Bootcamp in Kaiteriteri in November, spending the first day presenting and hearing about each other's research. It was an opportunity to hear what others in the MacDiarmid Institute do and to open up collaboration possibilities. They spent the second day hearing MacDiarmid academics discuss soft matter.

Cluster hui

The MacDiarmid Institute's 15th annual cluster hui on nanoclusters was held in Glenorchy in November. 29 MacDiarmid scientists from four universities presented a huge range of work within the cluster umbrella. Presentation topics included optimisation of gas dynamic virtual nozzles for bioimaging applications, the use of evolutionary algorithms for nanocluster morphology determination, and the development of highly accurate methods to model interactions between atoms of Oganesson (an element of which only five or six atoms have ever been detected).

The informal atmosphere of the cluster hui facilitated discussion and it was wonderful to see so many students engaging with each other's projects. Even more informal discussions continued into the Caples Valley afterwards, for the traditional post-hui tramp.

NanoCamp and DiscoveryCamp's popularity continues

The 2017 NanoCamp and DiscoveryCamp again saw high numbers of applications from Year 12 and 13 secondary school students.

The five-day, all-expenses-paid residential programmes give students an opportunity to learn about nanoscience through lectures and lab experience with MacDiarmid investigators. This year the programmes were run by Principal Investigators Dr Natalie Plank (Wellington, Discovery), Dr Geoff Willmott (Auckland, Discovery), and Dr Michel Nieuwoudt (Auckland, Nano).

> **"My mind exploded. No joke, the feeling was like I had a crush."**
>
> Summer student intern Eteroa Lafaele

Alumni summer studentships

DiscoveryCamp doesn't always stop at the end of the week. Eteroa Lafaele was one of four DiscoveryCamp alumni who spent summer 2016/17 working in MacDiarmid labs.
Eteroa says attending the 2012 DiscoveryCamp changed her life.

"In college I was hooked on chemistry. It was the year before university and all you heard was 'plan now for your future!' Summer camp came around and my mind was still set on chemistry. But it was a session about computer science that won me over.

"My mind exploded. No joke, the feeling was like I had a crush!" she laughs.
"I actually ditched my group and walked around the computer science department and there were all these old school computers. I looked into their displays and I promised myself that I would be up there with the computer science greats."

She's now over halfway to her goal, studying a double major in Software Development and Computational Intelligence at Auckland University of Technology, and plans to be a software engineer. Eteroa believes that science, technology, engineering, and maths are the perfect industries for our innovative Pacific people.
"It's important for Māori and Pacific students to be in the STEM industries because there are opportunities just flowing from this industry. The world is changing, and I believe we should change with it.

"I've been going to decile 1–3 schools in South Auckland to promote STEM. Now I want to go home and do the same thing in Cannons Creek. I want to give back to my place. I want to introduce the kids there to computer science because as a last resort they all go for sports – but they need a backbone to fall back on after sports. It's on my mind every time I come home and visit."

Eteroa spent the summer working on developing redox batteries for remote island communities.

Danielle Sword (Muaūpoko) is another DiscoveryCamp alumni (2013) who came back to do the summer studentship. She says that DiscoveryCamp helped her feel that science was something she could do at university.

"My DiscoveryCamp supervisor was encouraging about me going ahead in the science field at uni, especially in chemical science. So I stayed with science and have done biomed, so a bit of biology and chemistry."










She spent her summer studentship working on gold nanoparticles and DNA nanoflowers.

“The job really related to my project and the techniques I’d done in class. I got to meet the top supervisors and PhD students – and they chatted to me about opportunities for me for my masters. It was a good door-opener. And I got paid for it!”

Danielle is now thinking of a career in pharmaceuticals or immunology.

2017 Discovery Alumni Summer Studentships

Eteroa Lafaele
Redox batteries for remote island communities
AUT (CS and Maths)

Kia Paasi
Aptamer conjugated to gold nanoparticles
University of Otago (BSc Psychology)

Danielle Sword
Aptamer conjugated into gold nanoparticles and DNA nanoflowers
Victoria University of Wellington (Biomed Sci)

Mariah McDonald
Biosensors for medical implants
University of Canterbury (Engineering)

“The job really related to my project and the techniques I’d done in class.”

Summer student intern Danielle Sword

The three-minute video challenge

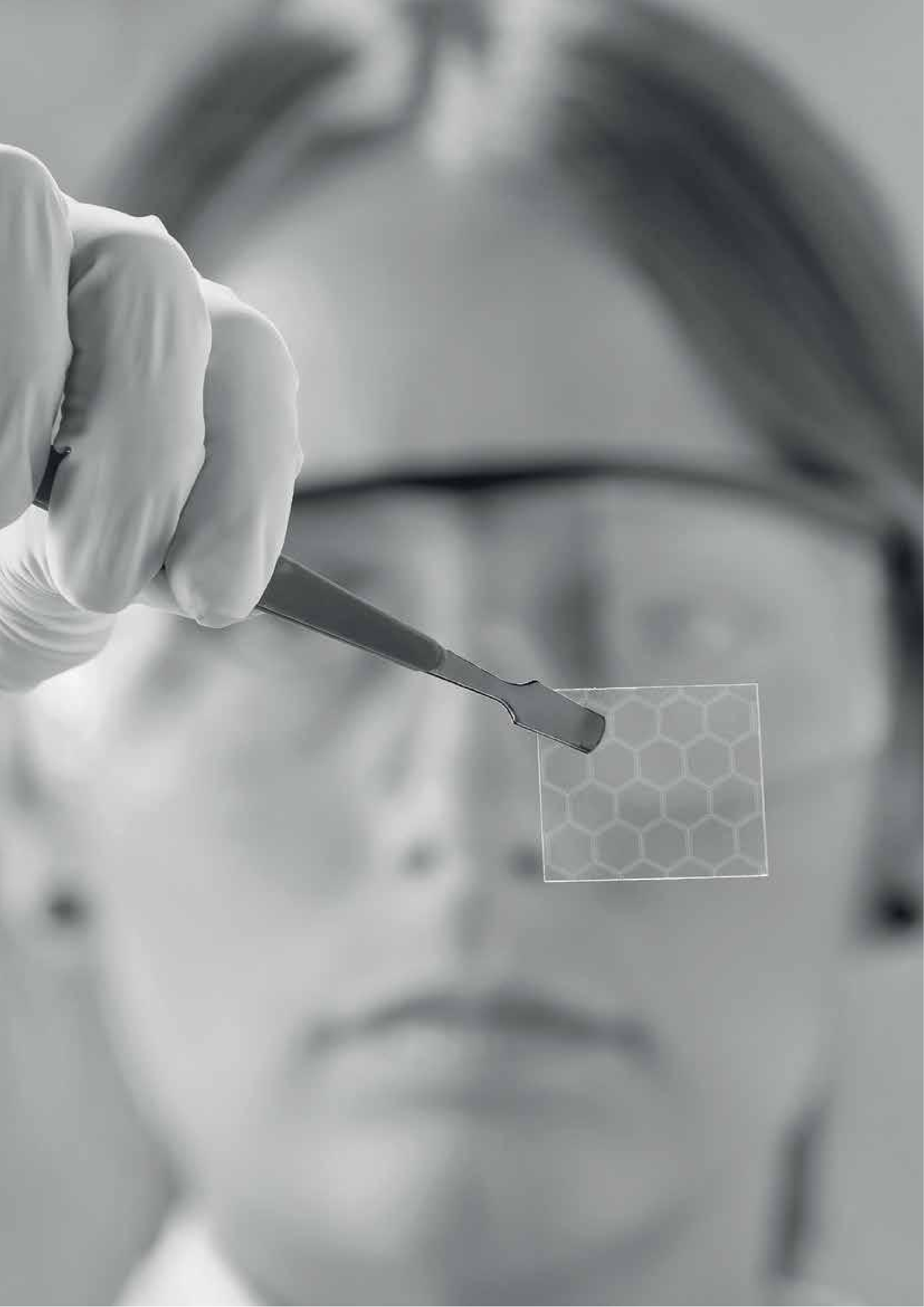
This year MESA again challenged MacDiarmid students and researchers to produce a three-minute video clip presenting their research to the general public (on a level that could be enjoyed and understood by a curious teenager). The panel of judges were Toby Manhire (The Spinoff); Dacia Herbulock (Science Media Centre); and MacDiarmid Principal Investigator and University of Auckland Senior Lecturer Dr Geoff Willmott.

Canterbury PhD student Alexandra McNeill won first prize for her video, *Zinc Oxide: Making the Most of a Sticky Situation*. The judges described it as clear, lucid and engaging, offering people a new perspective on the science.

To see the winning video, go to https://drive.google.com/file/d/1ZEYkmbRzqfH4CKbTEmhvK3uharNxbSWt/view

4. Into the future.

The true impact of the MacDiarmid Institute is the impact our graduates make in industry, academia, and through their own start-ups. We train our students not only in materials, but in leadership, communication, and commercialisation. We send tech-savvy graduates into the world and watch them soar. That's what we do. We are incredibly proud of our alumni.



INTO THE FUTURE

With 624 PhD students and 190 Postdoctoral Fellows having graduated and found their way in the wider world after their time with the MacDiarmid Institute, it's not surprising to see some real success stories. Here are three recent examples.

MacDiarmid alumnus Dr Andrew Preston's start-up company **Publons** was acquired by international data analysis company Clarivate Analytics on 1 July 2017. Dr Preston, who started Publons in 2012 with his colleague Daniel Johnston, was a MacDiarmid Institute PhD scholarship student under MacDiarmid Principal Investigator Associate Professor Ben Ruck from 2007 to 2009. Preston and Johnston set up Publons to incentivise peer review by giving credit and recognition to researchers who review publications. "It's a huge win for start-ups, their founders and investors." (NZ Herald)

Revolution Fibres Ltd is a nanofibre production company based in Auckland developing products for air filtration, skincare, acoustics, composites and much more. It's where MacDiarmid Institute alumnus Dr Bhuvana Kannan works as Research and Innovation Manager, developing nanofibres for cosmetics, skin scaffolding, textiles, batteries and filtration. Dr Kannan completed her PhD with MacDiarmid Principal Investigator Professor Jadranka Travas-Sejdic in 2011.

When **Rocket Lab**'s electron rocket made it to space on 25 May 2017, it also made it into headlines all around the world. It was the first successful launch of an orbital-class rocket launched from a private launch site. Rocket Lab Senior Vehicle Test Engineer, Dr Harry Warring, studied with MacDiarmid Principal Investigator Associate Professor Ben Ruck from 2010 to 2012 as a research assistant prior to doing his MacDiarmid Institute funded PhD with Associate Professor Ruck from 2013 to 2016.

Dr Warring says the skills he picked up during a PhD were easily transferred to the hi-tech sector.

At the end of a PhD, graduates have a whole bunch of useful tools that make them highly employable in the hi-tech sector.

Dr Harry Warring

"You learn a systematic way of approaching problems, and how to figure out why something is not working. It's a process of elimination. At the end of a PhD, graduates have a whole bunch of other useful tools that they may not initially realise make them highly employable in the hi-tech sector.

"On the one hand you're the world expert on a certain topic, but on the other, you have a bunch of skills that can lead you onto some really exciting job options."

Dr Warring says his experience as a MacDiarmid student was very positive.

"It was all the extras – the 'other' skills we built up, through being part of the MacDiarmid - especially the seminars, and boot-camps. I always tried to go to as many as possible."

A highlight for him was the MacDiarmid 'Mātauranga Māori, Nanotechnology and Advanced Materials' student and postdoc symposium.

"It was great to explore how we can better integrate science with Māori culture, and to understand how successful relationships can be built between science/technological endeavours and local Māori, and can have beneficial outcomes to both groups."

Dr Warring says the MacDiarmid Institute commercialisation workshop and internships for students had also been pertinent. "The commercialisation workshop was great – because we are essentially a start-up company. All these extra opportunities I had through being a MacDiarmid student, to get experience outside of my PhD work, were awesome."



















FUTURE LEADERS PROGRAMME

Our 2017 Future Leaders Programme – an annual two-day workshop for our emerging scientists – was themed commercialisation and industry career development. Students took a plunge into the world of a science entrepreneur and reflected on how to pitch themselves for industry careers, culminating in the opportunity to network with many of our industry partners and alumni.

> **"Having the Industry panel available for discussion was great! It helped paint a more realistic picture of what life after your PhD might look like."**

Student feedback

RECIPIENTS OF MACDIARMID INSTITUTE'S BUSINESS SCHOLAR-SHIPS

In 2017 for the first time we offered competitive MBA scholarships to our alumni, and awarded the following:

Nihan Aydemir, PhD 2016: Final course for Masters of Commercialisation and Entrepreneurship, University of Auckland

Nihan will use this scholarship for the completion of a Masters of Commercialization and Entrepreneurship.
She hopes to take what she learns to the start-up, SpotCheck, which won the 1st place in the Velocity 100k Challange in 2016.

Brendan Darby, PhD 2016: Postgraduate Diploma in Business Administration, Victoria University of Wellington

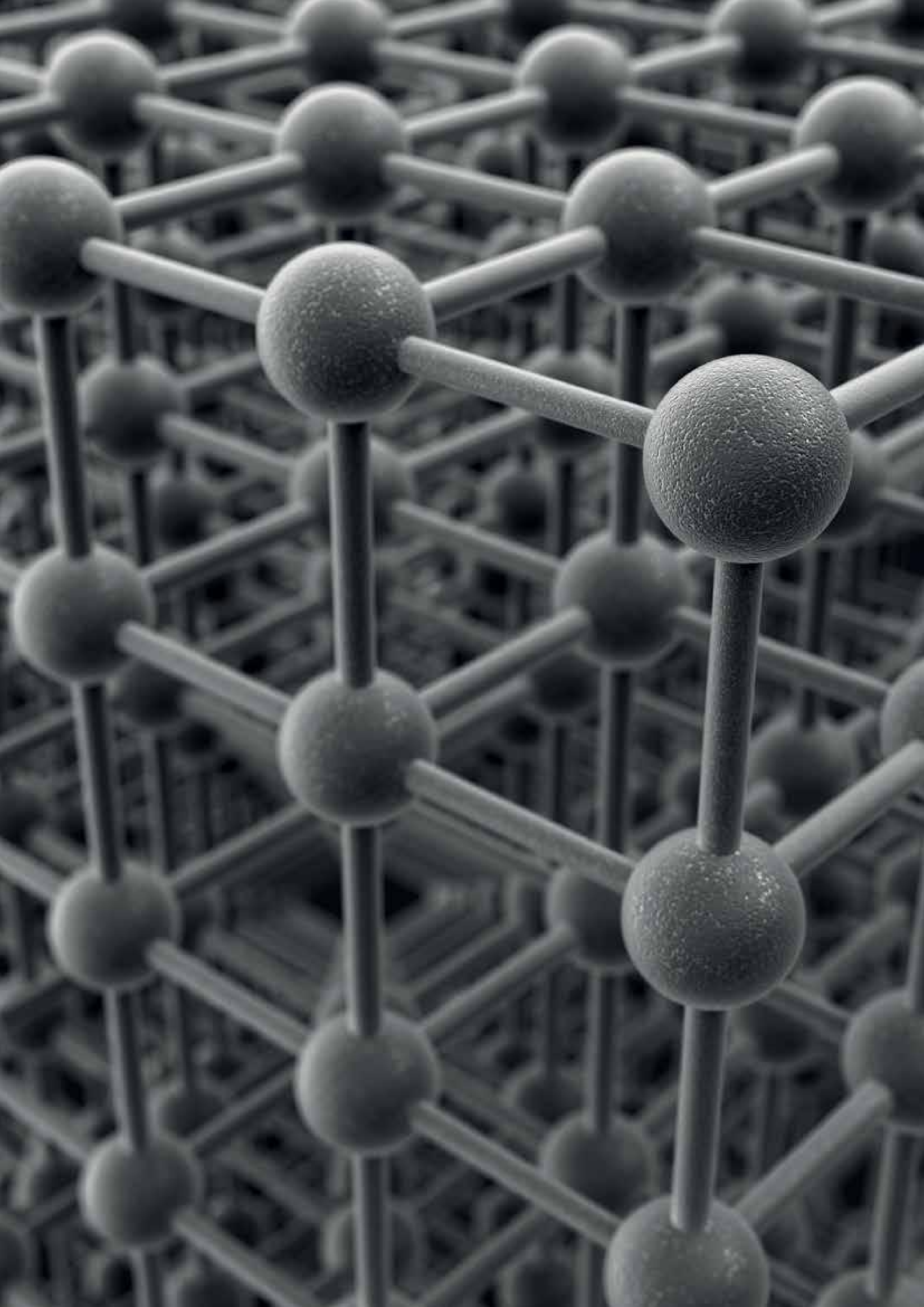
The MacDiarmid Institute business scholarship will allow Brendan to develop his career as an emerging commercial scientist by exposing him to cutting-edge business practices and fundamental corporate operations that will inevitably be asked of him in his future career as a founder of start-up MaramaLabs.

Manmeet Kaur, PhD 2016: Masters of Commercialisation and Entrepreneurship, University of Auckland

Manmeet will use the scholarship to develop the skill required to bridge academia and industry, to identify new investments and solutions, and make sense of the ever-present uncertainty associated with early stage ventures and start-ups.

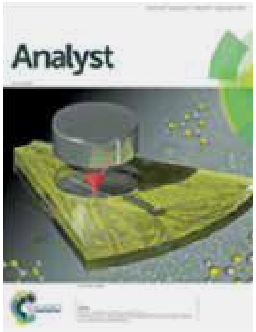
Matthew Cowan, PhD 2012: Postgraduate Diploma in Business Administration, College of Engineering, University of Canterbury

Matt plans to use the scholarship to boost him towards his goal of introducing innovative technologies to transform the petrochemicals industry. He's passionate about making a positive impact on the environment and society by adding to New Zealand's high-tech manufacturing ecosystem.

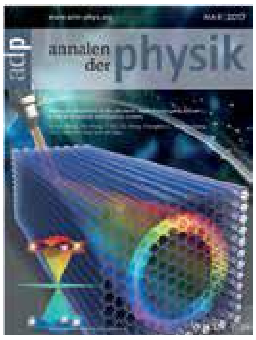


5. Into the metrics.

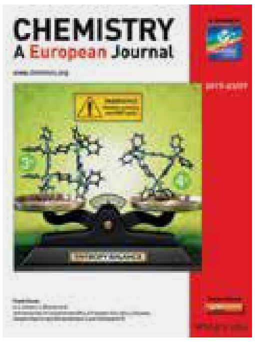
JOURNAL COVERS



Cather Simpson and coworkers
'Raman on a disc: High-quality Raman Spectroscopy in an Open Channel on a Centrifugal Microfluidic Disc'
Analyst 142(10), 1682-1688, 2017

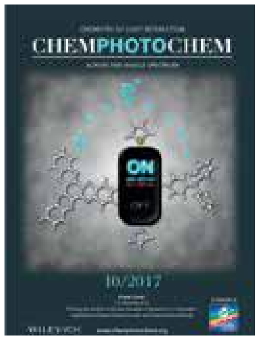


James Storey, Jeff Tallon and Coworkers
'London penetration depth and thermal fluctuations in the sulphur hydride 203 K superconductor'
Annalen der Physik, 529, 1600390



Anna Garden, Sally Brooker and coworkers
'Self-assembly of cyclohelicate $[M_3L_3]$ triangles over $[M_4L_4]$ squares, despite near linear bis-terdentate L and octahedral M'
Chemistry - A European Journal, 2017, 23, 14193-14199, 2017

Carla Meledrandri, Sally Brooker and coworkers
'Proof of principle: Immobilisation of robust $Cu^{II}_3Tb^{III}$-macrocycles on small, suitably pre-functionalised gold nanoparticles'
Chem. Eur. J. (2017) 23, 2517-2521



Nigel Lucas, Keith Gordon and coworkers
'Flicking the Switch on Donor-Acceptor Interactions in exaazatrinaphthalene Dyes: A Spectroscopic and Computational Study'
ChemPhotoChem Volume 1, Issue 10 October 2017, 432-441

FINANCIALS

	2017
Core funding	5,826,451
Other funding (mainly interest income)	287,715
Total revenue	6,114,167
Salaries and salary-related costs:	
Director and Principal Investigators	846,473
Post Doctoral Fellows	446,326
Research / Technical Assistants	579,307
Others	227,223
Total salaries and salary-related costs	2,099,329
Other costs:	
Overheads	1,281,815
Project costs	1,125,808
Travel	375,388
Postgraduate Students	1,231,827
Total other costs	4,014,838
Total expenditure	6,114,167

AT A GLANCE

Broad category	Detailed category	
Headcounts by category	Emeritus Investigators	15
	Principal Investigators	32
	Associate Investigators	22
	Postdoctoral researchers	42
	Students	205
	Total	316
Peer reviewed research outputs by type	Journal articles	303
	Book chapters	9
	Conference papers	17
	Total	329

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*Partial year

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Associate Professor Justin Hodgkiss
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Industry Engagement
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Sci Exec Representative
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*Partial year

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Designing structured nanoscale materials with
exceptional properties

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Faculty
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Nanostructured, organic, magnetic, and
superconducting materials

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Nanotechnology
Karlsruhe Institute of Technology | KIT
Institute of Applied Physics and Institute of
Nanotechnology
Karlsruhe, Germany
Scanning probe microscopy and
nanolithography

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University of New South Wales, Sydney, Australia
Quantum physics

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Queensland
Deputy Director and co-founder of the
Australian Institute for Bioengineering and
Nanotechnology
University of Queensland, Australia
Nanoscience, nanotechnology, and molecular
diagnostics

Dr David Williams
Chief Research Scientist and Laboratory
Manager, Hitachi Cambridge Laboratory
University of Cambridge, UK
Nano engineered electronic devices

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Victoria University of Wellington

Professor Simon Brown
Science Leader: Tomorrow's Electronic Devices
University of Canterbury

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Massey University

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University of Auckland

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MESA Chairperson
University of Auckland

Dr Geoff Willmott
Principal Investigator Representative
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Mrs Catherine Gibbs*
Centre Manager of the MacDiarmid Institute
Victoria University of Wellington

Ms Sonia Hutton
Administrator of the MacDiarmid Institute
Victoria University of Wellington

Ms Vanessa Young
Strategic Engagement Manager
of the MacDiarmid Institute
Victoria University of Wellington

*Partial year

MacDiarmid Emerging Scientist Association (MESA) 2017

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PhD Student
University of Auckland

Kathryn Schroeder
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PhD Student
Victoria University of Wellington

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Postdoctoral Fellow
Victoria University of Wellington

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Centre Representative
PhD Student
University of Canterbury

David Perl
Centre Representative
PhD Student
Massey University

Geoffrey Weal
Centre representative
PhD Student
University of Otago

Margaux Airey
Centre Representative
PhD Student
University of Auckland

Zuned Ahmed
Centre Representative
PhD Student
University of Canterbury

Princial Investigators (32)

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Martin Allen
Sally Brooker
Penny Brothers
Simon Brown
Alison Downard
Nicola Gaston
Juliet Gerrard
Keith Gordon
Michele Governale
Jonathan Halpert
Justin Hodgkiss
Paul Kruger
Eric Le Ru
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Carla Meledandri
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Franck Natali
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Cather Simpson
Shane Telfer
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AUTHORS	TITLE	JOURNAL
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AUTHORS	TITLE	JOURNAL
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R. J. Anderson, J. Li, L. Kedzierski, B. J. Compton, C. M. Hayman, T. L. Osmond, C.-W. Tang, K. J. Farrand, H.-F. Koay, C. F. Dos Santos Sa E. Almeida, L. R. Holz, G. M. Williams, **M. A. Brimble**, Z. Wang, M. Koutsakos, K. Kedzierska, D. I. Godfrey, I. F. Hermans, S. J. Turner and G. F. Painter	Augmenting Influenza-Specific T Cell Memory Generation with a Natural Killer T Cell-Dependent Glycolipid-Peptide Vaccine	*ACS Chemical Biology* **12**, 2898 - 2905 (2017)
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Batmunkh, M., Macdonald, T.J., Shearer, C.J., Bat-Erdene, M., Wang, Y., Biggs, M.J., Parkin, I.P., **Nann, T.**, Shapter, J.G.	Carbon Nanotubes in TiO2 Nanofiber Photoelectrodes for High-Performance Perovskite Solar Cells	*Advanced Science* **4**, (2017)

AUTHORS	TITLE	JOURNAL
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Tan, L.H., Sykes, P.H., **Alkaisi, M.M.**, **Evans, J.J.**	Cell-like features imprinted in the physical nano- and micro-topography of the environment modify the responses to anti-cancer drugs of endometrial cancer cells	*Biofabrication* **9**, (2017)
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Ma, Y., Vashishtha, P., Chen, K., Peach, E.L., Ohayon, D., **Hodgkiss, J.M.**, **Halpert, J.E.**	Controlled Growth of CH3NH3PbI3 Using a Dynamically Dispensed Spin-Coating Method: Improving Efficiency with a Reproducible PbI2 Blocking Layer	*ChemSusChem* **10**, 2677 - 2684 (2017)
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