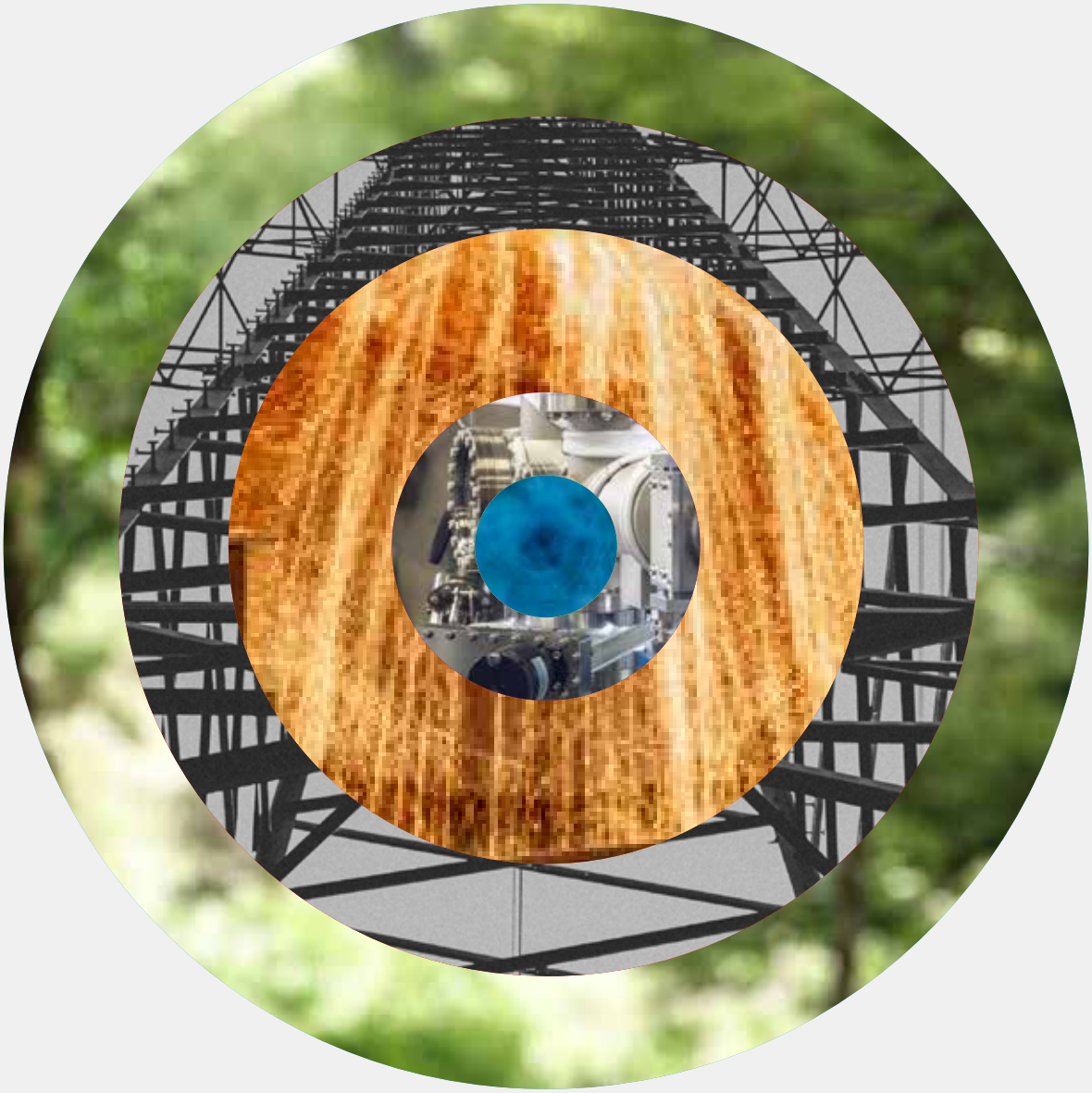
# MACDIARMID INSTITUTE

2019 ANNUAL REPORT



# *Tangata whakawhanake - to improve people's lives*

**We are a network of leading researchers united in a common goal: to create and explore innovative, sustainable materials that will improve the lives of people in Aotearoa and around the world.**

**We work together and partner with industry and government to address global challenges such as renewable energy and climate change mitigation.**

**From 2002 - 2019**

656 PhD graduates

852 research alumni

4000+ AMN conference attendees

73 inventions patented

19 affiliated start-up companies created

MacDiarmid Institute
Annual Report
2019

# Contents

MacDiarmid Institute

Annual Report
2019

Associate Professor Nicola Gaston, Paul Atkins and Professor Justin Hodgkiss

**In this coming decade humanity needs materials science like never before; more than any decade before it. This year we have, once again, unified NZ materials scientists for a common goal: to make, understand, and use new materials to improve people's lives.**

NICOLA GASTON AND JUSTIN HODGKISS, CO-DIRECTORS, MACDIARMID INSTITUTE

**It takes time to develop genuinely effective and meaningful collaboration between multiple institutions, to grow the trust and openness that enables high achievement. The MacDiarmid Institute has done this in spades.**

PAUL ATKINS, MACDIARMID INSTITUTE BOARD CHAIR



MacDiarmid Institute
Annual Report
2019

# Co-Directors' report

Nicola Gaston and Justin Hodgkiss
*Co-Directors*

A major focus for the MacDiarmid Institute in 2019 was building the proposal for our next eight years of CoRE funding. The process was both a wonderful opportunity to come together and dream about the ways in which materials science will transform New Zealand in the coming decade, as well to reflect on how far we've come since our beginnings in 2002.

We're connecting more closely with our alumni – New Zealand's future leaders. A survey of MacDiarmid PhD graduates over the past five years shows that over 70% are employed in senior technical roles, including local materials science-based startup companies. Over two thirds of our alumni remain in New Zealand. Considering that two thirds of our PhD recruits come from abroad, the Institute is doing its part to 'make New Zealand a place where talent wants to live', in the words of Sir Paul Callaghan.

Materials science is central to climate action. 2019 was a significant year – from the student climate strikes, to Greta Thunberg's powerful address at the United Nations, and the passing of the Government's Zero Carbon Act. The MacDiarmid Institute's research in renewable energy materials was highlighted at the national 'Just Transition' summit – held in Taranaki to tackle our pathway to zero carbon. Some of our technologies for climate change mitigation have also been seen by hundreds of thousands of visitors at Te Papa museum, and were the topic of our Sustainable Innovations regional lecture tour.

In this coming decade humanity needs materials science more than any decade before it. As the stories in this report will show, this year we have, once again, unified NZ materials scientists for a common goal: to make, understand, and use new materials to improve people's lives.

# Chair's report

Paul Atkins
*Chair*

The theme for the Institute's symposium this year – 'Haumi ē, hui ē, tāiki ē!' – sums up what the MacDiarmid Institute is all about. The expression is used to signal that a group of people is united and ready to progress the purpose of them coming together.

It takes time to develop genuinely effective and meaningful collaboration between multiple institutions, to grow the trust and openness that enables high achievement. The MacDiarmid Institute has done this in spades, and it is this unity of purpose that has enabled the Institute to achieve consistently outstanding outcomes, impact and influence over many years.

Much of the past year has been focussed on the CoRE rebid process. It has been an opportunity to reflect on our history and achievements, and consider how we apply those to the challenges of the future. The excellent science, integration of mātauranga Māori, community engagement, leadership in equity and the developing of great talent for the future, along with the success in commercialisation and industry engagement, means the Institute has all the elements important to this future.

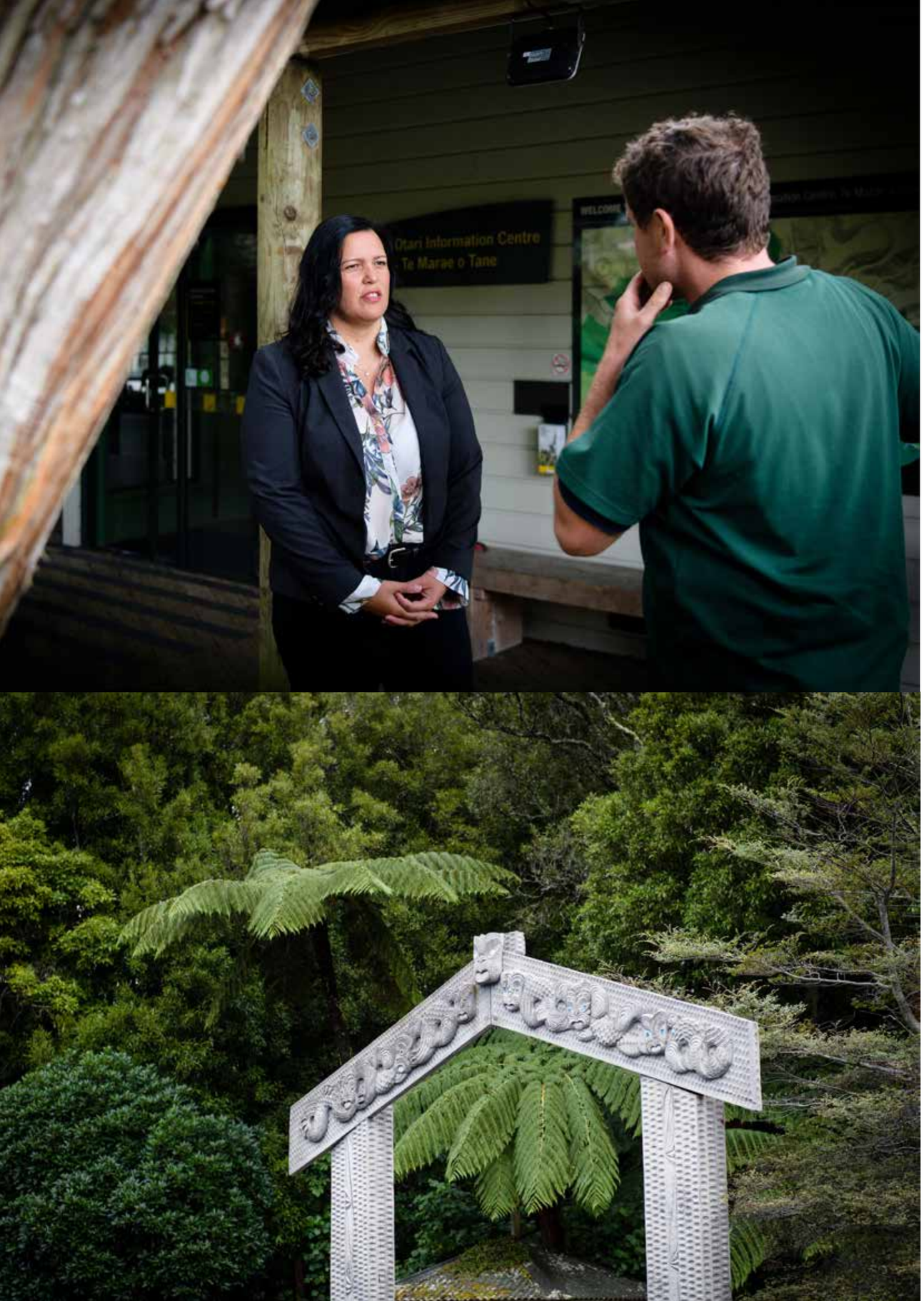
The three themes put forward in our rebid – low energy technologies, zero carbon, and zero waste – will ensure we are making a critical contribution to a sustainable future.

My sincere thanks go to everyone in the MacDiarmid Institute for the collaborative effort that has resulted in such significant and sustained achievements. My particular thanks go to the Co-Directors and Deputy Directors for their leadership and example.

# 1. Out of the lab.

**MacDiarmid research is a collaborative effort, aiming to answer some of the most important scientific questions that matter to New Zealand and the world. But those big questions are built on the expertise of our people – committed researchers, from a diverse range of backgrounds.**

**Here we introduce you to our people and their work.**




INTERVIEW

# Dr Pauline Harris

**Many know MacDiarmid Institute Principal Investigator, Dr Pauline Harris, for her work in Māori astronomy, and traditional calendar systems, but may not realise she also has a PhD in physics. What made her join the MacDiarmid Institute at this time?**

"Sustainability is central for Māori and indigenous people, and to see it at the core of the work of the MacDiarmid Institute was something I wanted to be part of. There's a willingness within the Institute to really focus on the future of our planet, and for sustainability to not be just a word to be thrown around but a word to be actioned. The MacDiarmid leadership really understand that."

Dr Harris sees her role as adding to the kaupapa. "I'm trying to act as a bridge to what Māori need and want. Communities are already telling me what's worrying them – environmental issues, health issues, and the want for a more sustainable world. I want to build a picture of what we as Māori would like organisations such as MacDiarmid to focus on in their research, to enable the healing of our lands and waters. For Māori, we understand that we are the water and we are the land. This gives us a unique perspective, one that sees the need to heal the earth."

Dr Harris, who was this year appointed to a new leadership position with the Institute – Māori Science Leader on the Institute's Science Executive Committee – says it was great to be asked to step into this role.

"I really appreciated being acknowledged for my experience and what I can contribute to the committee for both my knowledge as a physicist and in mātauranga Māori. The mātauranga Māori will always be a focal point for me, because I am Māori and I am passionate about seeing my people and my culture flourish. But it's also nice that the MacDiarmid Institute not only knows of my research and experience in astrophysics, but also knows that I used to work on conductive polymers. I feel seen and acknowledged for who I am."

**"I feel seen and acknowledged for who I am."**

Up next for Dr Harris in this role is to get talking with communities. "I want to have meaningful conversations with our whānau in different iwi, in order to determine what sort of issues are important to them – especially around environmental degradation, and issues with land, water and air. These conversations are already underway, but I want to have more, if communities are willing, and to then have a look to see what the MacDiarmid Institute can help develop, in order to contribute to solving these problems, using materials science. No one organisation will have all the answers, but everybody has a role to play.

"With the MacDiarmid Institute, there's a genuine willingness and desire to work with Māori and indigenous people, and to develop technologies that seriously address our environmental issues that the world is facing. By leading in this area, the MacDiarmid Institute could potentially have a huge role in opening the eyes of other organisations, about where we need to focus our efforts, and how important it is to hold meaningful discussions with the indigenous people of the land in order to build genuine relationships and collaborations based on shared values."

INTERVIEW

# Dr Jenny Malmström

**When Dr Jenny Malmström arrived in New Zealand fresh out of her PhD nine years ago to take up an 18-month postdoc position at the University of Auckland, a permanent position and the prospect of her own research lab seemed a long way off. Dr Malmström, who now runs her own lab at the University, says that the transition from a PhD into a permanent academic role can take time and perseverance for young researchers.**

“The time between the PhD and first permanent position is a key challenge for younger researchers. I spent six years in a series of postdoc positions – firstly in the lab of Jadranka (Travas-Sejdic), and then as a MacDiarmid funded postdoc.”

Dr Malmström says that a young researcher’s first permanent job, when it eventually comes, can often bring its own challenges.

“It’s great to have the new job, but it’s common for new academics to then be given a high teaching load, and this can really make it harder to get their own research established.”

Dr Malmström says for her, this was eased by some key funding awards.

“I was lucky to be given a Rutherford Discovery Fellowship plus a Marsden FastStart in 2016, just at the time I started in a permanent position. This meant my teaching load was much lighter, and I could concentrate on my own research.”

The other thing that helped was the interdisciplinary nature of the MacDiarmid Institute, in which she was, by then, an Associate Investigator.

“I’m pretty multidisciplinary myself so I fitted right in; I have a bioengineering degree, and a PhD in interdisciplinary nanoscience. So finding myself in such an interdisciplinary group of researchers in the MacDiarmid has really helped me find my feet as a researcher here in NZ.

**“Finding myself in such an interdisciplinary group of researchers in the MacDiarmid has really helped me find my feet as a researcher here in NZ.”**

“In general, research in New Zealand is much less interdisciplinary than in other countries. Back home (in Sweden) it’s the norm to span across everything.”

Dr Malmström, who has this year taken on the role of AMN10 Chair, says that she’s always been open to leadership roles.

“Early on in my time in the MacDiarmid Institute, I organised the student Future Leaders’ Programme. Having that behind me now as Chair of AMN10 is very reassuring.”

She says her time as, then, Associate Investigator representative on the MacDiarmid Institute Science Executive also gave her an insight into how things work within the Institute.

“It certainly helped me see what was possible within organisations and how to achieve things.”

Since being promoted to Principal Investigator in 2018, Dr Malmström says she now has her sights on the AMN10 conference in Rotorua in February 2021.

“Rotorua is quintessentially New Zealand. We have the strong relationship with Whakarewarewa Village, fantastic plenary speakers already confirmed, and exciting new aspects to the programme, including, for the first time, a Science in Society section. It’s going to be great.”

# FLEET collaboration

## Laying the groundwork for a low-energy computing revolution

When Microsoft chief executive, Satya Nadella, visited New Zealand in November he left his audience with some jaw-dropping statistics to illustrate the exponential growth in computing the world is experiencing.

By 2025, he told business and technology leaders in Auckland, 175 zettabytes of data will exist in the world (one zettabyte is a trillion gigabytes). By 2030, there would be 50 billion connected devices.

That presents one big problem for Microsoft and the other companies that increasingly host the bulk of our information in massive data centres scattered around the world - more computing power means more energy consumption.

### Eight percent and rising

Computers already account for 8% of global electricity consumption, a figure set to increase rapidly given the hyperconnected nature of the world.

“The bigger part of the problem is how quickly that number is growing,” says Dr Simon Granville, MacDiarmid Institute Principal Investigator and Senior Scientist in the Robinson Research Institute.

“If some new technology could stop the growth in the amount of electricity being used while allowing conventional computing to become more and more available, the benefits of this large scale computing would be achievable without bankrupting the world.”

While many researchers are looking to extend computing power as Moore’s Law starts to run out of steam, a trans-Tasman research collaboration is instead focused on solving the energy issue.

### Formalising a rich and ongoing relationship

In 2019, the Monash University-based Centre of Excellence in Future Low-Energy Electronics Technologies (FLEET) and the MacDiarmid Institute established a new partnership between the two science organisations, which share a mission to search for future low-energy electronics

**Working towards a new, low energy version of the silicon based transistor**

via the development of novel materials and devices. One early partnership project aims to produce a new, low energy version of the silicon-based transistor, which has underpinned the computing revolution to date.

“The transistor is a switch that can be turned on and off to allow a current to flow. It’s basically how we do most electronics,” explains Victoria University of Wellington Professor, Michele Governale, a Principal Investigator at the MacDiarmid Institute.

### Beyond the transistor

“In order to open and close the switch and run current through it, we use power. What FLEET wants to do is substitute the building block, the transistor, with something that is low power.”

The answer may lie in developing materials with electrical and thermal properties that go beyond what is possible with transistors on silicon-based chips when it comes to power efficiency - and to be able to do it at room temperature, rather than relying on energy-intensive cooling systems.

The MacDiarmid Institute’s team of theoretical and experimental physicists are studying the nature of these ‘topological’ materials, which could coat a future generation of transistors.

“They have what we call 'surface states'," says Professor Governale. “You can have transmission without energy dissipation, effectively zero resistance. We've done a lot of theoretical work on these materials and how their surface states change.”

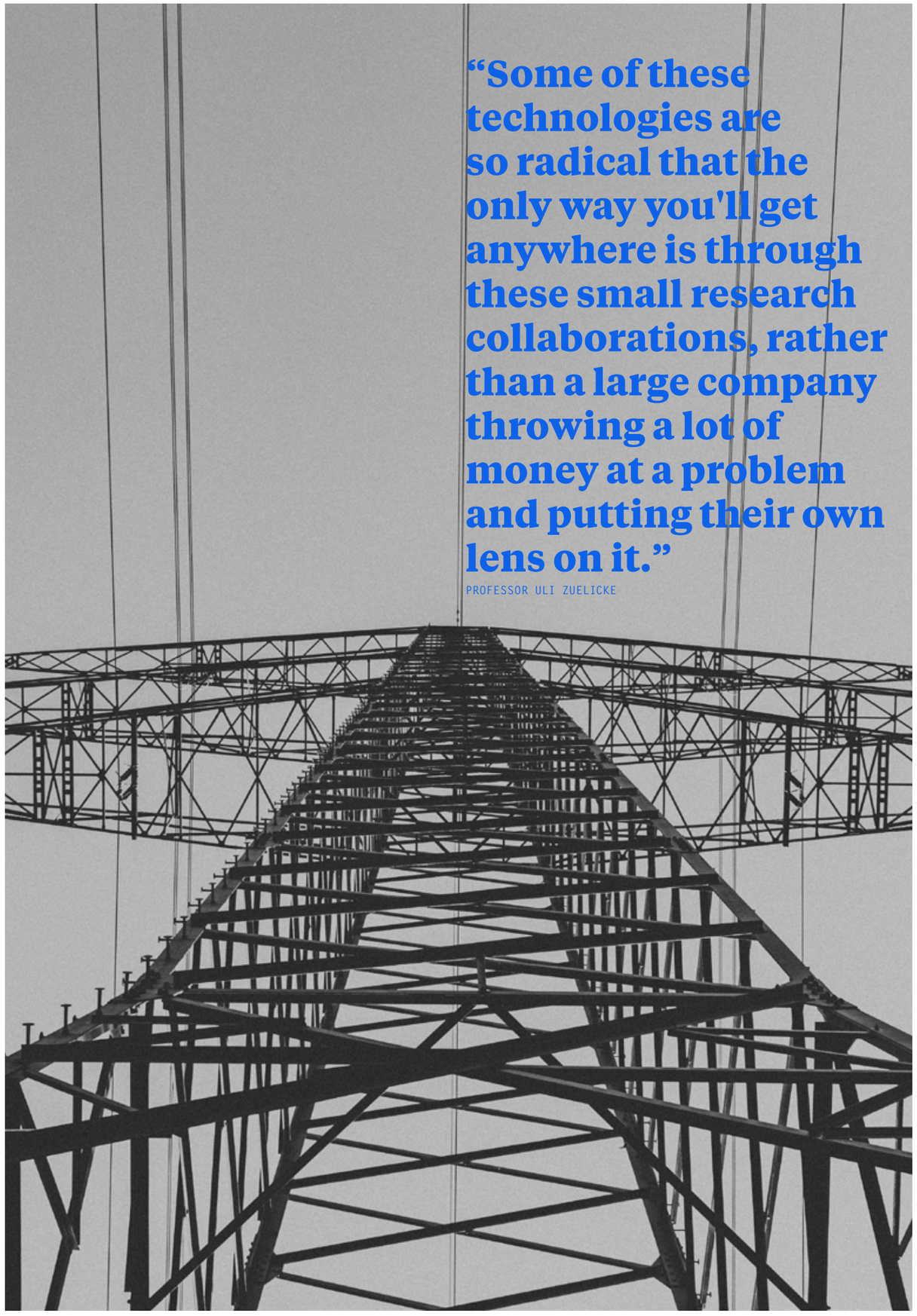
### Thin magnetic coatings

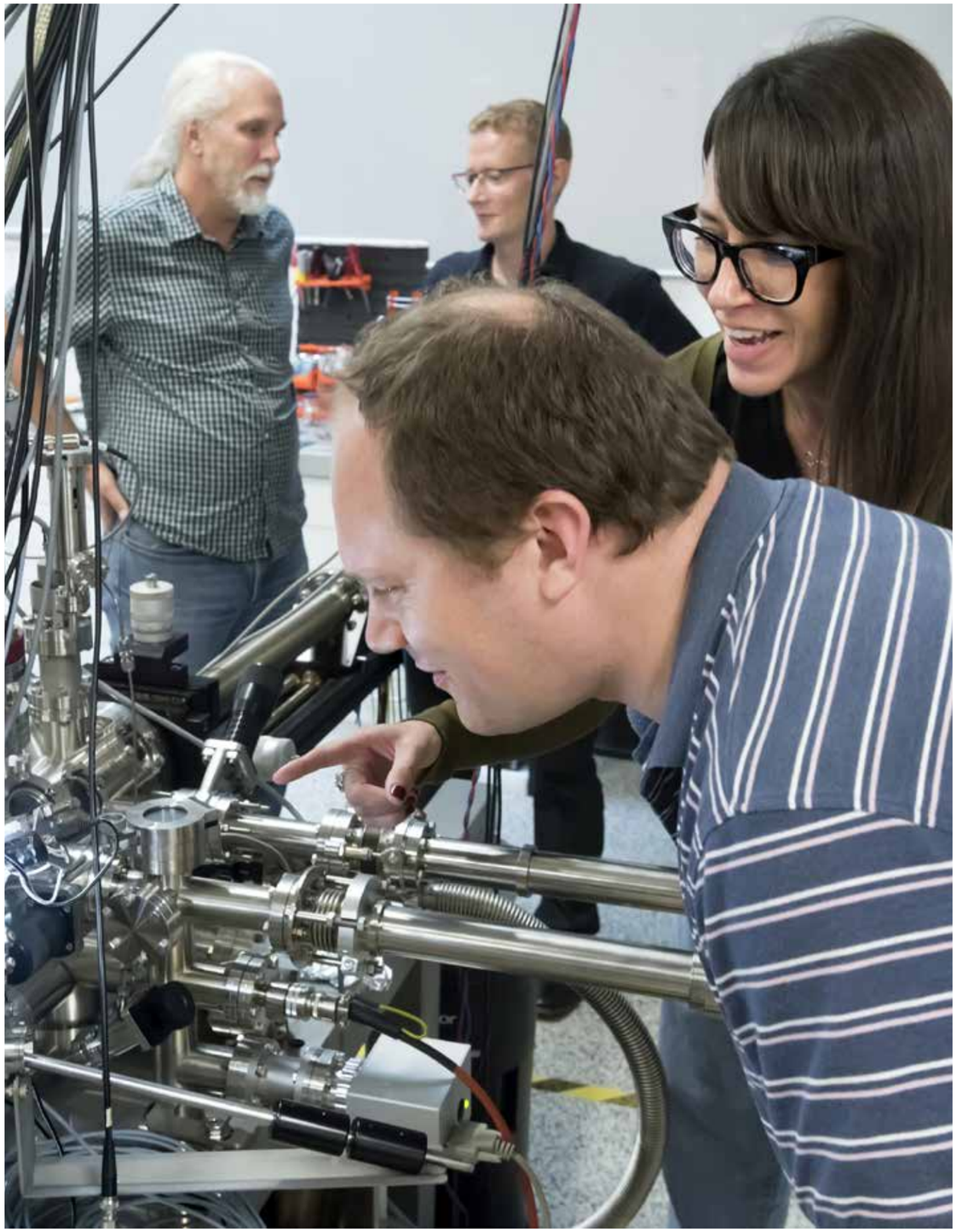
“What happens when you make them smaller and smaller? Will they still have that surface state or will it be destroyed?”
Dr Granville is setting out to answer that question in his lab, where he is experimenting with thin coatings of materials using a range of magnetic materials called Heusler alloys, which could optimise transistors for low-energy operation.

“The next step is to make very simple devices in the lab (big ones you can see, rather than tiny transistors), to try and prove you can use them as a switch,” he says. “At that point, you might get some idea of how much energy you could save.”

Partnering with FLEET allows the MacDiarmid Institute researchers to combine their nanoscale materials expertise with the Australians’ knowledge









of advanced electronics design. There are many technologies in the running to replace conventional transistors, from the topological materials that are the focus of the MacDiarmid Institute researchers, to superconductivity, quantum computing and even neuromorphic computing, which mimics the circuitry of the nervous system.

“Some are so radical that the only way you'll get anywhere is through these small research collaborations, rather than a large company throwing a lot of money at a problem and putting their own lens on it,” says Victoria University of Wellington Professor, Uli Zuelicke, who has been a Principal Investigator of the MacDiarmid Institute since 2004.

“It is like quantum computing. For years it was the domain of the universities. Now it has moved into the realm of big companies like IBM, Google and Intel,” he adds.

In October, researchers from the MacDiarmid Institute and FLEET gathered outside Trieste at the home of the UNESCO-sponsored Abdus Salam International Centre for Theoretical Physics (ICTP). As well as attracting some of the top physicists from around the world, the conference was fully funded by the International Centre for Theoretical Physics (ICTP), which allowed FLEET and the MacDiarmid Institute to contribute their own funding towards sponsoring scientists from developing countries to attend. Such efforts to share knowledge and foster collaboration will be crucial to solving the growing sustainability issue presented by the world’s insatiable demand for computing power.

“MacDiarmid is known for this connectedness internationally,” says Dr Granville.

“The Government views international collaboration as a priority and the work we are doing with FLEET is a big part of that.”

As well as opening up opportunities for PhD and post-doctoral researchers to participate in projects and work at each others’ labs, the trans-Tasman research effort is already seeing papers submitted for review to peer-reviewed journals.

Left: Dr Simon Granville with FLEET colleagues Dr Julie Karel, Professor Michael Fuhrer (FLEET Director) and Dr Mark Edmonds.

**“This agreement formalises what is already a very fruitful relationship and shared goals between the Institute and FLEET.”**

FLEET DIRECTOR PROFESSOR MICHAEL FUHRER

That knowledge could inform advanced electronics design within the next decade.

Says Professor Governale: “We can probably answer some of these fundamental questions in the next four years.”

# Moiré patterns – not just pretty pictures

**The heat coming off your laptop or mobile phone represents a huge loss of electrical energy. A loss an energy-hungry, climate-challenged world can ill afford.**

Since the discovery of graphene in 2004, 2D materials have been a new frontier of physics. They are the thinnest materials possible, just a single layer of atoms in the case of graphene. This reduces the number of ways electrons can move around and allows greater control over them. Graphene is 2D carbon, arranged in a hexagonal fashion. This regular and hyper-stable crystal is one of the strongest materials known and a million times more electrically conductive than copper. The almost unbelievable promise for an infinite number of electronic applications was immediately apparent.

## Huge losses of electrical energy

One application relates to the device you are likely reading this on. The heat coming off your laptop or mobile phone represents a huge loss of electrical energy. A loss an energy-hungry, climate-challenged world can ill afford. Imagine if it could be reduced to near zero? Imagine a new generation of computers that did not require the high energy input and environmental cost of modern supercomputers? Thousands of scientists around the world have the bit between their teeth.

University of Canterbury Physics Professor and MacDiarmid Institute Principal Investigator, Simon Brown, has been experimenting with 2D materials for the last 15 years.

He is particularly interested in what happens when you superimpose one sheet of atoms onto another. The sheets may be composed of the same or different elements. He says that at the macro-human scale, this is like superimposing two sheets of chicken wire or garden mesh.

**"Think of the interference patterns created as you rotate one sheet of chicken wire relative to the other."**
PROFESSOR SIMON BROWN

Professor Brown explains, "Think of the interference patterns created as you rotate one sheet of chicken wire relative to the other, or when you look through one fence or grid at another fence. These are called moiré patterns, and have become a very 'big deal' in 2D science because they can be used to engineer a whole range of exotic physical effects. At the atomic level, these interference patterns are responsible for new kinds of superconductors and materials with completely new 'fractal' electronic properties. By that I mean that these properties are the same on different size scales."

**"At the atomic level, these interference patterns are responsible for new kinds of superconductors and materials."**
PROFESSOR SIMON BROWN

Professor Brown's PhD student, Maxime Le Ster, originally from Brittany, France, working with postdoc Tobias Maerkl, from Germany, have come up with a "simple equation" (it's actually seven interlinked equations(!) but they are implemented in straightforward matlab code) describing and predicting the wavelength of these interference patterns, that is the distance between the interference fringes, and their orientations. Says Professor Brown, "This will allow more systematic prediction and analysis of the physical properties of different elements and combinations. As the angle between the layers changes, the physical properties, like conductivity, can change dramatically.

## New electronic properties

"Our team has been experimenting with layers of bismuth and antimony, which are the world's worst metals in terms of conductivity, but which have electronic properties such as 'spin-orbit coupling' that lead to exotic topological effects. We evaporate the elements to coat a super-thin layer of them onto a graphite substrate.

"Techniques have moved on since Andre Geim and Konstantin Novoselov, who won the 2010 Nobel Prize for Physics, produced the first single-atom carbon layer by using a bit of adhesive tape to lift graphene flakes from graphite."

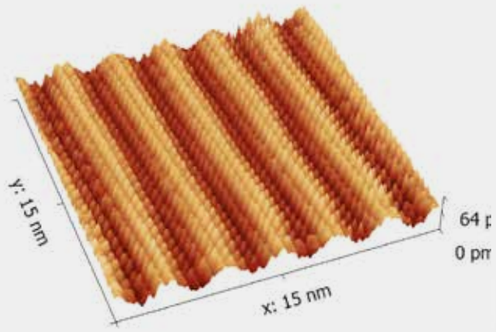
The results of Professor Brown and Mr Le Ster's work are not just pretty pictures, but hope for the future.

The paper on their powerful new equation, including new experimental observations, has just been published in the journal "2D Materials."[1]

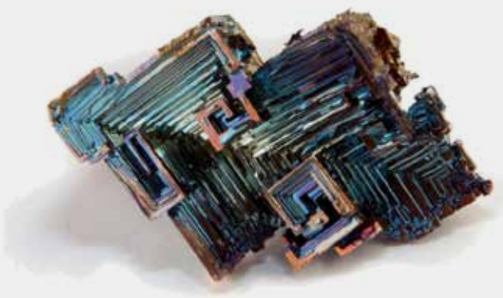
[1*] M. Le Ster, T. Maerkl, and S. A. Brown, 'Simple Analytical Model for Moire Patterns', 2D Materials 7, 011005 (2019).



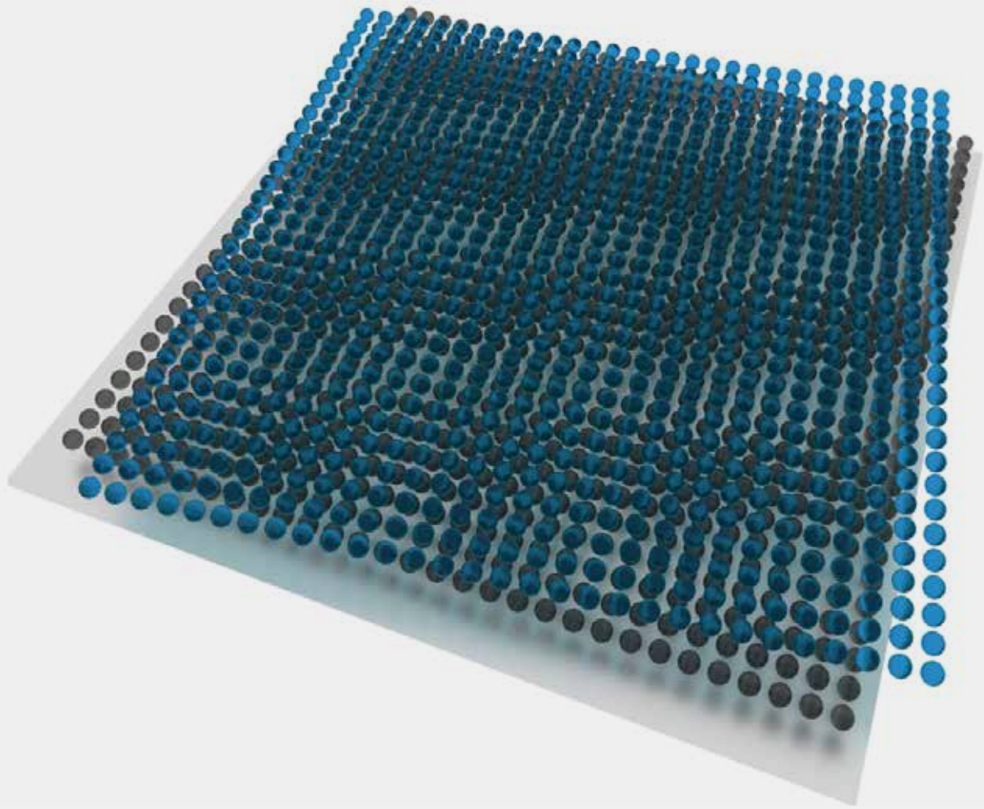





A 2D form of bismuth (each small 'blob' is a bismuth atom). This image was obtained with one of the most powerful microscopes available to solid-state physicists, a scanning tunnelling microscope. The corrugation in the image is a moiré pattern, caused by the superposition of two 2D materials, here bismuth and molybdenum disulfide ($MoS_2$). The width of the image here is about 10,000 times smaller than a strand of hair!



A 3D crystal of bismuth. The unusual shape of bismuth crystals is a consequence of their unique atomic structure and properties.



A model of a moiré pattern. When two 2D crystals (black and blue) are superposed, interference patterns occur, in turn changing the physical properties of the whole assembly.

# Taking essential metals into a zero-carbon future

## Steel and vanadium could be cleaned up thanks to our scientists

In today's urbanised world, steel is a ubiquitous material, used in everything from infrastructure like roads and railways, through to earthquake resilient buildings, wind turbines and electric vehicles. But making that steel comes with a significant environmental cost. In 2018, the IPCC reported that the global iron and steel industry was responsible for producing 2.6 Gt of carbon dioxide per year; that's 7% of the world's total $CO_2$ emissions.

### A new look at an old process

"The source of all this $CO_2$ is the chemical reduction of iron ore," says MacDiarmid Institute Associate Investigator, Dr Chris Bumby, from Victoria University of Wellington. "Modern ironmaking is an industry based on the incremental development of a 2000-year-old process." While our materials knowledge and process control have drastically improved since the Iron Age, the underlying chemistry has stayed largely the same. In all cases, the raw material, iron oxide, is combined with a carbon-rich fuel like coal in a furnace that runs at incredibly high temperatures. The coal reacts with the oxygen from the ore producing $CO_2$ and a liquid metal alloy known as pig iron – 95.5% iron and 4.5% carbon. The pig iron is then converted into high-strength steel by further processing, which removes almost all of the carbon.

Here in New Zealand, iron is produced from titanomagnetite ironsand – an unusual form of iron ore containing low levels of titanium oxide. This requires a slightly unusual ironmaking process (colloquially known as the 'NZ Steel process'), but the fundamental chemistry still depends totally on coal as the input reactant. Regardless of the route taken, all of this input carbon adds up – on average, the production of one tonne of steel emits 1.8 tonnes of $CO_2$.

**In 2018, the IPCC reported that the global iron and steel industry was responsible for producing 7% of the world's total $CO_2$ emissions.**

So, Dr Bumby and his colleagues at the Robinson Research Institute set out to find a new way to make iron, one that could eliminate the use of coal. It started back in 2014 through a collaboration with the University of Wollongong. Dr Bumby says, "The aim of that project was to use methane ($CH_4$) in the reduction of ironsand. But along the way, we switched to hydrogen, which took the carbon entirely out of the process." For the past 18 months, the VUW/Wollongong team (which includes on the Australian side, Professor Brian Monaghan and Dr Ray Longbottom) have been looking exclusively at hydrogen reduction of iron ores. "The results have been fantastic," he says. "We have an entirely new, zero-carbon way to make iron, and it works especially well for New Zealand ironsand." Their one-step process produces very high purity iron – up to 99.85% iron – in under 20 minutes. Dr Bumby continues, "For context, NZ Steel's equivalent process takes about 10.5 hours, and the product contains more than 4% carbon."

### NZ ironsand is unique

To make their iron, Dr Bumby uses a fluidised bed reactor. He explains, "It's effectively a tube containing ironsand sitting on top of a porous plug that allows us to push hydrogen gas through it." The unique chemical makeup of NZ ironsand has proved to be particularly helpful in this set up too. "As the reaction starts, we've found that the titanium content migrates out of the sand to form a very thin protective skin on the outside of each grain." As Dr Bumby reported in a recent paper, this stops the grains from sticking to one another, allowing for a faster reaction.

At the moment, this process has only been carried out at the laboratory scale, but that looks set to change. Dr Bumby and a trans-Tasman team of collaborators were recently awarded $6.5 million by the MBIE Endeavour programme. Spread over five years, this funding will allow them to scale-up production of their carbon-free iron from hundreds of grams to tens of kilograms and to extend their research to include another valuable component of NZ ironsand – vanadium.

"Vanadium is an exceptionally useful metal," says Dr Bumby, "it makes steel stronger so is used in lightweight alloys. It's

also the basis of the vanadium redox battery, widely regarded as the best energy storage solution for electricity grids. And it's expensive; in the range of $50k per tonne. So even though ironsand contains less than 1% vanadium, it's still an incredibly valuable resource. We want to find cleaner, more efficient ways to extract it from the ore."

**"As a country, if we're serious about becoming a zero carbon economy, then we need to look very seriously at how we will decarbonise our domestic steel industry."**
DR CHRIS BUMBY

### Collaborating across four institutions within the MacDiarmid umbrella

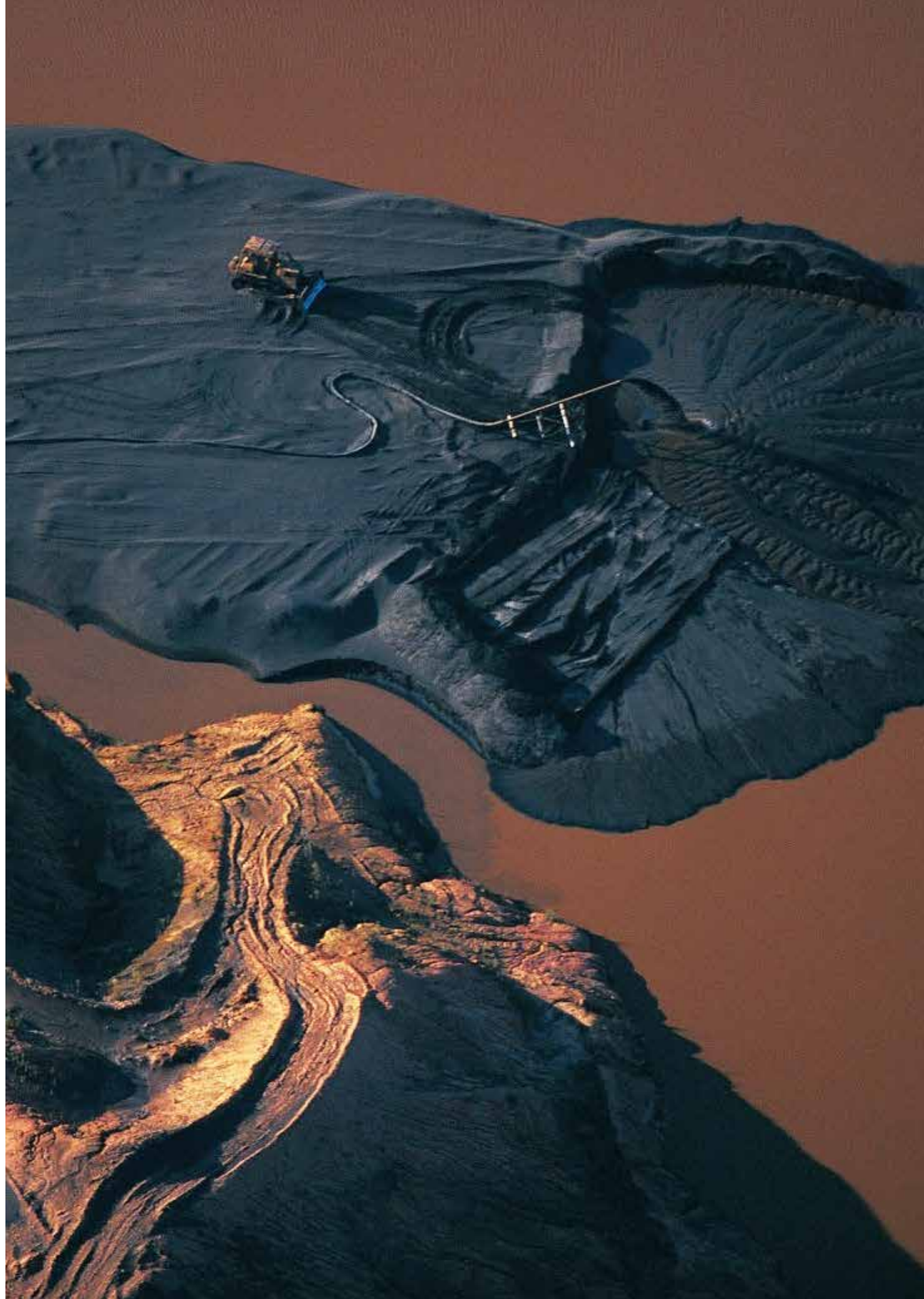
Leading this part of the work are two other members of the MacDiarmid Institute – Associate Professor Aaron Marshall (Associate Investigator, University of Canterbury) and Professor Jim Johnston (Emeritus Investigator, Victoria University of Wellington). They will be taking a new approach to vanadium extraction, "one that is much more careful about waste streams than today's processes," says Dr Bumby.

Another key figure in the project is MacDiarmid Institute Principal Investigator, Dr John Kennedy, from GNS, who will develop specialised microwave heaters for the new ironsand reactor.

"Ironsand absorbs microwave radiation really well," explains Dr Bumby. "It experiences a combination of magnetic and electronic heating that will let us reach much higher temperatures, making the whole reaction faster and more efficient."

New Zealand's relatively green electricity grid provides another opportunity for the team – the hydrogen gas so central to their work could be generated using renewable energy. "We're in discussions with electricity providers at the moment and we're optimistic about the economics stacking up," Dr Bumby says. "We have to look at the big picture. Demand for steel is growing all the time, and importing it will simply result in more $CO_2$ entering the atmosphere from overseas factories. So, as a country, if we're serious about becoming a zero-carbon economy, then we need to look very seriously at how we will decarbonise our domestic steel industry."

**"We're in discussions with electricity providers at the moment, and we're optimistic about the economics stacking up."**
DR CHRIS BUMBY



# Fuelling NZ's future with smart catalysts

## New collaboration combines chemistry and engineering

In February of this year, a group of leading scientists and engineers from the US, Spain, Switzerland, Canada and New Zealand gathered at the University of Otago. They had been invited there by MacDiarmid Institute Principal Investigator and University of Otago Professor, Sally Brooker, to talk about future 'green' fuels. Timed to precede AMN9 (see page 62), the inaugural Otago Future Fuels (OFF) workshop featured expert tutorials, student talks and poster sessions. "It was designed primarily as a training programme for postgrads working in this area," says Professor Brooker. "Students met with, and learnt from, an amazing group of international superstars. And it also gave staff like me the opportunity to hear about their latest research." The event was such a success that Professor Brooker will run another one (OFF-2) to tie in with AMN10.

### Combining chemistry and engineering

One of the speakers at OFF was another member of the MacDiarmid Institute, Associate Professor Aaron Marshall, from the University of Canterbury. He is an engineer whose research centres on materials development for a range of energy applications and like Professor Brooker, he's fascinated by catalysts. The pair met two years ago at a MacDiarmid Institute event, and after hearing about his work, Professor Brooker invited Associate Professor Marshall to give a departmental seminar.

"I was just so impressed," she says. "Not only by what Aaron was doing, but also his ability to communicate engineering to a chemistry audience. That visit also enabled us to have some key conversations, and cemented the idea in both our minds that if we combined our efforts, we could achieve something really exciting."

> **"Students met with, and learnt from, an amazing group of international superstars."**
> PROFESSOR SALLY BROOKER

Since then, they've been busy building a collaboration that combines their skills in synthetic chemistry and materials engineering. PhD students and postgrads from each group are starting to work together, and despite having offers from overseas, Professor Brooker chose to stay in NZ for her 2019 sabbatical so she could be based at the University of Canterbury with Associate Professor Marshall.

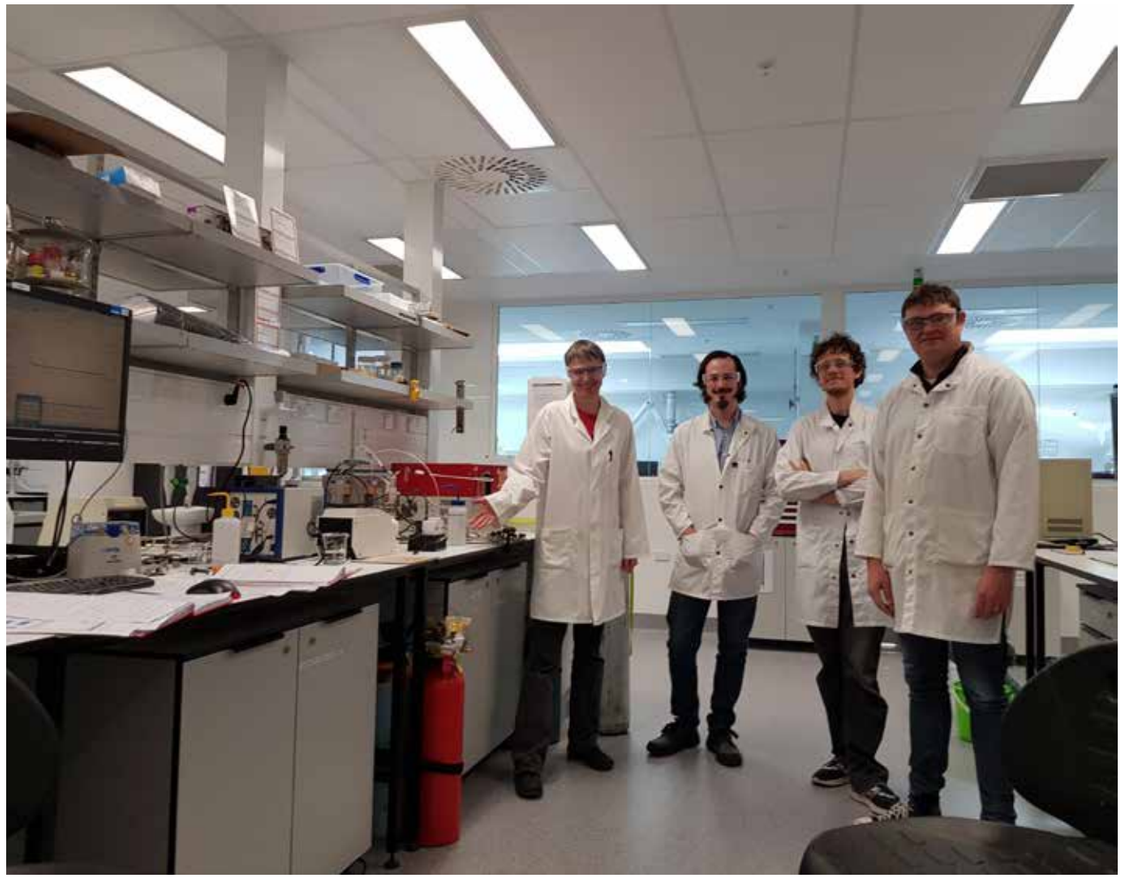
### Designing fuels less harmful to the environment

Their goal is to design a new generation of catalysts that could make tomorrow's fuels less harmful to the environment. One topic they're exploring is extracting hydrogen gas from water. As well as being an area of shared expertise, it also forms the basis of another of Professor Brooker's key collaborations – with Professor Garry Hanan at the University of Montreal. "Garry and I published a paper on the performance of some cobalt compounds – we made the catalysts here at Otago, and Garry tested them under photocatalytic conditions in his lab. They worked very well." Professor Brooker continues, "And now, by working with Aaron, we'll be able to explore how those compounds perform in an electrocatalytic set-up." Thanks to a Catalyst seed grant with Professor Hanan, Professor Brooker is also bringing new, hands-on knowledge to NZ. "Two of my PhD students, Abdullah and Fola, have spent extended periods in Montreal, learning how Garry's photocatalytic system works and collecting lots of data on our complexes. Rather than starting to build up a system like Garry's from scratch in Dunedin, the plan is to modify the system Aaron has to enable it to do photocatalytic testing too."

### $CO_2$ to fuel

Alongside their hydrogen work, Professor Brooker and Associate Professor Marshall will also develop catalysts for the production of commodity chemicals from carbon dioxide. "I think this is where we could potentially add the greatest value," she says, "There's a selectivity challenge with $CO_2$ reduction because of the vast number of potential products. As molecular chemists, we can help meet that challenge and potentially find a way to turn $CO_2$ into a liquid fuel, like methanol."

Both hydrogen generation and $CO_2$ reduction are of growing importance to the NZ energy landscape. In Taranaki, Hiringa Energy is working to generate hydrogen fuel for the heavy transport sector using wind power. And the nearby Methanex plant generates 2.4 million tonnes of methanol a year. So, supported



**“As molecular chemists, we can help meet that challenge and potentially find a way to turn $CO_2$ into a liquid fuel, like methanol.”**

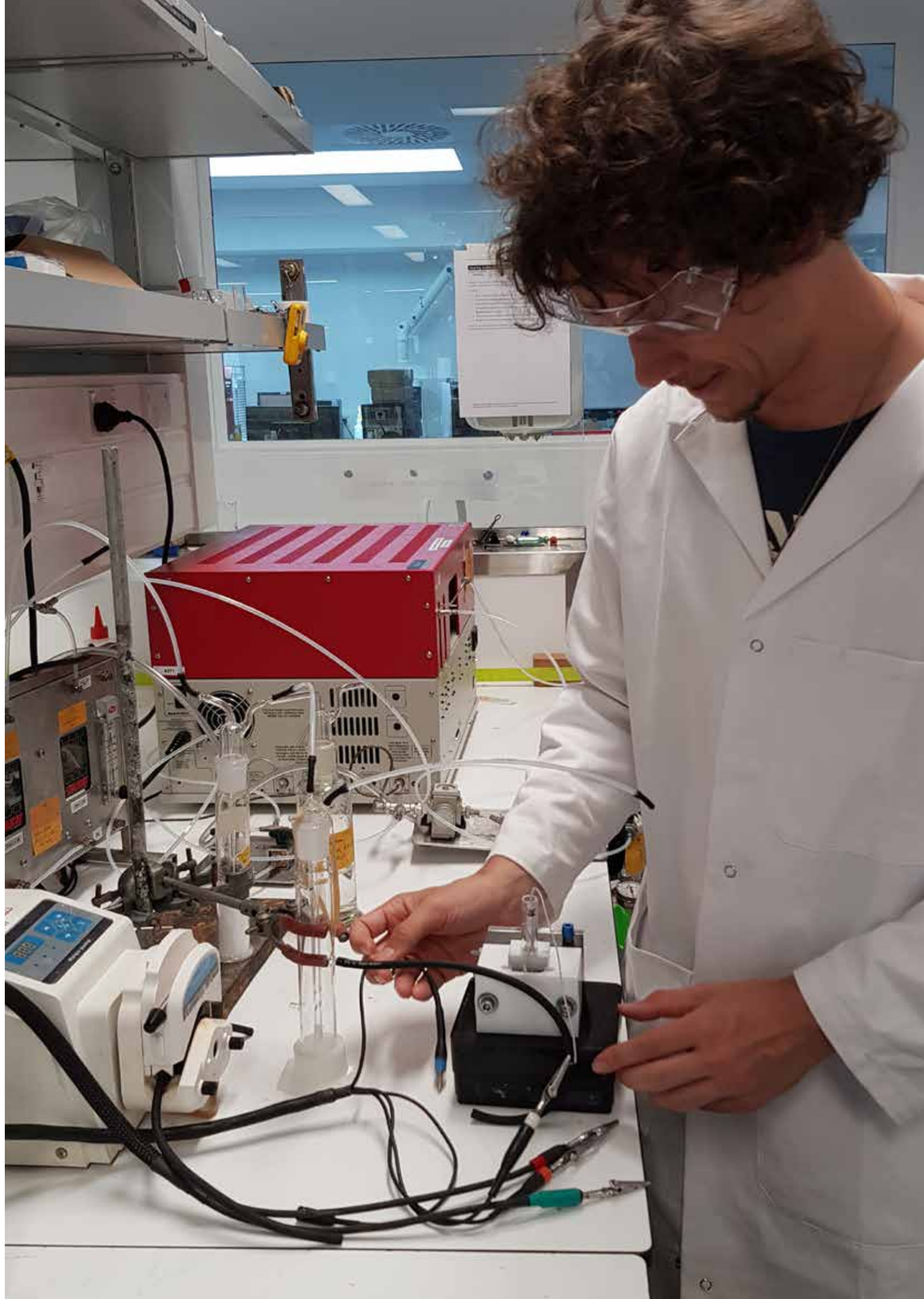
PROFESSOR SALLY BROOKER

by the MacDiarmid Institute, Professor Brooker and Associate Professor Marshall recently visited the region, to explore the potential industrial implications of their work. Professor Brooker says that she found the meetings with the team at Venture Taranaki to be “... really invigorating. They have such a positive can-do attitude, and they’re pushing to build this much greener future. It’s exciting.” She plans to stay in close contact, and Hiringa Energy have agreed to be part of her advisory board on grant applications. But, Professor Brooker says, they’re not thinking too far ahead just yet.

“In catalysis, you can get things badly wrong if you’re not careful, so we’re taking the time to set all this up and test our protocols properly. We want to build a robust and reliable testing system. That way, when we have our ‘eureka’ moment, we can really enjoy it.

“Growing up on a farm, I’ve always loved nature and been very keen on doing things to help the planet. If we can make catalysts that can genuinely contribute to either carbon zero fuels like hydrogen, or carbon neutral fuels like methanol, then I’ll be very happy.”





# Building better bioelectronics

## Conducting polymers could help probe the secrets of cell biology

Materials science happens at the surfaces and interfaces of materials, and at the interface between disciplines. For MacDiarmid Institute Principal Investigator, Professor Jadranka Travas-Sejdic, that interface is also where some of the biggest challenges – and most exciting research opportunities – can be found. Professor Travas-Sejdic's work at the University of Auckland focuses on what she calls the "fascinating interplay between biology and human-made electronics." Although her research encompasses a range of topics, one unifying theme is the use of conducting polymers. "These polymers have a remarkable combination of properties – they're electrically conductive, biocompatible, and flexible," explains Professor Travas-Sejdic. "They're very promising for a number of health and bioelectronics applications. And we've shown that it's possible to add other functions to them, through chemical synthesis."

### Alleviating mechanical mismatch

The functionalisation of conductive polymers is the subject of Professor Travas-Sejdic's Marsden project, carried out in collaboration with her colleague at both the University of Auckland and the MacDiarmid Institute, Professor David Barker. "One big challenge with conducting polymers is that in general, they're brittle and hard to process," says Professor Travas-Sejdic. "So David and I have taken a biomimetic approach, using 'side-chain engineering'. This allows us to alleviate the issues of mechanical mismatch, as well as tuning the other properties of the polymers." As a result, they've managed to create electrically-conductive materials that can bend, stretch and self-heal, making them suitable for use in a host of sensors and other biocompatible devices.

The same synthetic platform, which Professor Travas-Sejdic describes as looking "a bit like a bottle brush", goes beyond bioelectronics, and has been used to produce everything, from photoluminescent plastics, to stretchable strain sensors. Professor Travas-Sejdic is also looking to extend the work in collaboration with MacDiarmid Institute Associate investigator, Dr Viji Sarojini. "Viji has expertise in synthesising antimicrobial peptides," she says, "so we're hoping to develop antimicrobial conductive hydrogels that could help in wound healing, or even neuron repair."

### Simpler, faster molecular diagnostics

Another use of the platform has been to create conductive substrates that encourage cell adhesion, "...biointerfaces that can be switched on and off in response to external changes." This complements another area of research that Professor Travas-Sejdic had previously undertaken. Working with research groups in UCLA, Harvard and South Korea, she developed electrospun porous substrates that act as a test-bed for electrically-responsive cells, such as those found in the heart and nervous system. "We realised that if we could functionalise those substrates by adding biological recognition probes, we could produce a filter to selectively capture biological targets," she says. So in 2017, Professor Travas-Sejdic and Professor Barker, together with Auckland biologist Dr Clive Evans and MacDiarmid Institute Emeritus Investigator, Professor David Williams, successfully applied for funding from the MBIE Endeavour programme.

**Probing cells in 3D, literally adding another dimension to our understanding of the cell environment**

"Our goal is to develop a simpler, cheaper and faster way to carry out molecular diagnostics so we've been working closely with colleagues in the School of Medicine," explains Professor Travas-Sejdic. "The substrate that we've now made can rapidly pick out specific target molecules and because it is conductive, we can use electrochemistry to extract those molecules for analysis." In principle, the 'capture' stage could be as simple as pouring complex fluids through the filter. The 'release' step would involve adding the filter to a clean buffer and applying a voltage. "It could be just as easily applied in the field as in the lab," says Professor Travas-Sejdic. She is keen to develop this idea further, and is in discussion with patenting experts at the University of Auckland. She says, "We have demonstrated the proof-of-principle, so we know it works. The next stage will be to extend it to other targets, and to test how it performs with complex samples like blood or plasma."



MacDiarmid Institute
Annual Report
2019

### Electrically stimulating the growth of neural stem cells

For Professor Travas-Sejdic, developing novel materials is only part of the challenge. "I'm also really interested in new, effective fabrication techniques." Over the course of several years, Professor Travas-Sejdic and MacDiarmid Institute-funded PhD students Peikai Zhang and Cosmin Laslau, developed one such system – a micro-extrusion printer that can create arrays of 3D pillars, made from her conducting polymers (CP). She explains, "The printing principle is simple; we extrude CP ink from a micro-pipette to form these high aspect ratio microelectrodes; but altogether, it's very complex, so our lab is the only one that does it that way." Professor Travas-Sejdic's arrays offer a potential route to probing cells in 3D, literally adding another dimension to our understanding of the cell environment. One application of this platform is in electrically stimulating neural stem cells, a project that Professor Travas-Sejdic is working on in collaboration with the University of Wollongong. "Jeremy (Crook) and Eva (Tomaskovic-Crook) used their facilities for cell culturing to grow stem cells onto our microelectrode arrays, and to test how they responded to drug compounds," says Professor Travas-Sejdic. "We're now in conversation with Professor Michael Dragunow from Auckland Medical School and Brain Research NZ. We'd like to see if our platform could also be useful in the study of mature human neurons that come from patients."

**In 2019, Professor Travas-Sejdic became only the fifth woman to be awarded the prestigious Hector Medal, an award previously won by the great Ernest Rutherford**

The scope of Professor Travas-Sejdic's research and its remarkable, world-leading impact was recently recognised by the Royal Society Te Apārangi. In 2019, she became only the fifth woman to be awarded the prestigious Hector Medal, an award previously won by the great Ernest Rutherford.

# Researcher profiles

## James Storey

**Heading away to study, returning home to live**

Dr James Storey is an Associate Investigator at the MacDiarmid Institute, and a Senior Scientist at the Robinson Research Institute. After completing his PhD under Professor Jeff Tallon at Victoria University of Wellington in 2007, James headed to Cambridge University as a postdoctoral researcher. He says the experience was incredible but that after four years he knew he wanted to come home.

"I knew that by coming back to New Zealand I could have the lifestyle I wanted, near my family, as well as the ability to conduct world-class research. I'm quoting Paul Callaghan word for word here, but New Zealand really is a place talent wants to live."

**"I'm quoting Paul Callaghan word for word here, but New Zealand really is a place talent wants to live."**

Dr Storey joined the MacDiarmid Institute on his return to Wellington; he was already exposed to the networking and support crucial to him completing his PhD all those years ago. Now mentoring PhD student Thomas Knott, along with MacDiarmid researcher Dr John Kennedy, he encourages his PhD students to make the most of the all the Institute has to offer.

"There are lots of good connections for students working in the field of advanced materials. It adds a big value to the PhD experience."

Since becoming an Associate Investigator, Dr Storey's research has evolved. He began looking into fundamental high-temperature superconductors and over the last four years has migrated to applied research. His main project, funded under the MBIE Endeavour Fund, has his team focused on developing a prototype aircraft motor, specifically working on a levitation bearing programme using superconductors and theoretical modeling. His group of researchers at the Robinson Research Institute is small, and his work niche, but he says being part of the MacDiarmid Institute allows all researchers in the relevant field to pull on their resources together in one place.

"There have been so many collaborative opportunities as a result of being part of the MacDiarmid."

Dr Storey has been appointed leader of the Tomorrow's Electronic Devices (TED) theme.



MacDiarmid Institute
Annual Report
2019

## Krista Steenbergen

**Growing up in the MacDiarmid Institute**

New Associate Investigator, Dr Krista Steenbergen, has a long history with the MacDiarmid Institute. On arriving in New Zealand from the United States in 2009, she became the now Co-Director, Associate Professor Nicola Gaston's, first PhD student.

Dr Steenbergen loves outreach and engagement, such as being part of a panel on *Women in Science* during TechWeek. She says she loved speaking to girls at an age where they were making decisions about their future.

"Having part of the Institute dedicated to outreach and community makes it easy and fun to be part of events like this. I definitely want to do more in the future."

**"Everyone pays attention to each other's research. There's really nowhere else like it."**

**"It was a magnificent environment to grow up in as a PhD student."**

Despite taking up postdoctoral research positions in Berlin and Kansas, the collaborative community she has found herself within the MacDiarmid Institute is unlike anything she has witnessed worldwide.

"Everyone pays attention to each other's research. There's really nowhere else like it."

# Researcher profiles

## Jack Chen

**Meeting the right people**

For Dr Jack Chen, becoming an Associate Investigator with the MacDiarmid Institute this year has, he says, given him introductions to and connections with senior researchers he would likely otherwise not have met.

"As an early career researcher, one of the hardest things is meeting the right people. The most important NZ scientists in my field are here in the MacDiarmid, so getting to present my work to them at theme meetings, and working together on ideas for the rebid has been a great way to interact with them. It's such a collaborative environment. Elements of my ideas even made it into the rebid as one of the projects – so that's been very exciting."

**"The most important NZ scientists in my field are here in the MacDiarmid Institute, so getting to present my work to them and working together on ideas has been a great way to interact with them. It's such a collaborative environment."**

Dr Chen, who is a Senior Lecturer in Chemistry at Auckland University of Technology, is making catalysts that reversibly self-assemble using hydrophobic interactions – allowing the creation of stimulus-responsive systems.

"We recently added a light-responsive functional group to the hydrophobic part of the surfactant – so we're now able to use light to activate and deactivate the catalytic system. This has applications in smart materials, computing and molecular level intelligent chemical networks."

He says being in the Institute is a real drawcard for students. "The students get to come to Institute symposia and meet their peers from up and down the country – I can see how much fun they have – and these are their future research peers, so they're building great connections early."



MacDiarmid Institute
Annual Report
2019

## Nate Davis

**Heading back to a smaller pond**

Not many researchers moving from Cambridge University in the UK, to a smaller university in New Zealand, would be as excited about the move as MacDiarmid Institute Associate Investigator Dr Nate Davis is.

"Being here in NZ is actually amazing. I have been given such a great opportunity to grow and make a name for myself. New Zealand is a great place for this. I have learnt a lot from the University research department about writing grants which is essential to getting funding and growing your group. And being part of the MacDiarmid Institute has greatly increased my connections though NZ." He says NZ is a great place for younger researchers.

"It's a smaller pond, so you can grow and be fostered by organisations like the MacDiarmid Institute, and by the policies and government support for renewable technologies."

**"It's a smaller pond, so you can grow and be fostered by organisations like the MacDiarmid Institute and by the policies and government support for renewable technologies."**

Dr Davis says being a younger researcher comes with its challenges though; workload being one of them.

"I review for about nine journals, and also teach, write grants and still get publications out; ideally more and more each year to show growth. It seems like some of those things get simplified when you're a bigger name. You've taught the same course for years so it's less time input - students come to you; you have established funds and connections etc."

**More complicated than just chemistry**

He says the job of an academic is a lot more complicated than just chemistry. "It's like running a small company - securing finances, hiring students and delivering output to get more funding, all on top of teaching. MacDiarmid really helps with networking, exposure, students resources, guidance and collaborations."

Dr Davis has had a fair amount of success this year in funding rounds – $1.5 million – so what does this mean for him and his research?

"In simple terms it means I can afford to expand my lab to four PhD students and one postdoc over three years. I will have enough people in the right place to really start to do a nice bit of science which can then link with the wider NZ network through the MacDiarmid to form collaborations and future projects. This will give me a cohesive research group and subsequent research outputs that will place me in a great position for the next stage of my career."

# New Associate Investigators 2019

**Dr Ebubekir (Ebu) Avci** is a Lecturer in Mechatronics in the School of Food and Advanced Technology at Massey University. His research interests include nano-scale robots for molecule analysis, micro-scale robots for cell manipulation, and millimeter-scale robots for GI Tract analysis. In addition, he is interested in micro-nano manufacturing to develop novel smart mechanisms.

**Dr Marcus Jones** is a Senior Lecturer in Chemistry at the Auckland University of Technology. He is interested in the ways that nanoparticles interact with light: how they absorb light, emit light, and convert its energy into different forms. He aims to develop new ways to harvest photons for solar energy and enhance fluorescence for displays and biosensing applications.

**Associate Professor Peng Cao** teaches in the school of Chemical and Materials Engineering at the University of Auckland. His research is primarily focused on developing novel materials for energy-storage and light-while-strong materials for sustainability. Funded by Science for Technological Innovation (SfTI), Dr Cao's team is developing, for lithium-ion battery applications, self-healing silicon-based anode materials, which have shown significant improvement in energy capacity.

**Dr Vedran Jovic** is a Research Development Scientist in Energy Conversion Systems at GNS Science. His current work involves the development of materials and processes for electrocatalytic $H_2$ production and for conversion of carbon emissions to higher value chemicals. Much of his work involves fundamental synchrotron studies of the materials electronic band structure.

**Dr Jack Chen** is a Senior Lecturer in Chemistry at the Auckland University of Technology. His research group is interested in the way nanoparticles and molecules self-organise into functional architectures. He is also leading a project into sustainable chemistry in water catalysed by multi-functional gold nanoparticles.

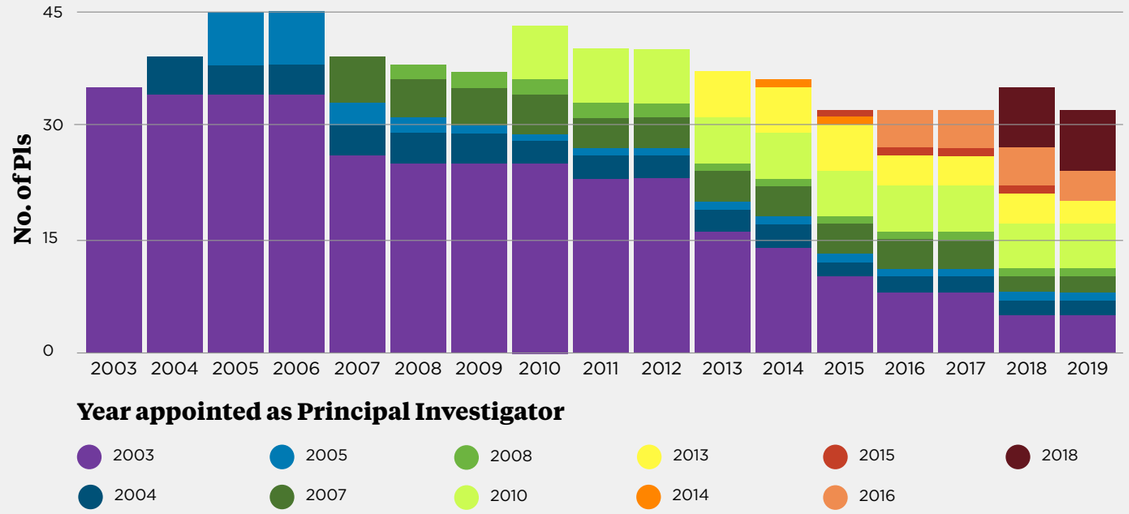
**Dr Nathaniel (Nate) Davis** is a Lecturer in the School of Chemical and Physical Sciences at Victoria University of Wellington and AI of the Dodd Walls Centre for Photonic and Quantum Technologies. He works on the synthesis of different nanomaterials (organic/inorganic) for optoelectronic applications such as photovoltaics, light emitting diodes and luminescence solar concentrators.

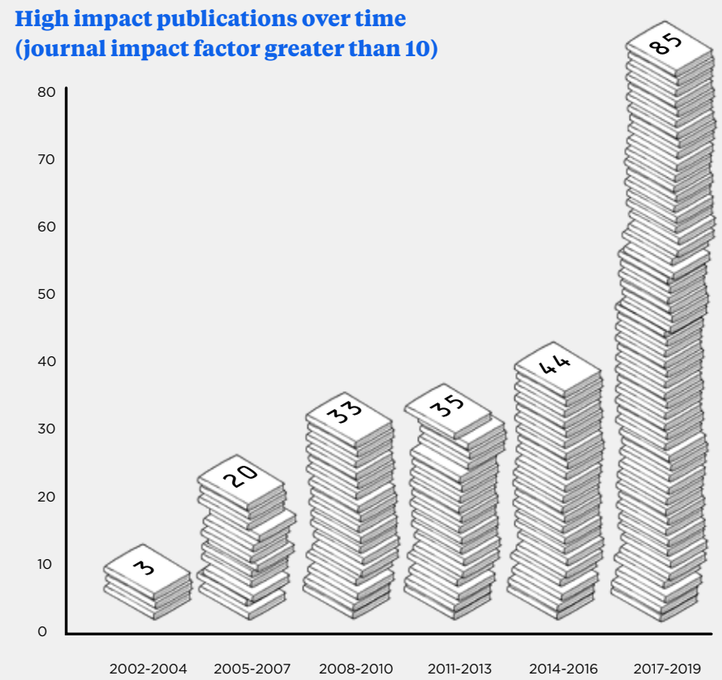
**Dr Eva Anton** is a Postdoctoral Research Fellow at the School of Chemical and Physical Sciences at Victoria University of Wellington. Her research is on magnetic materials and memory devices for superconducting computers. Dr Anton's research aims to develop computer memories that operate at the ultra-low temperatures required by more energy efficient, fast superconducting computers to pave the way for a sustainable growth of our digital resources.

**Dr Krista Steenbergen** is a Physics Lecturer in the School of Chemical and Physical Sciences at Victoria University of Wellington. Her research is focused on using and developing computational methods to characterise material properties. She is particularly interested in how materials properties change at the nanoscale. Dr Steenbergen's long-term research is focused on discovery and characterisation of materials with application to renewable energy, battery and sensing technologies.



# The changing face of the MacDiarmid Institute



# Awards successes

## Royal Society Honours Awards

| | |
|---|---|
| **Don Cleland**<br>Massey University | Scott Medal |
| **Keith Gordon**<br>University of Otago | MacDiarmid Medal |
| **Cather Simpson**<br>University of Auckland | Pickering Medal |
| **Jadranka Travas-Sejdic**<br>University of Auckland | Hector Medal |

## Kiwinet Awards

| | |
|---|---|
| **Margaret Brimble**<br>University of Auckland and SapVax | BNZ Supreme Award |
| | Baldwins Researchers Entrepreneur Award |
| **Will Charles**<br>Auckland UniServices & University of Auckland | MinterEllisonRuddWatts Commercialisation Professional Award |
| **Shalen Kumar**<br>AuramerBio/Victoria University of Wellington | Norman Barry Foundation Breakthrough Innovator Award |



MacDiarmid Institute
Annual Report
2019

## Awards - Other

| | |
|---|---|
| **Margaret Brimble**<br>University of Auckland | Inducted into the American Chemical Society Medicinal Chemistry Division Hall of Fame |
| | Zonta Centenary Women of Achievement Awards |
| | Sosnovsky Distinguished Lecturer - University of Wisconsin, Milwaukee, USA |
| | Dewar Lectureship - Queen Mary University, London, UK |
| **Sally Brooker**<br>University of Otago | Sesquicentennial Distingushed Chair at the University of Otago |
| | Inaugural Sesquicentennial Distinguished Professor at the University of Otago |
| **Will Charles**<br>University of Auckland UniServices | MinterEllisonRuddWatts Commercialisation Professional Award - KiwiNet Research Commercialisation Awards 2019 |
| **Don Cleland**<br>Massey University | Scott Medal – The Royal Society Te Apārangi Research Honours 2019 |
| **Anna Garden**<br>University of Otago | Early Career Award for Distinction in Research |
| **Keith Gordon**<br>University of Otago | Royal Society of Chemistry Australiasian Lectureship |
| **Justin Hodgkiss**<br>Victoria University of Wellington | 2019 Maurice Wilkins Centre Prize for Chemical Science – New Zealand Institute of Chemistry |
| **Franck Natali**<br>Victoria University of Wellington | Postgraduate Supervisor Award at the Victoria University of Wellington Postgraduate Research Excellence Awards |
| **Krista Steenbergen**<br>Victoria University of Wellington | NeSI Merit Award, 1 million CPU-hours (NeSI core-hour allocation for supercomputer time) |
| **Jadranka Travas-Sejdic**<br>University of Auckland | Fellow of the Scientific Council for Oil and Petrochemical Economy and Energy of the Croatian Academy of Science and Art, Petrochemical Section, Croatian Academy of Sciences and Arts |
| **Geoff Waterhouse**<br>University of Auckland | Web of Science Group 2019 Highly Cited Researcher |
| **Stuart Wimbush**<br>Victoria University of Wellington | Fellowship of the UK Institute of Physics (FInstP) |

# Funding successes

## 2019 Marsden Grants

| | |
|---|---|
| **Margaret Brimble**<br>University of Auckland | Unleashing new generation lanthipeptides from nature to combat antimicrobial resistance |
| **Shen Chong with Grant Williams and Jeff Tallon**<br>Victoria University of Wellington | Next generation magneto-piezochromic composites for optically based intelligent magnetic field sensing |
| **Matthew Cowan with Paul Kruger**<br>University of Canterbury | Engineering defect-free organic framework membranes in tubular ceramic supports |
| **Nate Davis**<br>Victoria University of Wellington | Photon multiplying light harvesting antenna systems for luminescent solar concentrators |
| **Renwick Dobson**<br>University of Canterbury | Understanding bacterial membrane transport protein: setting an antimicrobial TRAP |
| **Keith Gordon***<br>University of Otago | Development and assessment of a multi-spectroscopic fiber optic probe capable of disease diagnosis in the gastro-intestinal tract |
| **Justin Hodgkiss**<br>Victoria University of Wellington | Can enhanced exciton diffusion propel organic photovoltaic cells beyond the bulk heterojunction? |
| **Eric Le Ru***<br>Victoria University of Wellington | Could airborne microplastics play a role in climate change? |
| **Shane Telfer**<br>Massey University | Reinventing asymmetric catalysts using multicomponent frameworks |
| **Grant Williams**<br>Victoria University of Wellington | Controlled magnetic heterogeneity |

*Contributing as an AI

## 2019 MBIE Funding

### Research programmes

| | |
|---|---|
| **Margaret Brimble**<br>University of Auckland | • New Frontiers in Antiviral Development<br>• Novel Boron Carriers for Boron Neutron Capture Therapy, a Non-invasive Cancer Treatment<br>• Precision Antimicrobials: Targeted Therapeutics for Food and Companion Animal Infections |
| **Chris Bumby, Aaron Marshall and John Kennedy** – Victoria University of Wellington, University of Canterbury and GNS | Zero-$CO_2$ production of essential technological metals |
| **Petrik Galvosas**<br>Victoria University of Wellington | 3-D printed porous media for process engineering |
| **Joe Trodahl**<br>Victoria University of Wellington | Magnetic memory for superconducting computing |
| **Stuart Wimbush**<br>Victoria University of Wellington | Thermal management of cryogenic superconducting magnets in small satellites |

### Smart Ideas

| | |
|---|---|
| **Nate Davis**<br>Victoria University of Wellington | Non-toxic hybrid nanomaterials for luminescent solar concentrators |
| **John Kennedy and Geoff Waterhouse**<br>GNS and the University of Auckland | Nano-catalytic surfaces for efficient, stable fuel cells and eco-friendly hydrogen production |
| **Cather Simpson and Michel Niewoudt**<br>University of Auckland | Drinking-water pathogen monitoring in real-time |
| **Volker Nock** – University of Canterbury | Development of a multi-axis spin-coating system to coat curved surfaces |





### Catalyst

| | |
|---|---|
| **James Storey and Ben Mallett**<br>Victoria University of Wellington and University of Auckland | Superspin – using polarised spins and spin correlations to probe the enigmatic electronic phase behaviour of high-temperature superconductors |
| **Charles Unsworth**<br>University of Auckland | Small Brain Cancer Networks on Chip |

## Fellowships

| | |
|---|---|
| **Volker Nock**<br>(Rutherford Discovery Fellowship)<br>University of Canterbury | Electrotaxis and protrusive force generation in fungal and oomycete pathogens - Pathways to new biocontrol strategies |

## 2019 NSC (National Science Challenge) Grants

| | |
|---|---|
| **Jack Chen**<br>Auckland University of Technology | Cellulose-based surfactants: Enhancing manufacturing and product performance with minimal of Technology environmental impact |
| **Nate Davis**<br>Victoria University of Wellington | Hybrid organic/inorganic nanoparticles for luminescent solar concentrators |
| **Laura Domigan**<br>University of Auckland | Science for Technological Innovation - 4D printing |
| **Simon Granville and Ben Ruck**<br>Victoria University of Wellington | A new transistor exploiting electron spin |
| **Volker Nock**<br>University of Canterbury | SfTI Medical Devices spearhead Tranche 2 |
| **Emilia Nowak**<br>Massey University | Development of an innovative multidimensional manufacturing and intelligent fluid management |

## 2019 HRC (Health Research Council) Grants

| | |
|---|---|
| **Geoff Jameson**<br>Massey University | Transforming the paradigm of functional genome organisation |
| **Jadranka Travas-Sejdic**<br>University of Auckland | A novel device for early cancer detection |

## 2019 KiwiNet Funding

| | |
|---|---|
| **Geoff Jameson**<br>Massey University | Novel inhibitors of cytidine deaminase |
| **Aaron Marshall**<br>University of Canterbury | Recovery and treatment of spent acid from galvanizing plants |
| **Franck Natali**<br>Victoria University of Wellington | Ammonia Production Catalyst |

## 2019 Domestic Grants – Government Funding

| | |
|---|---|
| **David Barker**<br>University of Auckland | Molecular Sponges - MPI - Primary Growth Partnership with NZ Winegrowers |
| **Laura Domigan**<br>University of Auckland | Lens protein biomaterials for ocular surgery - MBIE Pre-Seed Accelerator Fund and Royal Society |
| **Volker Nock**<br>University of Canterbury | Photonic Professional GT2 - Lottery Health Equipment Grant and UC Equipment Grant Nanoscribe |

## 2019 Domestic Grants – Other

| | |
|---|---|
| **David Barker**<br>University of Auckland | Senzatek synthesis contract |
| **Margaret Brimble**<br>University of Auckland | • PD Derivatives 2019<br>• PGGRC Inhibitor programme<br>• Drug Development CGRP<br>• Lipidated Pramlintide Pramlintide<br>• AMR Flagship - (3.3) Overcoming antimicrobial resistance<br>• New Toxins for Antibody-Drug Conjugates |
| **Chris Bumby**<br>Victoria University of Wellington | Experimental development of chemical production processes (Confidential) |
| **Jack Chen**<br>Auckland University of Technology | Tackling the antibiotic resistance crisis - Maurice and Phyllis Paykel Trust |
| **Aaron Marshall**<br>University of Canterbury | • Carbon Analysis<br>• Battery analysis<br>• Polymer/corrosion analysis |
| **Michel Nieuwoudt**<br>University of Auckland | Consultant analytical Raman spectroscopist for Orbis Diagnostics Limited |

## International – 2019 Public Sector Funding

| | |
|---|---|
| **Martin Allen**<br>University of Canterbury | Controlling the surface chemistry and surface electronic properties of Î²-Ga2O3 for high-efficiency power electronic devices - Australian Synchrotron Beamtime |
| **Margaret Brimble**<br>University of Auckland | Diabetic Cardiomyopathy – New Molecular Intervention Targets and a Biomarker Strategy |
| **Jack Chen**<br>Auckland University of Technology | Dynamics of structure formation in stimuli-responsive amphiphilic catalysts - ACNS Neutron Beam Instrument Proposal, Australia |
| **Anna Garden**<br>University of Otago | Artificial nitrogen fixation at ambient conditions through rational catalyst design |
| **Ben Mallett**<br>University of Auckland | • What is the Magnetic Ordering in Cuprate-Manganite Multilayer Sandwiches? A Polarized Neutron Reflectometry and Elastic Neutron Scattering Study (Part II) - ANSTO Neutron Beamtime<br>• Interfacial Orbital Order in Cuprate-Manganite Multilayer Thin Film Sandwiches - Australian Synchrotron Beamtime |
| **Elke Pahl**<br>University of Auckland | Atoms and Molecules in Extreme Environments - Centre for Advanced Study, Oslo, Norway |
| **Geoff Waterhouse**<br>University of Auckland | • Renewable Energy Technologies - Shandong Provincial Distinguished Foreign Expert Award<br>• Chair Professorship in School of Materials Science and Engineering at the South China University of Technology (SCUT) |

## International – 2019 Private Sector Funding

| | |
|---|---|
| **Margaret Brimble**<br>University of Auckland | • Synthesis of hPam2 Adjuvants<br>• Synthesis of SapVax hPam2 Adjuvants Sep 2019<br>• Asymmetric Synthesis of SFN876-3 |
| **Petrik Galvosas**<br>Victoria University of Wellington | NMR based mass flowmeter (ECS led) |

## 2019 University Internal Funding

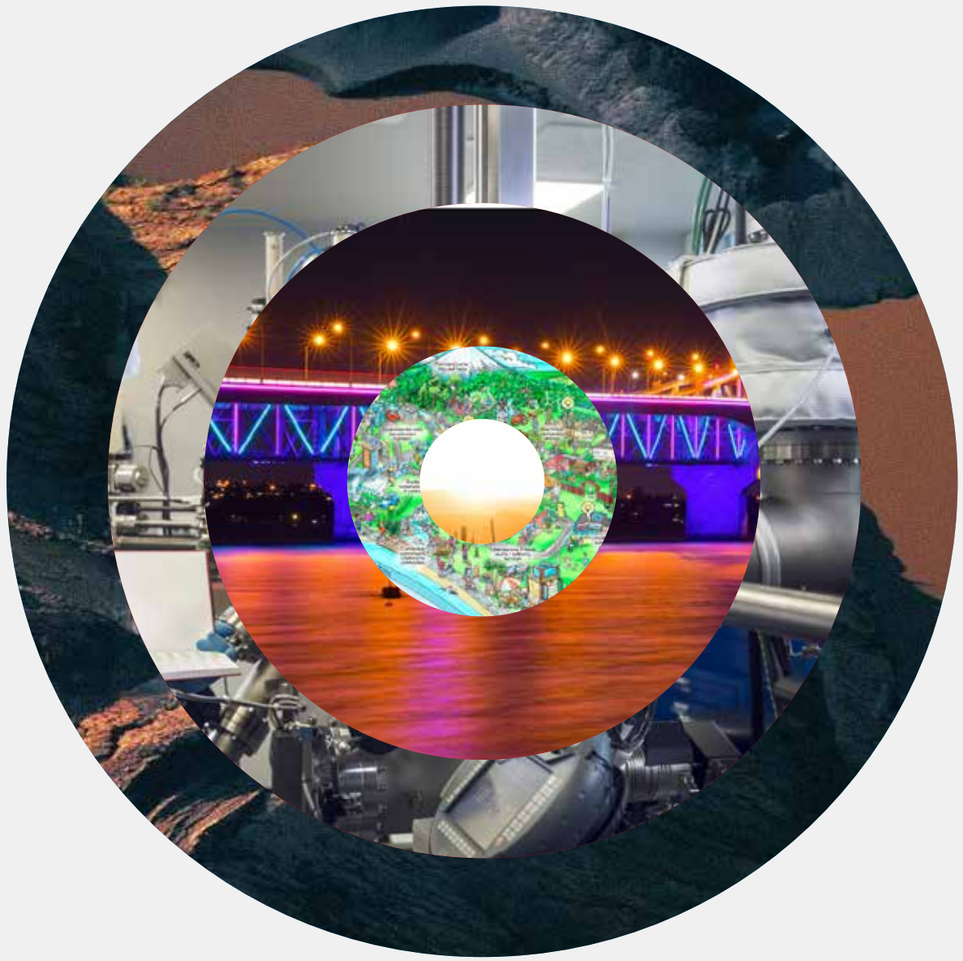
| | |
|---|---|
| **Ebu Avci** | The Wisdom of Crowd: Swarm Behaviour of Micro Robots |



MacDiarmid Institute
Annual Report
2019

Massey University

| | |
|---|---|
| **Bob Buckley**<br>Victoria University of Wellington | Electronic Properties of Heusler Based Weyl Semimetals - VUW Research Fund Grant |
| **Laura Domigan**<br>University of Auckland | Hemoglobin protein nanofiber scaffolds for tissue engineering applications - University of Auckland FRDF |
| **Simon Granville**<br>Victoria University of Wellington | Electronic Properties of Heusler Based Weyl Semimetals - VUW University Research Fund |
| **Marcus Jones**<br>Auckland University of Technology | AUT Faculty Research Development Fund |
| **Elke Pahl**<br>University of Auckland | PBRF (University of Auckland) |
| **Jadranka Travas-Sejdic**<br>University of Auckland | Design of Novel Antibacterial Platforms Based on Capacitive Materials - PBRF, School of Chemical Sciences, University of Auckland |
| **Mark Waterland**<br>Massey University | Characterising vibrational modes of at the edges of low-dimensional nanomaterials: Terahertz spectroscopy of $MoS_2$ nanoribbons and quantum dots - ANSTO / New Zealand Synchrotron Group |



# 2. Into the marketplace.

**We seek to get our innovations into the global marketplace while applying our research to solve New Zealand's existing industrial, sustainability and business challenges. This work makes a difference for New Zealanders by earning export revenues and stimulating high-tech jobs within the high-value manufacturing (HVM) sector and by contributing to sustainability goals. We work alongside companies, iwi and other groups, to address their business opportunities. We connect financial capital, human capital, science and business, to enhance New Zealand's deep tech pipeline.**

# MacDiarmid Institute affiliated people fill the leaderboard of annual KiwiNet Awards

Six of the KiwiNet awards finalists this year were MacDiarmid Institute affiliated; our researchers, Board members and CEOs of affiliated start-up companies. MacDiarmid people won three award categories as well as the KiwiNet BNZ Supreme Award.

Since 2016 there have been eight different MacDiarmid Institute Investigators, alumni and start-up leaders as finalists for KiwiNet awards across 'Breakthrough' and 'Entrepreneur' categories, winning four category awards and two supreme awards.

Distinguished Professor Dame Margaret Brimble, co-founder of SapVax.

**BNZ Supreme Award**
Distinguished Professor Dame Margaret Brimble, *Co-founder of SapVax*

**Norman Barry Foundation Breakthrough Innovator**
Winner – Dr Shalen Kumar, *CEO of Auramer Bio Limiited*

Finalist – Dr Brendan Darby, *CEO of Marama Labs Limited*

**Baldwins Researcher Entrepreneur**
Winner - Distinguished Professor Dame Margaret Brimble

Finalist – Dr Leonardo Negron, *CTO of Hi-Aspect Limited*

**MinterEllisonRuddWatts Commercialisation Professional**
Winner – Will Charles, *Executive Director Commercialisation Uniservices and MacDiarmid Institute Board member*

Finalist - Geoff Todd, *Previous Managing Director Viclink and MacDiarmid Institute Board member*



MacDiarmid Institute
Annual Report
2019

## AuramerBio

Dr Shalen Kumar, CEO of Auramer Bio, was the recipient of the KiwiNet Norman Barry Foundation Breakthrough Innovator category. Auramer Bio supports biosensor solutions for roadside, workplace and environmental testing and provides aptamer development for partner platforms across electrochemical, lateral flow, and microfluidic systems.
"We want to be the leaders in custom diagnostics development, making sure that our components are integrated into other companies' products globally."
AuramerBio is able to rapidly design, develop and synthesise new bespoke single-stranded DNA bio-receptors, called aptamers. With a broad range of components already on the market, Shalen is always on the lookout for new technical challenges to solve that will continue to set AuramerBio ahead of the international competition.

**"We want to be the leaders in custom diagnostics development, making sure that our components are integrated into other companies' products globally."**
AURAMERBIO CEO DR SHALEN KUMAR

## SapVax

SapVax is based on the licensed intellectual property developed by Distinguished Professor Dame Margaret Brimble (MacDiarmid Associate Investigator), Professor Rod Dunbar and Dr Geoff Williams. The company is dedicated to the development and commercialisation of a pipeline of powerful, self-adjuvanting peptide-based cancer vaccines. Their proprietary platform consists of highly specific TLR2 agonist adjuvants which can be covalently conjugated to virtually any synthetic peptide antigen in a rapid and cost-effective manufacturing process. SapVax has 2 lead programs, 1) SVX-ESO which targets the cancer testis antigen, NY-ESO-1, which is commonly overexpressed in ovarian cancer and 2) SVX-NEO, a discovery stage personalized neoantigen cancer vaccine. SapVax plans to identify its lead candidate Q1 2020 and conduct GLP safety and toxicology studies, CMC/GMP and clinical site reviews Q3-4 2020. Additionally, SapVax intends to secure a co-development deal with a neoantigen company in Q2 2020 to develop SVX-NEO. In the next year, SapVax aims to secure $25M in Series A financing to progress SVX-ESO through IND-filing and completion of Phase 1 clinical safety and immunogenicity and SVX-NEO through IND-filing.

## Hi-Aspect Limited

Hi-Aspect is commercialising protein nanofibril technology for a range of over-the-counter medicated skin care and wound care applications with a current focus on the acne market.
CTO Dr Leonardo Negron, KiwiNet finalist in the Baldwins Researcher Entrepreneur category, demonstrates the value of cross-disciplinary experience in leading the technical development of a highly regulated product. With his training and experience spanning clinical pharmacy, drug development and medical diagnostics R&D, he is well placed to manage the complexity of a technical development programme in a deep tech startup. This experience enables him to lead the company's development programme through regulatory compliance, as well as addressing the interplay between product design, customer feedback and product efficacy. Leonardo has valued being able to tap into the experienced commercialisation support networks locally and believes New Zealand entrepreneurs who seek out experienced advisors and highly qualified graduates will be well positioned to succeed.

**"The MacDiarmid intern we received was a highly valuable asset for Hi-Aspect, they were well skilled in nanotech and were able to "just get on with it" with minimal further training from me."**
HI-ASPECT LIMITED CTO DR LEONARDO NEGRON

For 2020 Hi-Aspect will be raising further capital to fund market expansion and new product development for its "over the counter" pharmacy range and seeking licensees for its Fibraspect[300] ingredient in applications outside of human health.

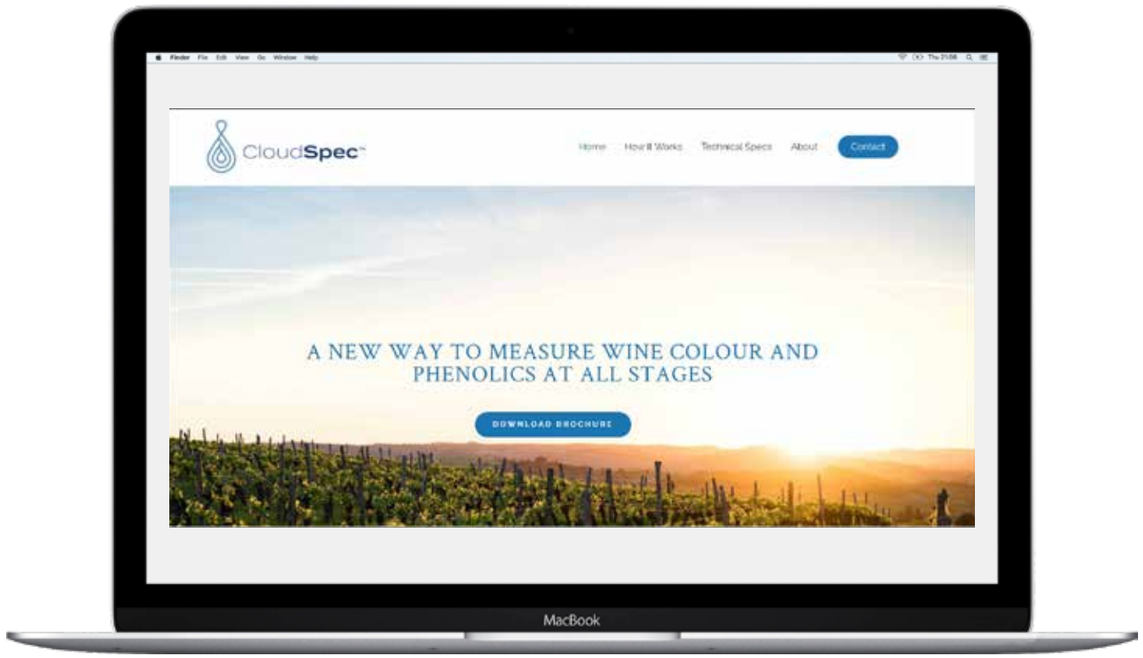
## Marama Labs

Marama labs is developing world-first technologies that are pushing the boundaries of how spectroscopy is applied to industry challenges. The company is taking on a new staff member to further develop, test and calibrate their CloudSpec instruments, as they move from prototype to market ready-product. The CloudSpec instruments have been developed to deliver simultaneous measurement of absorption, extinction and scattering spectra in clear and turbid liquids and have been validated in the wine industry.

Being a deep tech startup, the team are comfortable collaborating with a top research group in Australia one day and applying their technology in partnership with a wine producer the next. With 2020 being the year to roll out the launch of CloudSpec, the team are making progress on engaging a European distribution partner.

**"It's awesome to be able to contribute to New Zealand's economic success and have scientific talent working in a deep tech startup solving quality problems in the wine industry."**

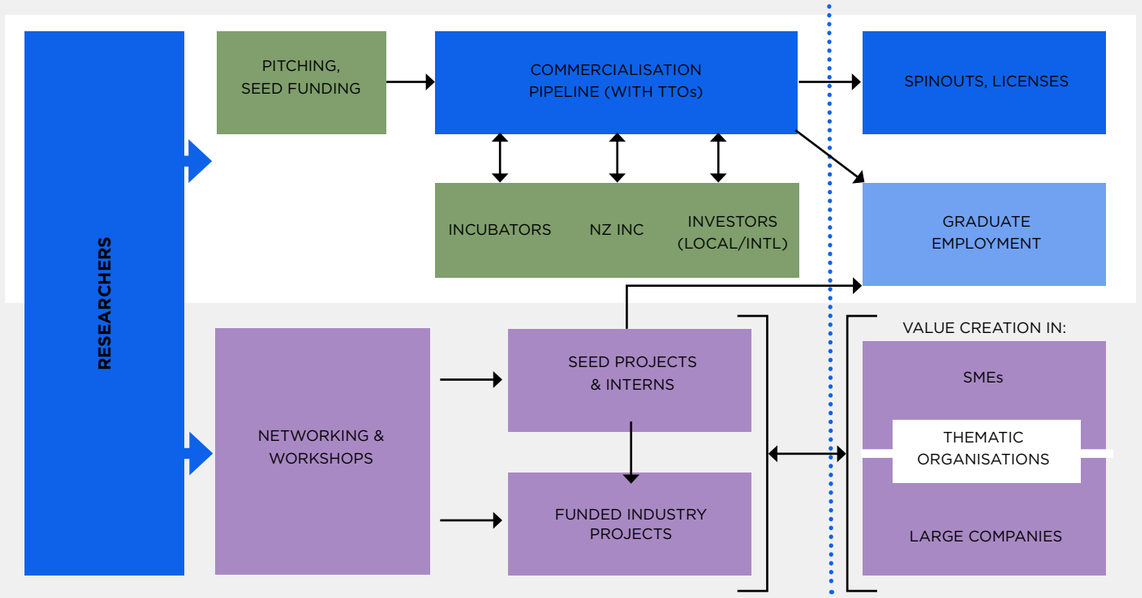
MARAMA LABS CEO DR BRENDAN DARBY, KIWINET FINALIST, NORMAN BARRY FOUNDATION BREAKTHROUGH INNOVATOR.




## An integrated research commercialisation approach

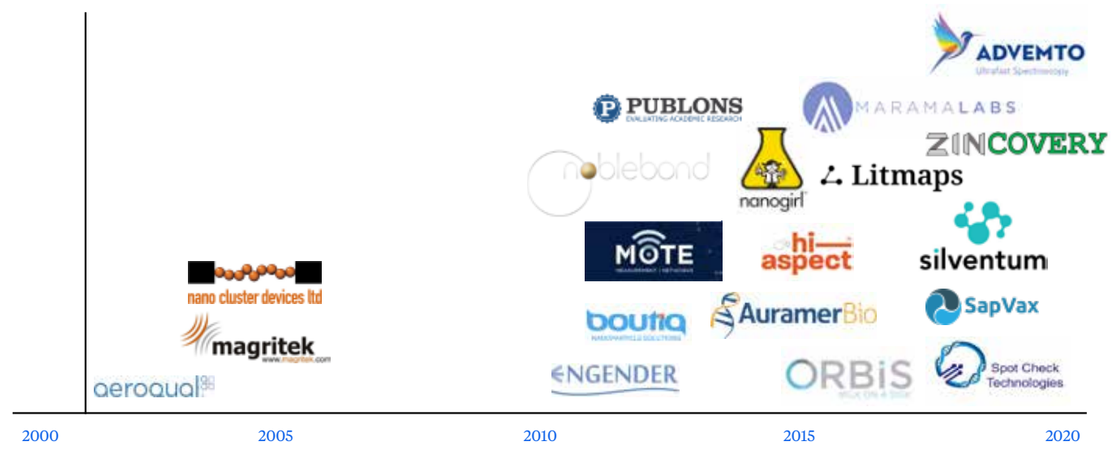
Our efforts towards supporting emerging science entrepreneurs are integrated with the initiatives of the MBIE funded Commercialisation Partner Network (KiwiNet, Return on Science and Momentum) as well as the commercialisation offices of each of our partner organisations. This highly connected network that links students, experienced researchers, industry and investors helps NZ researchers achieve the network scale that enables us to increasingly compete internationally in deep tech commercialisation. Our work provides an integrated approach to building commercial capability among researchers, linking with companies through our "Interface" industry engagement programme, and facilitating the work our partners undertake. As an example, we may identify the potential for a researcher to focus on an industry challenge, make the relevant introductions to local companies who need the technology, advise on protecting the intellectual property and provide seed funding for projects that meet industry milestones, all to ensure the TTO has high quality opportunities to take to market.

The touchpoints of this approach are shown in the diagram below.



# Affiliated start-ups

We now have 19 affiliated start-up companies, on average one for each year of the Institute's existence, which employ upwards of 85 people. Our informal survey of recent Institute alumni (see the section *Into the Future*) revealed that they are employed in at least 13 separate NZ deep tech start-ups, including four of our own affiliated start-ups and three Interface partners. Three of these alumni are start-up CEOs (at Marama Labs, Litmaps and Inhibit Coatings). Start-ups are just one model for commercialisation; MacDiarmid Institute scientists have additionally developed 73 patented inventions.




## MacDiarmid Institute affiliated start-ups:

| | |
|---|---|
| R&D Spending (2018 and 2019) | $10,300,000* |
| Employees (FTEs in 2019) | 90 |
| R&D staff (FTEs in 2019) | 40.4 |
| Capital raised (2002 to Dec 2019) | >$23.2 million* |
| Number of start-ups and spinouts preparing to raise capital | 7 companies |
| Number of patent applications by researchers (2019) | 13 |
| Number of patents granted to researchers (2019) | 9 |
| Number of inventions disclosed to TTOs (2019) | 10 |

*Lower than actual totals due to commercial confidentiality



MacDiarmid Institute
Annual Report
2019

# Growing the next generation of science entrepreneurs

We continue to support our researchers to take their science into the commercial sphere and in 2019 we teamed up with Exponential Founders (the XF90 programme) to identify outstanding researcher-entrepreneurs affiliated with the Institute. We've supported these researchers and now leaders of start-ups into coaching programmes with successful entrepreneurs, Daniel Batten and Dr Shieak Tzeng, with the goal of instilling an ambitious growth mindset and breeding successful serial entrepreneurs right here in New Zealand.

**"The MacDiarmid Institute has been proactive in helping students develop skills necessary to be successful entrepreneurs and intrapreneurs."**

DANIEL BATTEN, XF90 FOUNDER

**"A transformative experience for me ... helped me deal with many professional and personal fears and obstacles, accelerating how fast I achieve things, reducing the effort that takes, and we will probably see the impact on the results I achieve as time goes on."**

MACDIARMID INSTITUTE INVESTIGATOR REGARDING XF90

# Bridging academia to industry

Industry engagement, through our Interface programme, is a major pillar of our drive into the marketplace. Internships with Interface partners (e.g. Mint, see the section *Into the Future*) support our alumni employment outcomes. In 2019, we have grown engagement with thematic organisations which represent smaller businesses with shared interests. As part of our Interface activities we ran a Techweek event in Auckland where we brought together researchers and companies with an interest in sustainablity. Examples include groups such as the Sustainable Business Network and the National New Energy Development Centre (page 52), and Māori economy groups, such as FOMA Innovation and Poutama Trust.

Catherine Clennett, Executive Director and Co-Founder, Hiringa Energy, speaking at our Techweek event

Industry Interface Event TechWeek 2019 - Advanced materials, making an impact on energy and sustainability

**"If we had continued along the path of trying to crack this problem in-house, without the MacDiarmid Institute, it is unlikely we would have been successful."**

JAMES OBERN (COMMERCIAL DIRECTOR, AVERTANA)

**"The MacDiarmid Institute seed project enabled us to move forward into two other collaborations with confidence."**

DR OLLIE CRUSH (CSO, MINT INNOVATION)





# Tech Tasters

The Institute's commercialisation success is built on a pipeline of ideas and opportunities emerging from the lab. This pipeline is in turn supported by effective grass-roots training and other activities, including 'business-as-usual' such as commercialisation workshops, IP training and commercial project seed funding.

In 2019, we ran an inaugural "Tech Tasters" start-up showcase alongside our AMN9 conference and engaged with business mentors XF90 for advanced mentoring of our exceptional entrepreneurs (above). Investors such as Matū (see the section *Into the Future*) are attracted to the Institute by our start-up portfolio and our research focus that meets the needs of the global trend towards desirability of "deep tech" and "sustainability" investments.

**"The MacDiarmid Institute does a great job of connecting exciting deep tech with investors like us and that helps us get New Zealand's best science and technology out of the lab and into the real world."**

GREG SITTERS AND DR ANDREW CHEN, MATŪ FUND


# Engaging with Māori business

The MacDiarmid Institute has made meaningful headway in connecting to the Māori economy through a number of initiatives this year. One of these was sponsoring and attending the Federation of Māori Authorities annual conference where Māori trusts and business leaders addressed the challenges and business opportunities they face. We partnered with Victoria Business School, FOMA Innovate and KiwiNet to hold a workshop (Te Kōmanawa – a spring or well) that brought together 18 Māori trusts and the tech transfer professionals from universities and Crown Research Institutes to build bridges and mutual understanding of the technology opportunities for Māori emerging from New Zealand's scientific research. We have also signed a Memorandum of Understanding (MOU) to work with Poutama Trust, an independent charitable trust established in 1988 that strives to create an environment for successful business ventures and economic growth for Māori. Poutama has a wide range of business members undertaking R&D and commercial activities across numerous industries, e.g. Movers in Hemp Innovation (MIHI) and Waiū Dairy, a geothermal milk processing plant in partnership between Māori and Japanese company Imanaka.

POUTAMA

# Materials science in the new energy sector

In May, the Government hosted the Just Transition summit in Taranaki, a nationwide summit on preparing to thrive in a low emissions economy. The Prime Minister announced funding to establish a National New Energy Development Centre in Taranaki, along with a new strategic investment in clean energy research. The summit featured an inspiring range of local and international speakers. We were invited to highlight emerging material science technologies, including MOFs, mixed matrix membranes, a flow battery, and luminescent solar concentrators. Following on from the Just Transition summit, a team of MacDiarmid Institute researchers visited Venture Taranaki in September to discuss economic opportunities of new materials research into decarbonisation and sustainability and other ongoing opportunities with the National New Energy Development Centre (NNEDC) and Venture Taranaki.

The NNEDC has appointed MacDiarmid Institute Co-Director Professor Justin Hodgkiss to its Steering Committee, and Deputy Director Associate Professor Geoff Willmott to its Advisory Committee.

The Taranaki region has identified the 'Just Transition' as a way to support people in the oil and gas industry to move into new areas of employment while maintaining their strong engineering and technical services capabilities e.g. developing hydrogen infrastructure for NZ.


The Hydrogen roadmap report released by Venture Taranaki identifies numerous opportunities for materials science to contribute to new national infrastructure developments. Our researchers have had follow up meetings with the region's engineering companies and continue to pursue commercial and research partnerships. Our engagement with the hydrogen economy is just one aspect of a wider range of work with NZ sustainability start-ups (Avertana, Mint, Aquafortus) through Interface and with renewable energy sector (Mercury, Infratec, Hiringa).

Professors Sally Brooker and Justin Hodgkiss (right) presenting to Venture Taranaki.



MacDiarmid Institute
Annual Report
2019

# Disruptive science for sustainable fertiliser

Globally, ammonia-based fertilisers are responsible for supporting 50 percent of the world's food production—ammonia is one of the single largest chemical industrial processes on Earth. MacDiarmid Institute Principal Investigator, Dr Franck Natali, is leading commercialisation of a newly discovered process to manufacture ammonia at room temperature and low pressure, with support from Wellington UniVentures (previously named Viclink). The team have been working on techniques to deposit thin film coatings of rare earth nitrides and have developed an application of these thin films that enables distributed small-scale ammonia production. A distributed model of ammonia production offers the exciting prospect of end users of agricultural fertilisers being able to make these where they're needed, substantially reducing logistics and transport costs and emissions. Low energy manufacture would also reduce the carbon dioxide emissions inherent in current manufacturing processes. The group will be developing a prototype scale process in partnership with process engineers this year with recently announced funding from the Preseed Accelerator Fund.

**"A revolution is urgently needed to reduce the massive carbon footprint created by the current industrial production process of ammonia."**

PRINCIPAL INVESTIGATOR, DR FRANCK NATALI

# Patents 2019

## Details of invention disclosure

| | |
|---|---|
| **Chris Bumby** | "Superconducting Switch" |
| **Nate Davis** | "Luminescent Solar Concentrator" |
| | "Molecular Augmented Reality" |
| **Geoff Jameson** | "Novel inhibitor of cytidine deaminase" |
| **Aaron Marshall** | "Recovery and treatment of spent acid from galvanizing plants" |
| **Bill Williams** | "Syringe Pumps" |
| | "Peltier Microfluidics" |
| | "Microfluidic Connections" |
| | "Delta Microscope" |
| | "High Temperature Microfluidics" |

## Details of patent application

| | |
|---|---|
| **Margaret Brimble** | "Lipidated Polymyxins"<br>NZ Patent Application 757118, 2019 |
| | "Peptide Conjugates Incorporating Urea Elements and Their Use as Vaccines"<br>US Provisional Patent Application No. 62/841,893, 2019 |
| | "Peptide Conjugate Amylin Agonists and Uses Thereof"<br>US Patent Application 34772US01, 2019 |
| **Simon Brown** | "Nanoparticle networks"<br>NZ Patent Application 760520 |
| **Chris Bumby** | "Superconducting Switch" |
| **Laura Domigan** | "Biomaterials and Methods Related Thereto" |
| **Justin Hodgkiss** | "Optical system for narrowing the bandwidth of radiation"<br>PCT/NZ2018/050170 |
| **Jenny Malmström** | "Skin Engineering – electrospun technology"<br>PCT/NZ2017/050177 |
| **Volker Nock** | "POC insulin sensor" |
| | "Transistor valves and self-closing valves for capillaric circuits" |
| **Shane Telfer** | "Metal-organic frameworks for gas adsorption" |
| **Jadranka Travas-Sejdic and David Williams** | "Methods and Apparatus for Amplifying Nucleic Acids"<br>Publication Number 20190062808 |
| **David Williams** | "Method for Calibrating Networks of Environmental Sensors"<br>US Patent Application 62,798,580 |



MacDiarmid Institute
Annual Report
2019

## Details of patent granted

| | |
|---|---|
| **Eva Anton, Franck Natali and Ben Ruck** | "Magnetic materials and devices comprising rare earth nitrides"<br>US patent US 15/300,753 |
| **Vladimir Golovko** | "Photocatalytic Conversion of Carbon Dioxide and Water Into Substituted or Unsubstituted Hydrocarbon(s)"<br>Publication number US 2019 / 0002364 A1 |
| **Marcus Jones** | "Quantum Dot Light Emitting Devices" |
| **Franck Natali and Ben Ruck** | "Rare Earth Nitride Structure or Device and Fabrication Method"<br>US Patent US 15/607,596 |
| | "Doped Rare Earth Nitride Materials And Devices Comprising Same"<br>US Patent 10,415,153 |
| **Jadranka Travas-Sejdic** | "Methods and apparatus for quantification of nucleic acid amplification by monitoring impedances"<br>Patent number: 10167501 |

# Spinouts formed in 2019

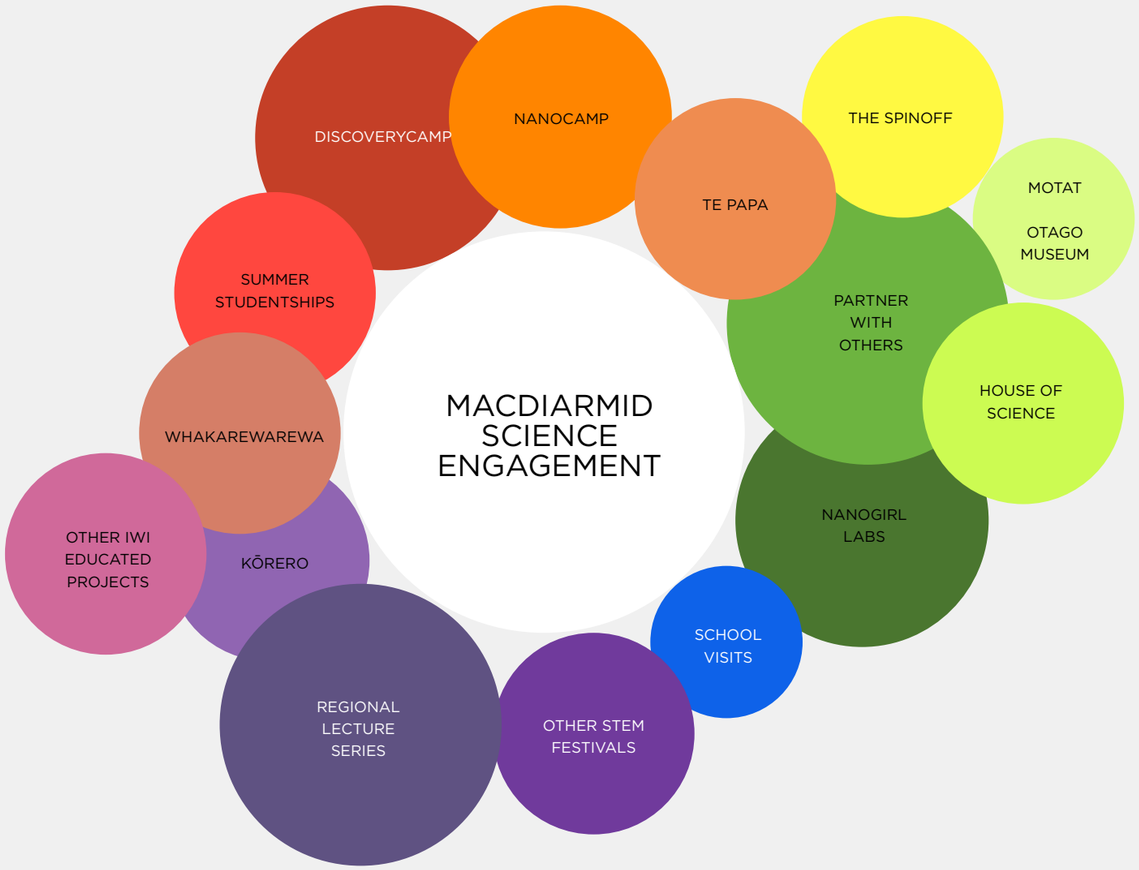
| | |
|---|---|
| **Justin Hodgkiss and Kai Chen**<br>Victoria University of Wellington | Advemto<br>Ultrafast Spectroscopy |
| **Eric Le Ru, Brendan Darby and Matthias Meyer**<br>Victoria University of Wellington | Marama Labs Limited<br>The world's first UV-Vis spectrophotometer that can simultaneously measure absorption, extinction, and scattering spectra of clear and turbid liquids. |
| **Aaron Marshall and Jonathan Ring**<br>University of Canterbury | Zincovery Process Technologies<br>Recycling the galvanizing industry's spent acid and zinc for reuse. |

# 3. Into the community.

**We share the beauty of science to inspire teachers, students and communities and to ignite, or reignite, a love of science.**

**We do this through our people and their stories. Our Investigators, students and postdoctoral fellows are our story tellers.**

**Each year, dozens of our people directly engage with thousands within the community. Through our partnerships, we reach hundreds of thousands. Communication is a two-way street; whilst we endeavour to inspire, we ourselves are enriched and inspired by this engagement.**




# Building capability at the intersection of science with mātauranga Māori

Our ongoing partnership with the Whakarewarewa Village Charitable Trust in Rotorua aligns materials science alongside mātauranga Māori in order to explore the synergies of these two knowledge systems. Planning is already in place for the research findings and experiences from the joint project to be shared openly in a variety of ways, including Wānanga, educational resources and other outreach through local schools.

We submitted two joint research papers for the World Geothermal Congress in 2020. These have both been accepted and will be presented at the Congress (postponed to 2021) hosted in Reykjavik, Iceland.

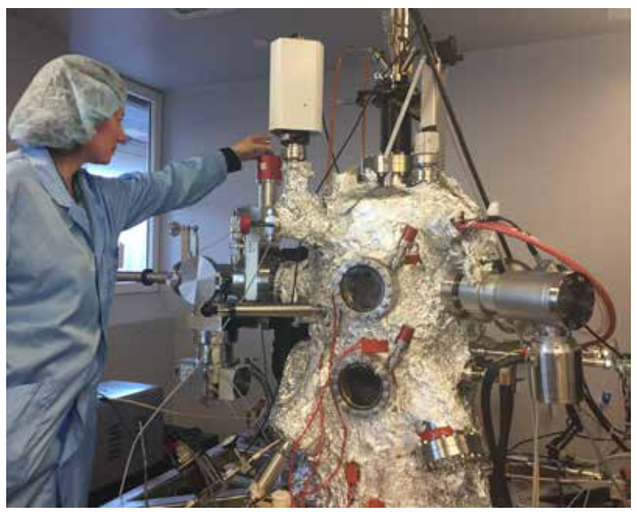
# How can materials science offer a greener future for our planet?

Climate change is undeniable. The IPCC 2018 report made this clear. Humanity is on notice to keep global warming below 1.5°C to prevent a climate change catastrophe.

To achieve these targets, we will need new materials and the renewable technologies based on these materials, including solar, batteries and new types of computing. With this clearly in our sights, we focussed our annual regional showcase on 'NZ Innovation for Sustainability'.

Our researchers again traveled to the regions - Hawke's Bay, Nelson, Queenstown, Wanaka, Tauranga and Gore - speaking with science societies, schools and business groups. These researchers were Principal Investigators, Associate Professor Carla Meledandri, Professor Shane Telfer, Dr Natalie Plank, Associate Professor Nicola Gaston, and Associate Investigators, Dr Matt Cowan, Dr Marcus Jones, Dr Laura Domigan, Dr Ben Mallett, Dr Anna Garden and Dr Saurabh Bose.

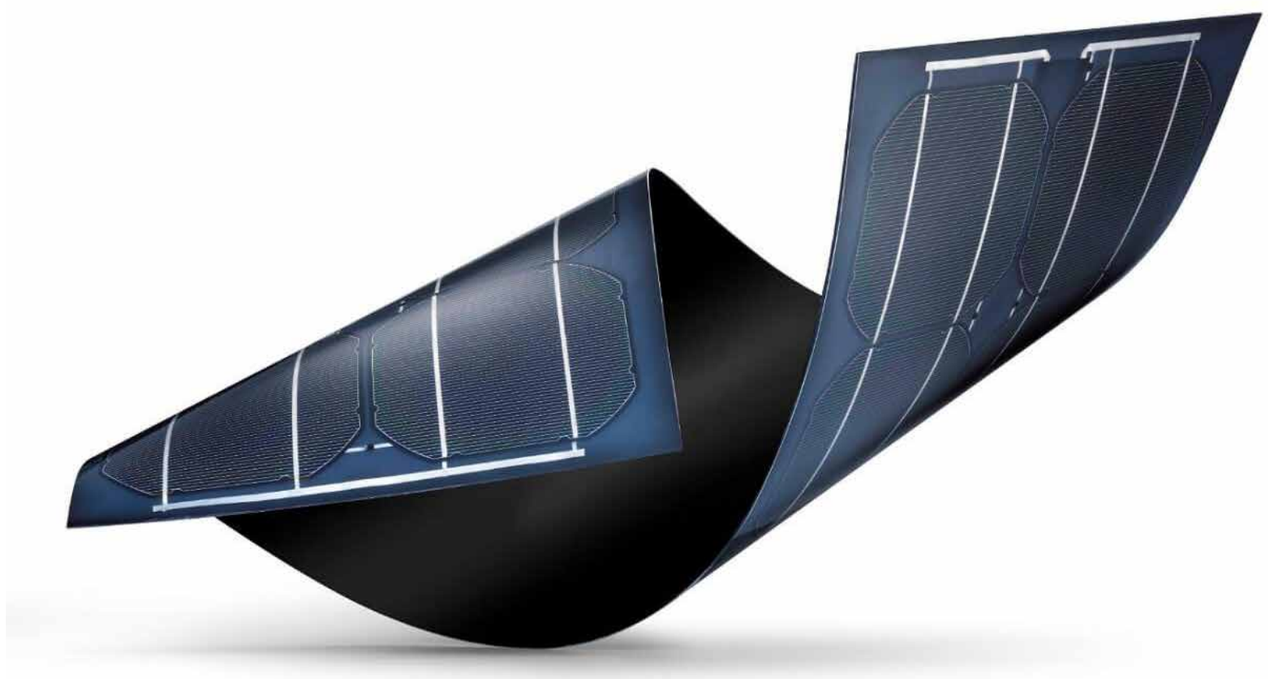
We took our 'NZ Innovation for Sustainability' showcase to the main centres as well, speaking to Rotary clubs across Auckland, Dunedin, Wellington and Christchurch. These were led by Principal Investigators, Associate Professor Geoff Willmott and Professor Keith Gordon, Associate Investigators, Dr Nate Davis, Dr Viji Sarojini, Dr Guy Dubuis and Postdoctoral Fellow, Dr Rodrigo Martinez Gazoni.









# AMN9 – 9th International Conference on Advanced Materials and Nanotechnology

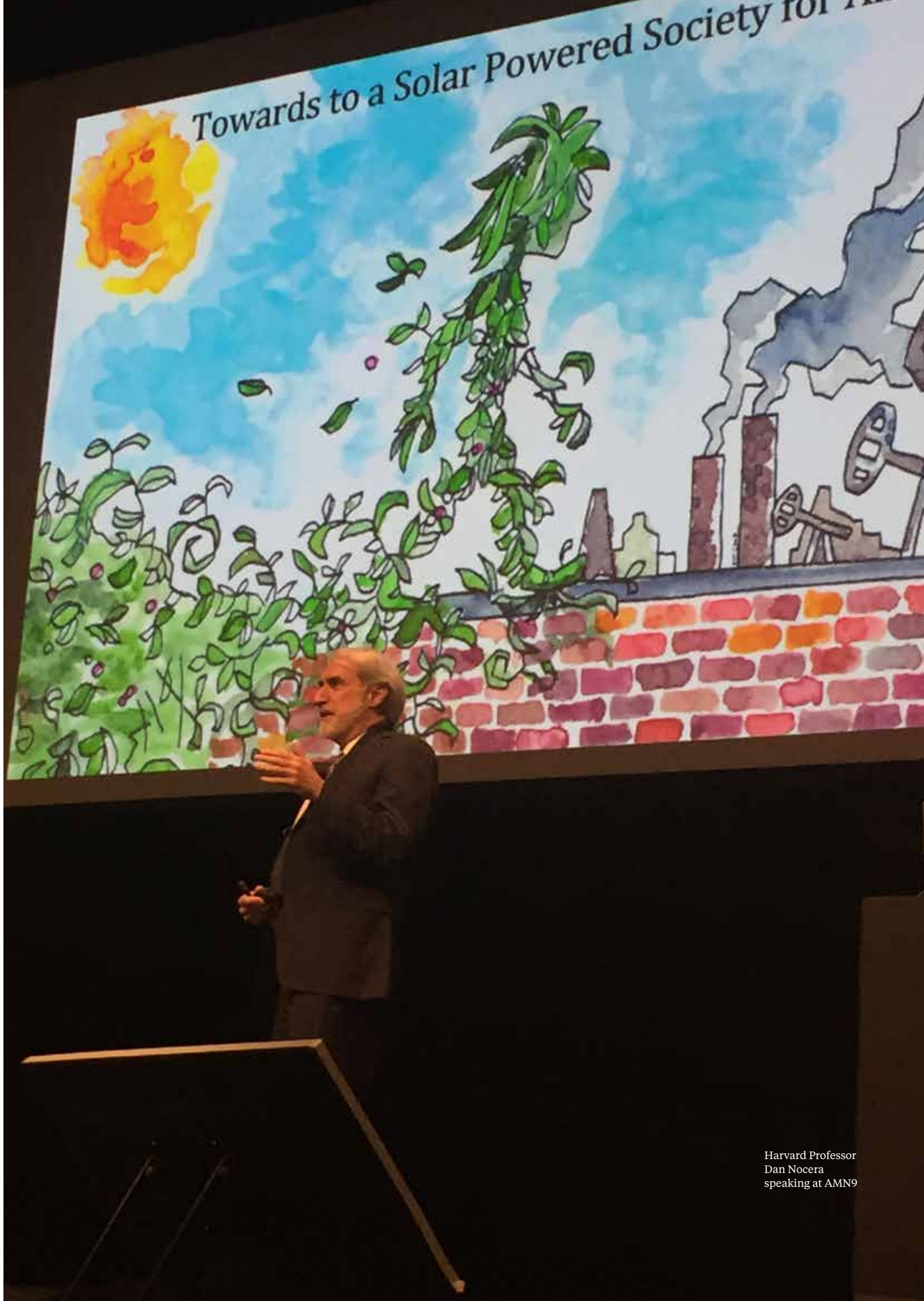
We held our 9th International Conference on Advanced Materials and Nanotechnology at Te Papa Tongarewa in Wellington, 10 – 14 February. The biennial AMN conferences are becoming increasingly international. The majority of the nearly 400 delegates travelled to Wellington from overseas, including Australia, South Korea, the United States, Taiwan and Germany.


Minister of Research, Science and Innovation, Hon Dr Megan Woods, opens AMN9


Nanogirl, Dr Michelle Dickinson, leading the 'Kitchen Science' workshop

## AMN9 - much more than a typical Materials Science conference

- Dr Michelle Dickinson and Professor Cather Simpson gave a public lecture to a packed-out theatre about their work and being women in science.
- 50 mothers and daughters attended the Nanogirl-led ‘Kitchen Science’ workshop.
- School visits by 600 children from low and mid-decile schools (ages 8-14) attended the Nanogirl Live! Show.
- Over 100 people attended a screening of Dancing with Atoms, a biography of our founding Director, Sir Paul Callaghan, with a gold coin koha raising money for the Cancer Society.
- An evening talk by Harvard University Professor, Dan Nocera, on transitioning to a solar-based society, was attended by in excess of 150 people.
- A ‘Women in Science Breakfast’, attended by over 100 NZIC members and conference delegates, to celebrate the progress made by women in STEM in New Zealand. Speakers included Associate Professor Nicola Gaston and Dr Pauline Harris and – by video, Professor Juliet Gerrard and Julie Maxton (CEO of the Royal Society London).
- Associate Professor Martin Allen ran his SunSmart programme for 80 school children at a Wellington school.
- A ‘Science media savvy’ day, in collaboration with the Science Media Centre, to upskill investigators on their science communication.




Harvard Professor Dan Nocera speaking at AMN9

Hon Dr Megan Woods with
Professor Dan Nocera at AMN9


Dr Craig Rofe at the annual
MacDiarmid Institute
Symposium

# DiscoveryCamp and NanoCamp

Every year, a group of New Zealand's brightest year 12 and 13 secondary school students spend a week at NanoCamp and DiscoveryCamp. The camps are hugely popular and attract many more applications than there are places available. The five day, all-expenses-paid residential programmes give students a hands-on opportunity to experience science under the guidance of New Zealand's top nanoscience and advanced materials researchers.

The MacDiarmid Institute DiscoveryCamp – Te Tohu Huraina - is now in its 11th year, giving Māori and Pasifika students with a passion for the sciences a chance to enhance their scientific knowledge and help them carve out a potential career in science and technology. Hosted by our researchers, the camp gives these students an experience of the university environment beyond taught coursework. Entering into the university environment can be alienating for Māori and Pasifika students; connecting the students with researchers and with university communities that provide support has proven successful.

DiscoveryCamp alumna Mariah McDonald (Ngāi Tahu, Tuahuriri) graduated with a degree in Engineering, and she is now studying for her PhD in Biomechanical Engineering. She attended the camp in her final year of high school and said this allowed her to try out different things and helped her discover what she wanted to study.

Māori and Pasifika continue to be under-represented across science and technology in New Zealand, so DiscoveryCamp intervenes early.

To help with the transition in education, high school students are given a valuable opportunity to become familiar with university life, by attending lectures and living in residential halls.

Instead of feeling frustrated over these statistics, DiscoveryCamp alumnus Eden Skipper (Ngāi Tahu) said he used this as motivation to achieve great things. After completing a Bachelor of Science with Statistics, Eden says he encourages high school students to not be afraid to go to university, even if they are only one of a few Māori and Pasifika students in their class.

**"A week full of new friends, amazing mentors, fascinating learning and great social activities, I couldn't have asked for a more awesome trip to be a part of."**
DISCOVERYCAMP PARTICIPANT

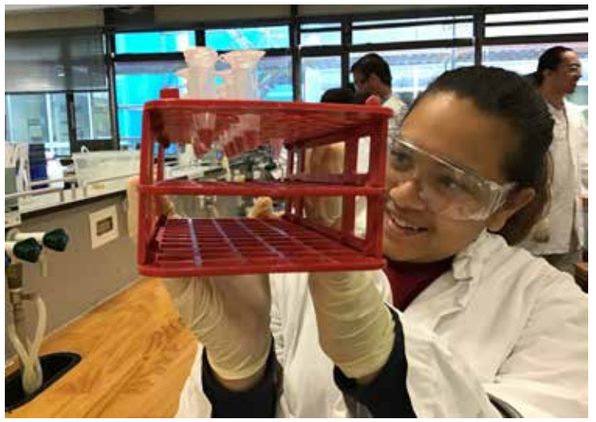
The camps took place between 12th and 17th January 2020, and this year were located at two different locations: University of Auckland and Victoria University of Wellington. The camp programmes included such diverse activities as visits to nanoscience laboratories, hands-on activities in the fields of biosensors and microfluidics, preparing and delivering videos and excursions to Zealandia, Weta Workshops and Tiritiri Matangi Island. We hosted 48 students across the two locations:

NanoCamp – University of Auckland – 15 students (hosted by Associate Investigators Dr Erin Leitao and Dr Michel Nieuwoudt)
NanoCamp – Victoria University of Wellington – 15 students (hosted by Associate Investigator Dr Guy Dubuis)

DiscoveryCamp – University of Auckland – 8 students (hosted by Principal Investigator Associate Professor Geoffrey Waterhouse)
DiscoveryCamp – Victoria University of Wellington – 10 students (hosted by Associate Investigator Dr Nathaniel Davis)
The Wellington-based students particularly valued getting the opportunity to visit Te Papa in Wellington and see behind the scenes with one of their scientists, as well as getting the opportunity to attend a PhD panel and listen to current students speak about their own academic experiences. In Auckland, camp attendees appreciated getting to hear from MacDiarmid Institute alumna, Dr Michelle Dickinson ('Nanogirl'), the sessions on solar cells and learning about 3-D printing.






# DiscoveryCamp alumni

Entering into the university environment can be alienating for Māori and Pasifika students; connecting the students with researchers and with university communities that provide support has proven successful.

DiscoveryCamp alumna, Mariah McDonald (Ngāi Tahu, Tuahuriri), graduated with a degree in Engineering and she is now studying for her PhD in biomechanical engineering. She attended the camp in her final year of high school and said this allowed her to try out different things and helped her discover what she wanted to study.

“Before doing DiscoveryCamp I knew that I liked maths and science but I didn’t even know what engineering was. And afterwards I knew for sure that was the career path I wanted to go down.”

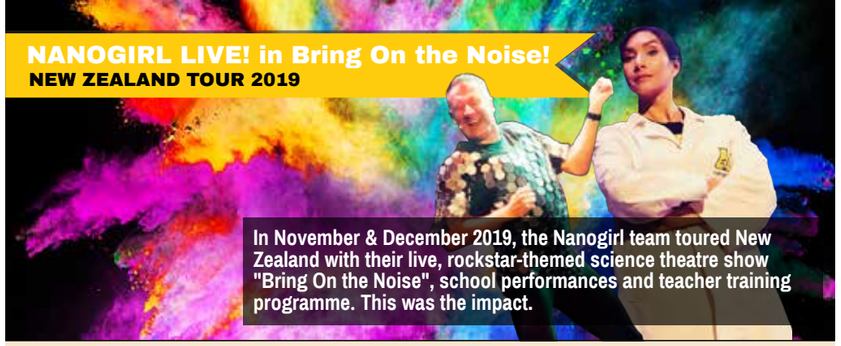
Māori and Pasifika continue to be under-represented across science and technology in New Zealand, so DiscoveryCamp intervenes early. To help with the transition into education, high school students are given a valuable opportunity to become familiar with university life, by attending lectures and living in residential halls.

“The fact that Māori and Pasfika students are underrepresented in education is a fault on society, it is not a fault on us. We are good enough to be doing this work and we should be doing it if we have a passion for it,” Mariah says.

Instead of feeling frustrated over these statistics, DiscoveryCamp alumnus, Eden Skipper (Ngāi Tahu), said he used this as motivation to achieve great things. After completing a Bachelor of Science with Statistics, Eden says he encourages high school students to not be afraid to go to university, even if they are only one of a few Māori and Pasifika students in their class.

**“Be brave and challenge the norm. Be proud of the fact that you are there, be proud of the fact that you are holding your whānau name.”**

EDEN - DISCOVERYCAMP ALUMNUS




People Engaged

41352

We engaged more than 41,000 New Zealand students in schools and theatres right across New Zealand.

Increasing diversity in STEM participation is one of our core goals. We specifically design our work to be engaging and accessible for all. 58% of those engaged were female, 42% were male.

Gender Diversity

58%

42%

Our Work With Teachers

243

243 TEACHERS TOOK PART IN OUR SCIENCE TRAINING WORKSHOPS, DELIVERED IN PARTNERSHIP WITH THE MACDIARMID INSTITUTE, DESIGNED TO INCREASE CONFIDENCE IN TEACHING SCIENCE.

96% OF TEACHERS ENGAGED SAID THE WORKSHOP HAD SIGNIFICANTLY INCREASED THEIR CONFIDENCE IN TEACHING SCIENCE IN THE CLASSROOM

Our Work With Students

10,094

10,094 PRIMARY AND INTERMEDIATE STUDENTS WERE ENGAGED THROUGH OUR SCIENCE IN SCHOOLS PROGRAMME.

59% OF STUDENTS ENGAGED ATTEND A DECILE 1-4 SCHOOL.
WE DESIGN OUR WORK PROGRAMME TO ENSURE ACCESS FOR ALL.

Did the show make you like science more?

Yes (94%) No/Maybe (6%)

What the audience told us...

Did the show make you want to try more science in school, or do experiments at home?

Yes (93%) No/Maybe (7%)

AUDIENCE FEEDBACK

“Scientists and engineers design and create new technologies. Nanogirl (AND BORIS) inspired me to do that when I'm older.”
CAITLYN, 11 YEARS

“Colours, lights, explosions - science is AWESOME!”
DAISY, 8 YEARS

"You can make CRAZY things with stuff you don't need any more! I want to study engineering now!"
MICHELLE, 9 YEARS

"I learned how to make rubbish into cool things, and that science is for everyone!"
GRACIE, 11 YEARS

"Frequency, resonance, waves - I learned all about sound through dancing and explosions!"
LUCA, 10 YEARS

"I loved when Boris roasted marshmallows on the fire wave showing resonance!"
JACOB, 9 YEARS

PAY IT FORWARD

1046 PAY-IT-FORWARD TICKETS GIFTED
THANKS TO THE GENEROUS SUPPORT OF OUR DONORS, 1046 YOUNG PEOPLE WERE ABLE TO ATTEND THEIR LOCAL NANOGIRL LIVE! SHOW WHO OTHERWISE WOULD NOT HAVE HAD THE OPPORTUNITY.

11 CENTRES
4340 Kilometres

Made in New Zealand. Built for the World.

THANK YOU TO TO EVERYONE WHO HELPED TO MAKE THIS PROJECT A REALITY.
THE NANOGIRL LABS TEAM.
MEDIA & PARTNERSHIP ENQUIRIES, PLEASE CONTACT INFO@NANOGIRLLABS.COM

## Nanogirl

We again partnered with Nanogirl Labs to extend our programme into regional New Zealand, in partnership with their 2019 show ‘Nanogirl Live! Bring on the Noise’. Our partnership also supported Nanogirl Labs to deliver their science training workshops to 243 teachers around the country.

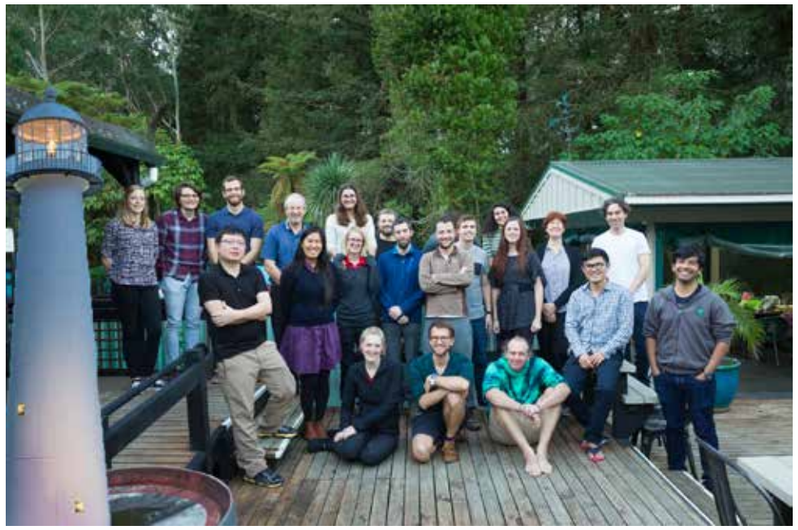
## Kōrero partnership with NZEI

In partnership with the New Zealand Education Institute (NZEI), we held Kōrero sessions around the country teaching nanoscience to early childhood and primary teachers.

Principal Investigator, Professor Eric Le Ru (Victoria University of Wellington), ran two 2-hour sessions in Wellington for 45 primary, intermediate and ECE school teachers.

Associate Investigator, Dr Anna Garden (University of Otago), ran a session in Dunedin for 15 teachers. Principal Investigator, Professor Paul Kruger (University of Canterbury), ran a session in Christchurch for 18 primary, intermediate and ECE school teachers.

Principal Investigator, Associate Professor Duncan McGillivray (University of Auckland), ran two sessions in Auckland for 20 teachers.



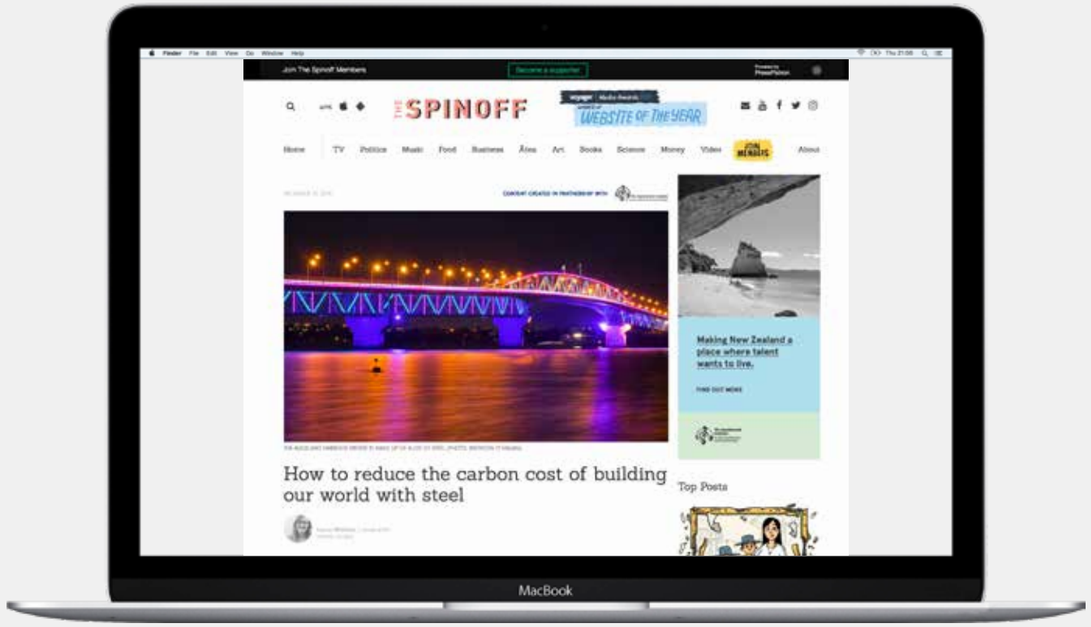
## Cluster Hui

The Light and Optical Spectroscopy hui organised by Dr Baptiste Auguie took place in Kerikeri, Bay of Islands, with 23 attendees representing nine different groups, five universities, and a diverse mix of participants including students, postdoctoral fellows and investigators.



MacDiarmid Institute
Annual Report
2019

# Partnering with The Spinoff




We continue our 3-year partnership with award-winning The Spinoff website www.thespinoff.co.nz to get research stories to a non-traditional science audience. In 2019, 10 of the 89 stories on the Science page featured the work of MacDiarmid Institute researchers, and were viewed on average more than 2,400 times for longer than 6 minutes each view.

*Mothers, daughters and overcoming bias in the science world*
Page views: **1,801**
Ave. Time on page: **07:31**
Facebook Reach: **38,603**

*How the fertiliser of the future could help save New Zealand's environment*
Page views: **3,268**
Ave. Time on page: **08:31**
Facebook Reach: **37,596**

*Single use plastic is piling up. Is pyrolysis the answer?*
Page views: **2,612**
Ave. Time on page: **06:08**
Facebook reach: **11,390**

*Building batteries that go beyond lithium*
Page views: **2,701**
Ave. Time on page: **07:36**

*WTF is molybdenum disulfide? An expert on why this nano-material matters*
Page views: **2,158**
Ave. Time on page: **07:32**
Facebook reach: **27,903**

*The camp where young Māori and Pasifika explore the wonders of science*
Page views: **2,856**
Ave. Time on page: **03:22**
Facebook reach: **43,928** and **199 clicks**

*Converting nitrates: science's alternative solution for clean drinking water*
Page views: **1,615**
Ave. Time on page: **04:55**
Facebook reach: **10,198**

*The cure for climate change could be in our own backyard*
Page views: **1,833**
Ave. Time on page: **04:55**
Facebook reach: **7,988**

*After decades of service, the lithium-ion battery has won a Nobel Prize*
Page views: **3,076**
Ave. Time on page: **04:11**
Facebook reach: **14,980**

*How to make solar electricity cheap? Move light sideways*
Page views: **3,097**
Ave. Time on page: **04:30**
Facebook reach: **11,415**

## Te Papa Nature Exhibition

We partnered with Te Papa Tongarewa to include future sustainability science in the national museum's new Te Taiao | Nature exhibition which opened in May 2019. Over 300,000 visitors saw the MacDiarmid Institute exhibit in the first five months of the display.

The new permanent exhibition explores the unique natural environment and highlights the innovative ways we are protecting it. Based on the work of scientists at the MacDiarmid Institute, new energy technologies that can capture carbon dioxide out of the air and new types of solar cells are on display as part of the climate change section of the exhibit.


**"Our new partnership with the MacDiarmid Institute allows us to showcase some of New Zealand's leading research on materials science relating to building a more sustainable future."**

DR DEAN PETERSON, DIRECTOR OF COLLECTIONS AND RESEARCH AT TE PAPA


**"In the face of much negativity around climate change, it's important to maintain a sense of optimism that solutions may exist. These will be driven by investment in research."**

PRINCIPAL INVESTIGATOR, PROFESSOR SHANE TELFER

## House of Science

As the first national partner of the House of Science, we sponsor the NanoChem box, one of the most requested boxes for teachers. We have 13 kits in circulation (with another one on order). In 2019, the NanoChem box has been in 210 classrooms, with 7,350 children engaging in nanoscience.

Student quotes:

- "It was so fun making the flubber. After I put the two things in the beaker I had to stir it. It was still wet but then after that it started to go slimy. I really liked making it because I have never done it before. I never wanted it to end."

**"It smelt a bit stinky but I still loved it."**

NANOCHEM KIT STUDENT

- "I really liked making the flubber because it was gooey. We needed to put in some blue glue and we also needed to add some clear liquid. We had to keep stirring it. It was fun to play with because when you put it in your hands it felt like soft marshmallow. It smelt a bit stinky but I still loved it."

Teacher quotes:

- "My class loved this kit and were very motivated! Such a great initiative."(Mangapapa School, Gisborne)
- "This was a hot favourite in my class. The kids loved the experiments and the microscopic camera was a hit!"(Pirinoa School, Wairarapa)
- "Kids loved making the flubber. We enjoyed discussing whether it was a solid or a liquid. We also discussed whether there was a physical change or a chemical change. It was great having all the equipment ready to go!" (Pirinoa School, Wairarapa)

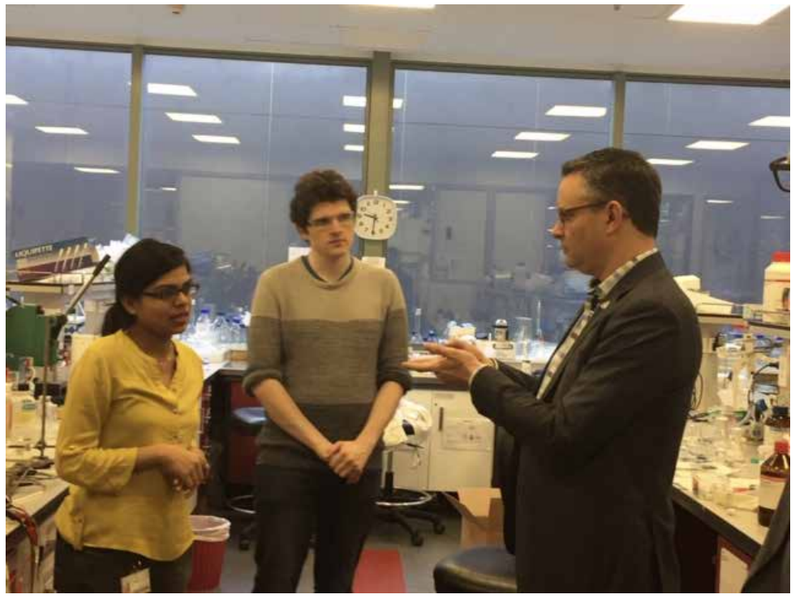
**"I have 7-year-olds running around talking about polymerisation and crystallisation and blowing their teachers away!"**

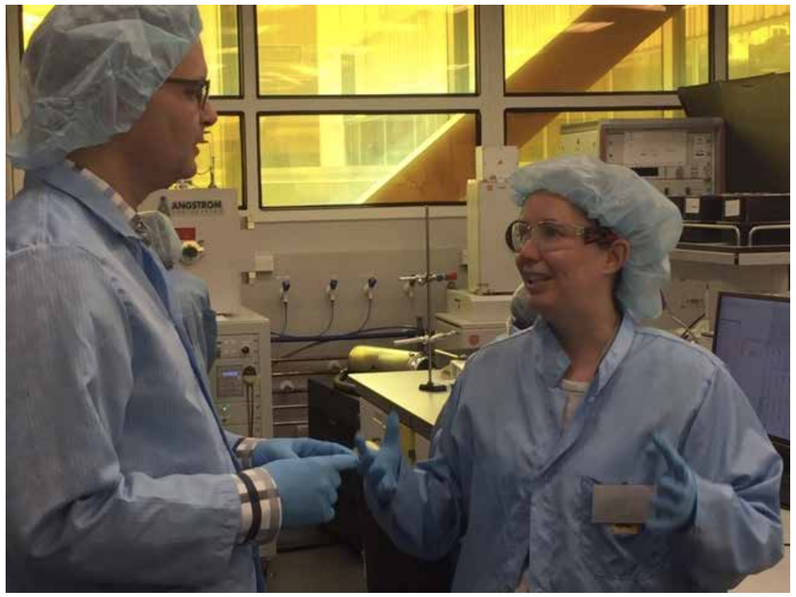
TEACHER EAST BAY SCHOOL

- "Awesome kit! The kids loved it and it generated great discussion and ideas." (Oroua Downs School, Himatangi)
- "We had a really great week with the Nano science kit. Such a great resource! Cheers."(Kahutara School, Masterton)
- "I have 7-year-olds running around talking about polymerisation and crystallisation and blowing their teachers away! So on behalf of all those schools who have had the pleasure to use the kit, and those waiting on their turn, thanks so much!" (East Bay School)

**"Awesome kit! The kids loved it."**

(TEACHER, OROUA DOWNS SCHOOL, HIMATANGI)





## James Shaw lab visit

In September, Climate Change Minister, Hon James Shaw, checked out some of our climate mitigation materials research; new battery technologies, luminescent solar concentrators, printed photovoltaics, next generation computing devices, carbon capture research and materials for the hydrogen economy.

## Inspiring the next generation of scientists and technologists

Throughout the year, our researchers took our sustainable innovation science to a range of STEM festivals across the country, including the Tauranga STEMfestival, the Accenture Girls in STEM showcase and the Nelson Inspire Festival. Our flexible solar cells, carbon-capture sponges (metal organic frameworks - MOFs) and solar concentrators were on display to engage and inspire a new generation of scientists and technologists, to show the difference students can make to sustainability and climate change if they continue to study STEM. We also hosted lab visits from 80 female secondary school students who won places in the Innovative Young Minds programme, where they also heard from women scientists about their journey into their career and their current research.



MacDiarmid Institute
Annual Report
2019

## Mighty Small, Mighty Bright

In collaboration with the Museum of Transport and Technology (MOTAT), the Dodd-Walls Centre, and Otago Museum, we have been taking hi-tech stories to museums around the country.

**“MOTAT’s partnership with the MacDiarmid Institute resulted in a wonderful exhibition, bringing complex science to a broad audience.”**

REBECCA BRITT, EXHIBITIONS MANAGER MOTAT

The ‘Mighty Small, Mighty Bright’ travelling showcase is a hands-on exhibit that illustrates the journey of extraordinary science from the lab to New Zealand homes and businesses.

The exhibition kicked off at MOTAT in Auckland in May and then headed south to open at Te Manawa in Palmerston North in November.

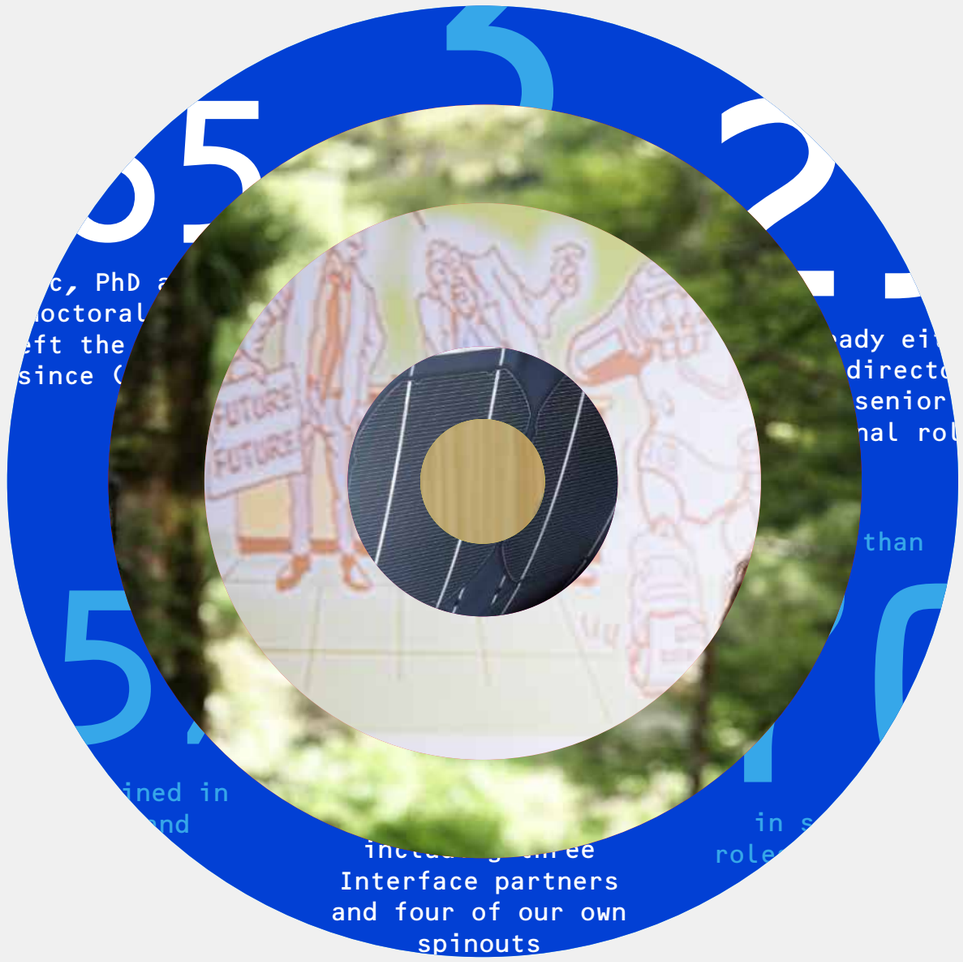
## MESA 2019

In its 9th year, the MacDiarmid Emerging Scientists Association (MESA) runs networking and training for all MacDiarmid Institute students and postdoctoral researchers. In 2019, the MESA executive was: David Perl (Chair), Tarek Kollmetz (Treasurer), Edoardo Galli (Secretary), Shalini Divya (Social Media Representative) and Nicola Altenhuber, Sam Brooke, Taniela Lolohea, Kira Pitman, and Sriram Sundaresan.

This year, the committee organised workshops on electrochemistry, writing and graphics. MESA members feed in information that decides the themes and locations of workshops and minimises wasteful travel. In particular, this year’s committee focused on supporting the wellbeing of MESA members, including dedicating the first day of the Future Leaders Programme to host expert speakers to introduce wellbeing from a range of different perspectives.

**“MESA provided a clear way to engage with the community to build social, academic, and professional development support outside of biology.”**

MACDIARMID STUDENT




# 4. Into the future.

**During their time at the MacDiarmid Institute, our students are equipped not only with deep scientific knowledge but with leadership, communication and commercial skills.**

**Through our Future Leaders Programme, industry connections and internships within the government and commercial sectors, we expose students to the government side of science funding and policy, as well as to the realities of the business world, including intellectual property, pitching and investment funding.**

# Alumni survey

Informal survey of

**165**

MSc, PhD and Postdoctoral alumni who left the Institute since 2014

**3**

alumni are CEOs of NZ start-ups (Marama Labs, Litmaps and Inhibit Coatings)

**25**

are already either company directors or in 'senior' professional roles

Employees in at least

**13**

separate NZ deep tech start-ups, including three Interface partners and four of our own spinouts

**65%**

have remained in New Zealand

More than

**70**

in scientific roles (acedemic or otherwise)





# Alumni Event

We held our first Alumni networking event in October to bring our Wellington based alumni together with existing investigators, students and postdoctoral fellows to reconnect as whānau. The theme for the evening was “The Future of Work” as presented by our guest speakers, Professor Sally Davenport and Dr Andrew Chen.

**“Excellent to see MacDiarmid backing up its push for alumni connections with such a strong presence and excellent speakers.”**

MACDIARMID INSTITUTE ALUMNUS

# Future Leaders Programme

Our annual ‘Future Leaders Programme’ for our students and postdocs this year focused on wellbeing and communication. This two-day workshop for our emerging scientists is designed to prepare them for life after a PhD or Postdoctoral study. Each year the programme is focused around either science communication, presentation skills and leadership or entrepreneurship.

At the request of our student body MESA, we ran for the first time a workshop developing skills to manage wellbeing. This was facilitated by Nilima Chowdhury, a Psychology PhD candidate with expertise in mental illness and professional and gender identity. Within a safe environment, attendees learnt how to remain present and grounded during stressful situations, build resilience, and deal with imposter syndrome. The second day included a scientist communicators panel as well as workshops on writing technical papers, giving talks and making graphics and posters.

# Sustainability report

As an Institute focused on materials for sustainability, we decided to take a good look at our own carbon footprint. We calculated the carbon footprint using the World Business Greenhouse Gas Protocol, assessing building electricity and gas usage, commuting habits, and laboratory electricity use. We found that (as expected), the vast majority of the carbon footprint of the Institute was determined to be due to air travel (89%). We plan to monitor our air travel and to also look at other ways to reduce the carbon footprint of the Institute.

# Business Scholarship recipients

In 2019, we again offered competitive business scholarships to our alumni and awarded the following:

**Dr Lita Lee, PhD 2015: Postgraduate Certificate in Commercialisation and Entrepreneurship at the University of Auckland**
With this scholarship, Dr Lee (Senior Scientist Mint Innovation) hopes to gain a better understanding of the challenges involved in the commercialisation process. She's keen to be able to help start-up companies with their commercialisation journey.

**Dr Amy Zheng, PhD 2017: Postgraduate Certificate in Commercialisation and Entrepreneurship at the University of Auckland**
Dr Zheng (Research Fellow, University of Auckland) plans to use this scholarship to gain practical tools and a solid commercialisation mindset. She is keen to pursue a long-term R&D and science-led commercialisation career with a focus on translating biomaterial research into products that can benefit human wellness and social wellbeing.

# Our 2018 MacDiarmid Business Scholarship recipients reflect on their studies

**Dr Eldon Tate, 2018 Business Scholarship recipient**
**"The Business Scholarship opened up an amazing opportunity for me to upskill, helping me tackle the challenges I've been facing in start-up life."**

**Dr Akshita Wason, 2018 Business Scholarship recipient**
**"The programme makes you view each idea through the lens of strategy, finance and risk – a mould required for any concept to be a commercial success."**

**Dr Sam Yu, 2018 Business Scholarship recipient**
**"Business is about managing people, money and risks. Being able to balance these factors in a rapidly changing environment is the resilience we should all learn to build and strengthen."**

**Dr Hannah Zheng, 2018 Business Scholarship recipient**
**"Studying business makes me reassess the way I approach my work. I have to think about science in a different way."**





# Government and industry Internships

Most science PhD graduates will not remain in academia. Many are looking to use their skills across a range of areas, including government and industry. 2019 saw the launch of the inaugural MacDiarmid Institute three-month internships in government and industry. The internships cover the period from thesis hand-in, through to oral PhD exam.

**"In March we were excited to launch our intern programme and have particularly enjoyed having our enthusiastic PhD graduates from the MacDiarmid Institute join us in the Office."**
PRIME MINISTER'S CHIEF SCIENCE ADVISOR, PROFESSOR JULIET GERRARD

**"Recruiting a summer intern into the team from MacDiarmid has introduced a new wave of energy and ideas into the project. We have been so impressed with Mohsen's work we are seeking to extend his contract. MacDiarmid Institute did an outstanding job to match the technical skills required for this project with the technical competencies of their interns."**
KEVIN GUDMUNDSSON, MSL

**"The internship at the Measurement Standards Laboratory of New Zealand (MSL) has led to a long term position for me at MSL."**
MOHSEN MADDAH

# Paths to policy

Good science and environmental policy making requires people within the policy system who understand the science system, and the science itself, and who have the deep analytic and data skills required to make good recommendations to government. With this in mind, we have this year supported 13 MacDiarmid Institute graduates into three-month internships within government – with seven graduates joining the Office of the Prime Minister's Chief Science Advisor (OPMCSA), four joining the Ministry for the Environment, one starting at MBIE and another with Dunedin City Council.

### PMCSA Office

**Odile Smits:** Minimizing the carbon footprint by efficient electricity distribution and storage.

**Ankita Gangotra:** Equity, diversity and inclusion (EDI) policy options for Aotearoa New Zealand's science workforce.

**Wayne Crump**: The state of quantum computing in 2019, what the future might hold and what that means for Aotearoa New Zealand.

**Georgina Shillito**: Potential impact of current solar use on energy use and policy in New Zealand.

**Akshita Wason**: Rethinking plastic and diversity in education work stream.

**Kyle Webster**: The technological background of artificial intelligence and the long-term impacts of AI development on NZ society and policy.

**Jono Barnsley**: Insect decline and potential impacts for New Zealand industry and biodiversity.

### Ministry for the Environment

**Dani Metin**: Developing processes and documentation primarily around the change to a code based, reproducible reporting platform.

**Heather Jameson**: Standardising data and enabling easier Treaty settlement environmental reporting.

**Nishat Sultana**: Joined the Strategy and Stewardship team to understand New Zealanders' perspective on ministry proposals related to environmental reporting, data science and Te Ao Māori.

**Shota Shirai**: Development and validation of R code used for analysing air quality data and reviewing analysed data and interpretation in Kaitaki survey.

### Ministry of Business, Innovation and Employment

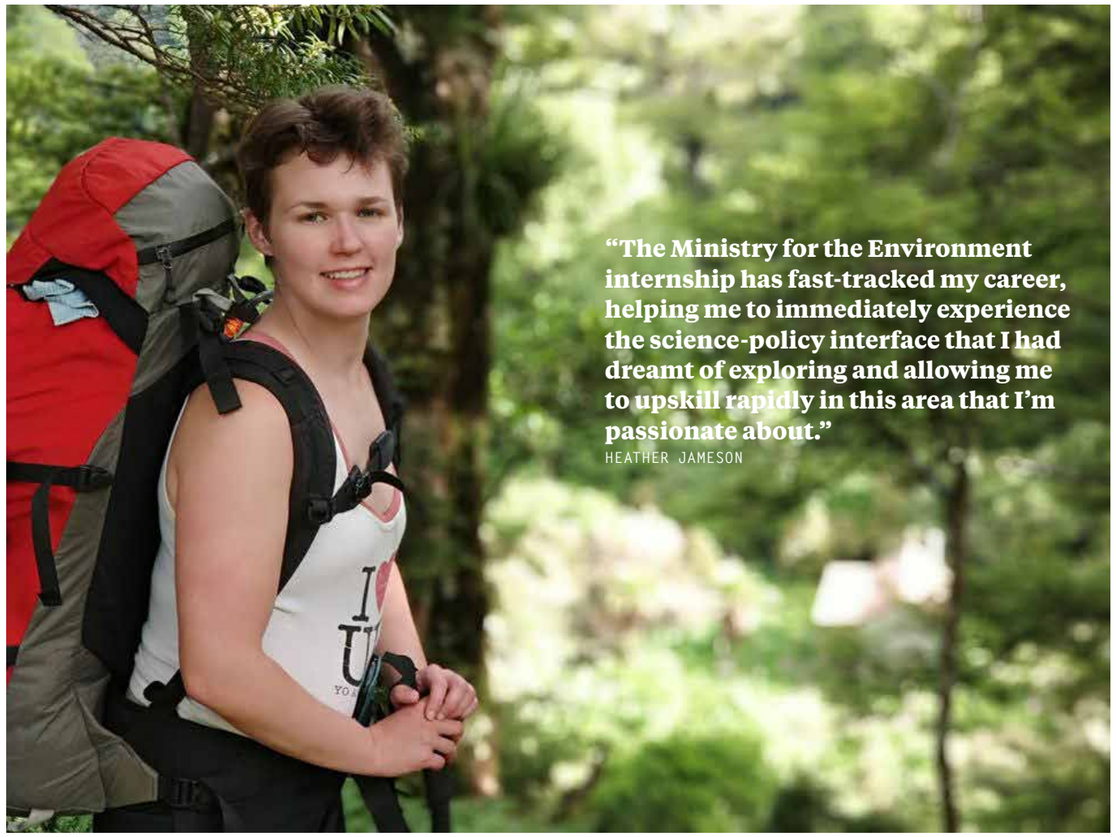
**Alexander Smith**: International trends, market opportunities, and New Zealand strengths and capabilities for clean energy.

### Measurement Standards Laboratory (MSL)

**Mohsen Maddah:** The project was to automate the existing MSL mass comparators for calibrating industrial mass units that involved the design and development of the system hardware and software.

### Dunedin City Council

**Noah Hensley**: Stormwater quality and supporting the drinking water treatment team.



**“The Ministry for the Environment internship has fast-tracked my career, helping me to immediately experience the science-policy interface that I had dreamt of exploring and allowing me to upskill rapidly in this area that I’m passionate about.”**
HEATHER JAMESON

**“I have been juggling scientific research and science policy on a weekly basis. The process has been enlightening.”**
ANKITA GANGOTRA

**“The interns' work ethic, eagerness to learn and problem solving nature, is showcased by the innovative lens they’ve brought to our work environment.”**
HUGO BLOOR, MFE

**“This was completely unlike other science related work I have done which of itself gave rise to valuable insights on the role of science in our society.”**
KYLE WEBSTER

**“Thanks so much Kyle, for all your work and organisation of this massive topic and again to the MacDiarmid Institute and all the researchers and policy folk who invested time in helping Kyle straddle the science-policy interface in an enormous topical area!”**
PRIME MINISTER'S CHIEF SCIENCE ADVISOR, PROFESSOR JULIET GERRARD



MacDiarmid Institute
Annual Report
2019

# Commercial internships

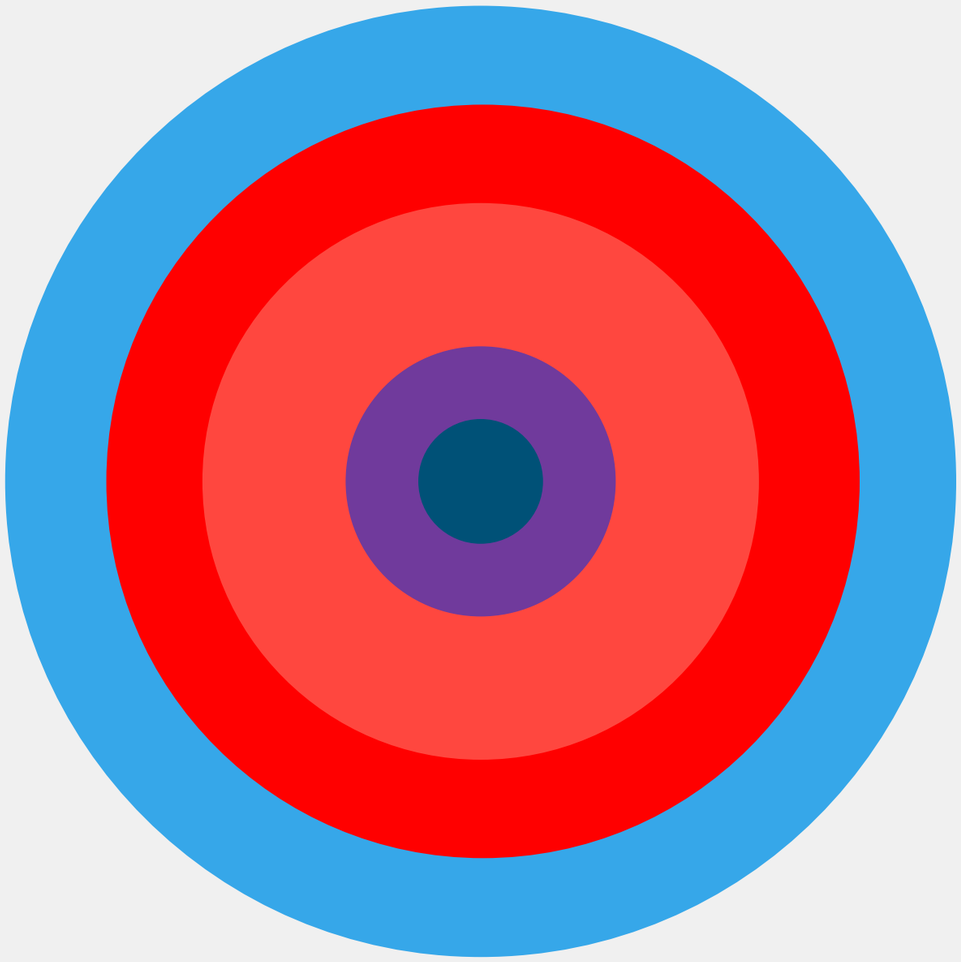
MacDiarmid Institute students are a high-quality resource for local companies needing advanced technical and R&D skills and we’ve worked towards matching these skills and the companies through our internships. The internships help students who have submitted their PhD theses to find placements that relate to their experience while rapidly developing valuable industry experience. We support companies to find the right people as well as sourcing funding from numerous funding sources, including our own. We aim to provide a wide range of placements to ensure there’s something to suit everyone’s needs and have found both mature and early stage companies are able to benefit from the interns’ placements.

**1: Mint.**
Mint Innovation is a startup company developing the ability to turn electronic waste into valuable raw materials, including gold. After raising $5.2 million in late 2018, they have developed an industrial demonstration plant to refine their chemical and industrial processes and have needed robust technical capability to develop these innovative processes towards commercial scale. Mint are hosting MacDiarmid Institute alumna, Loc Tran, following her PhD submission on methods to remove either nitrate or heavy metals from water.

**“Having Loc work with us as an intern has been very valuable and we are in the process of offering her a position at Mint once she has completed. If she accepts, we will have four PhD chemists on our staff who were trained through the MacDiarmid Institute.”**
DR OLLIE CRUSH (CSO, MINT INNOVATION)

**2: Matū.**
Matū is a New Zealand VC firm that makes active, syndicated investments in early-stage deep tech start-ups supported by an experienced scientific advisory board. They have an active intern programme upskilling recent graduates to work in the investment industry, a crucial need if New Zealand is to develop a large science-based economy. The firm has developed good links to the Māori economy, including through a partnership with FOMA Innovate and has an ethical investment policy, where the fund takes a long-term view on the impacts of their investments. There is a good match between Matū and the research and ethos of the MacDiarmid Institute with the long development cycles of deep tech, shared values, people development and recognition of the value of sustainability to New Zealand’s economic future. Matū are hosting MacDiarmid Institute alumna, Dana Goodacre, with a background in analytical chemistry.

**“Dana’s excellent analytical abilities have helped the fund reach out to more researchers in the materials, additive manufacturing, and biochemistry fields. Her contributions to the team have been greatly valued, with both scientific expertise and strong communication skills.”**
DR ANDREW CHEN (VENTURE ASSOCIATE, MATŪ FUND)



# 5. Into the metrics.

# Financials

| | 2018 | 2019 |
|---|---|---|
| Core funding | 8,150,408 | 8,847,015 |
| Other funding (mainly interest income) | 268,007 | 222,892 |
| Total revenue | 8,418,415 | 9,069,907 |
| **Salaries and salary related costs** | | |
| Director and Principal Investigators | 854,688 | 814,090 |
| Post-Doctoral Fellows | 640,724 | 705,597 |
| Research / Technical Assistants | 225,487 | 222,852 |
| Others | 444,317 | 467,620 |
| Total salaries and salary related costs | 2,165,216 | 2,210,159 |
| **Other costs** | | |
| Overheads | 1,893,583 | 2,407,636 |
| Project Costs | 1,823,281 | 2,789,634 |
| Travel | 549,967 | 462,915 |
| Postgraduate Students | 1,986,368 | 1,199,563 |
| Total other costs | 6,253,199 | 6,859,748 |
| Total expenditure | 8,418,415 | 9,069,907 |
| Net surplus / (Deficit) | - | - |





# At a glance

| | Detailed category |
|---|---|
| **Headcounts by category** | Emeritus Investigators 20<br>Principal Investigators 33<br>Stakeholder Relations Partner Iwi 1<br>Associate Investigators 44<br>Postdoctoral researchers 125<br>Students 348 |
| | **Total 571** |
| **Peer reviewed research outputs by type** | Journal articles 401<br>Book chapters 4<br>Conference papers 18<br>Books 1<br>Keynote speakers and invited addresses 40 |
| | **Total 464** |

# Board, executive, staff and students

## Governance Representative Board

**Paul Atkins**
Chair of the Board

**Professor Richard Blaikie**
Deputy Vice-Chancellor, Research & Enterprise
University of Otago

**Will Charles**
Executive Director, Technology Development, UniServices
University of Auckland

**Professor Don Cleland**
Professor of Process Engineering
Massey University

**Heather Deacon***
General Manager - Research and Technical Services Operation, Māori Economy and Programmes
Callaghan Innovation

**Professor David Harper***
Acting Pro Vice-Chancellor Science, Engineering, Architecture & Design
Victoria University of Wellington

**Professor Wendy Lawson**
Pro Vice-Chancellor Science
University of Canterbury

**Joe Manning**
Head of Department – Materials and Air
GNS Science

**Hēmi Rolleston***
General Manager Māori Forestry Futures
Scion

**Geoff Todd**
Managing Director, VicLink
Victoria University of Wellington

**Professor Mike Wilson***
Pro Vice-Chancellor Science, Engineering, Architecture & Design
Victoria University of Wellington

*Partial year

### Ex-Officio

**Associate Professor Nicola Gaston**
Co-Director, MacDiarmid Institute
University of Auckland

**Professor Justin Hodgkiss**
Co-Director, MacDiarmid Institute
Victoria University of Wellington

**Associate Professor Geoff Willmott**
Deputy Director Commercialisation and Industry Engagement, MacDiarmid Institute
University of Auckland

**Professor Paul Kruger**
Deputy Director Stakeholder Engagement, MacDiarmid Institute
University of Canterbury

**Associate Professor Carla Meladandri**
Science Executive Representative, MacDiarmid Institute
University of Otago

**Catherine Gibbs**
Centre Manager, MacDiarmid Institute
Victoria University of Wellington

**Rosie Wayte***
Administrator, MacDiarmid Institute
Minute-taker
Victoria University of Wellington

**Carol Wheatley***
Administrator, MacDiarmid Institute
Minute-taker
Victoria University of Wellington

*Partial year

## Industry Advisory Group

**Paul Adams**
Chairperson & Chief Executive Officer
EverEdge IP

**Simon Arnold**
Managing Director
Arnold.co.nz – Investing with Science
Part-time CEO of NZ's National Energy Research Institute

**Dr Andrew Coy**
Chief Executive Officer
Magritek

**Suse Reynolds**
Executive Director
The Angel Association New Zealand
Board member of Wellington region's Angel HQ

**Greg Shanahan**
Managing Director & Co-founder
Veriphi and Founder of the Technology Investment Network

**Dr Shaun Tan**
Head of Technology
Lanaco

**Dr Andrew West**
Chairman
Aquafortus
General Partner of Matu

## International Science Advisory Board

**Professor Sir Richard Friend**
Cavendish Professor of Physics
University of Cambridge, UK
Physics of energy materials, condensed matter

**Professor Justin Gooding***
Scientia Professor
Founding Co-director of The Australian Centre for NanoMedicine
University of New South Wales, Australia
Nano-medicine and electrochemistry

**Dr Anita Hill***
Chief Research Scientist, Future Industries
CSIRO, Australia
Porous materials

**Professor Wilhelm Huck***
Professor of Chemistry, Institute for Molecules and Materials
Radboud University, Netherlands
Artificial cells

**Professor Michael Kelly***
Prince Phillip Professor of Technology
University of Cambridge, UK
Electro-optic materials and devices

**Professor Jeffery Long***
Professor of Chemical & Biomolecular Engineering
University of California, Berkeley, USA
Inorganic and solid state chemistry

**Professor Tomonobu Nakayama**
Deputy Director, Administrative Director, Group Leader of WPI-MANA
Deputy Director of ICYS
Professor at the University of Tsukuba
National Institute for Materials Science | NIMS
International Center for Materials Nanoarchitectonics (MANA)
University of Tsukuba, Japan
Surface physics and chemistry, nanotechnology, nanobioscience

**Professor Daniel Nocera**
Patterson Rockwood Professor of Energy
Harvard University, USA
Chemistry of renewal energy



MacDiarmid Institute
Annual Report
2019

**Professor Teri Odom***
Associate Chair of the Department of Chemistry
Charles E. and Emma H. Morrison Professor
Northwestern University, IL, USA
Designing structured nanoscale materials with exceptional properties

**Professor Ivan Parkin**
Dean of Mathematical and Physical Sciences Faculty
University College London, UK
Nanomaterials

**Professor Annie Powell***
Professor of Inorganic Chemistry, Institute of Chemistry and Institute of Nanotechnology
Karlsruhe Institute of Technology
Germany
Molecular materials

**Dr Charles Royal***
Independent researcher and consultant
New Zealand
Mātauranga Māori

**Professor Thomas Schimmel***
Director, Institute of Applied Physics
Head of Department, Institute of Nanotechnology
Karlsruhe Institute of Technology
Institute of Applied Physics and Institute of Nanotechnology
Germany
Scanning probe microscopy and nanolithography

**Professor Michelle Simmons**
Director, Australian Research Council Centre of Excellence for Quantum Computation and Communication Technology
Laureate Fellow
Scientia Professor of Physics
University of New South Wales, Australia
Quantum computing, condensed matter physics

**Professor Matt Trau**
Professor of Chemistry, University of Queensland
Deputy Director and co-founder, 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
Materials for computing

*Partial year

## Science Executive

**Associate Professor Nicola Gaston**
Co-Director, MacDiarmid Institute
University of Auckland

**Professor Justin Hodgkiss**
Co-Director, MacDiarmid Institute
Victoria University of Wellington

**Professor Paul Kruger****
Deputy Director Stakeholder Engagement
University of Canterbury

**Associate Professor Geoff Willmott**
Deputy Director Commercialisation and Industry Engagement
University of Auckland

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

**Dr Renee Goreham***
Associate Investigator Representative
Victoria University of Wellington

**Dr Pauline Harris***
Māori Research Representative
Victoria University of Wellington

**Associate Professor Carla Meladandri**
Principal Investigator Representative
University of Otago

**David Perl**
MESA Chairperson
Massey University

**Dr Natalie Plank**
Principal Investigator Representative
Victoria University of Wellington

**Associate Professor Geoffrey Waterhouse***
Science Leader: Energy
University of Auckland

**Dr Catherine Whitby***
Associate Investigator Representative
Massey University

**Professor Bill (Martin) Williams**
Science Leader: Functional Nanostructures
Massey University

### Ex-Officio

**Catherine Gibbs**
Centre Manager, MacDiarmid Institute
Victoria University of Wellington

**Kevin Sheehy***
Commercialisation Manager, MacDiarmid Institute
Victoria University of Wellington

**Rosie Wayte***
Administrator, MacDiarmid Institute
Minute-taker
Victoria University of Wellington

**Carol Wheatley***
Administrator, MacDiarmid Institute
Minute-taker
Victoria University of Wellington

**Vanessa Young**
Strategic Engagement Manager, MacDiarmid Institute
Victoria University of Wellington

*Partial year
** Change in status from Science Leader: Energy to Deputy Director

## MacDiarmid Emerging Scientist Association (MESA) 2019

**David Perl**
Chair
PhD Student
Massey University

**Edoardo Galli**
Secretary
PhD Student
University of Canterbury

**Tarek Kollmetz**
Treasurer
PhD Student
University of Auckland

**Shalini Divya**
Social Media Representative
PhD Student
Victoria University of Wellington

**Nicola Altenhuber**
Centre Representative
PhD Student
University of Canterbury

**Sam Brooke**
Centre Representative
PhD Student
Massey University

**Taniela Lolohea**
Centre Representative
PhD Student
University of Auckland

**Kira Pitman**
Centre Representative
MSc Student
Victoria University of Wellington

**Sririam Sundaresan**
Centre Representative
PhD Student
University of Otago

## Principal Investigators (33)

Maan Alkaisi
Martin Allen
Sally Brooker
Penny Brothers
Simon Brown
Alison Downard
Nicola Gaston
Keith Gordon
Michele Governale
Simon Granville
Pauline Harris
Justin Hodgkiss
Derek Kawiti
John Kennedy
Paul Kruger*
Eric Le Ru
Nigel Lucas
Jenny Malmström
Duncan McGillivray
Carla Meledandri
Franck Natali***
Thomas Nann****
Volker Nock
Natalie Plank
Craig Rofe
Ben Ruck
Shane Telfer
Jadranka Travas-Sejdic
Geoff Waterhouse**
Grant Williams
Martin (Bill) Williams
Geoff Willmott
Ulrich Zuelicke

* Indicates pro-rata status shift from Science Leader to DD
** Indicates pro-rata status shift from PI to Science Leader
***Indicates pro-rata status shift from DD to PI
**** Partial year - left the MI in 2019

## Stakeholder Relations Partner Iwi (1)

Diane Bradshaw

## Associate Investigators (44)

Eva Anton*
Baptiste Auguie
Ebubekir (Ebu) Avci*
David Barker
Saurabh Bose
Margaret Brimble
Philip Brydon
Chris Bumby
Peng Cao*
Damian Carder
Jack Chen*
Shen Chong
Matthew Cowan
James Crowley
Nathaniel Davis*
Renwick Dobson
Laura Domigan
Guy Dubuis
Christopher Fitchett
Robin Fulton
Petrik Galvosas
Anna Garden
Vladimir Golovko
Renee Goreham**
Shaun Hendy
Bridget Ingham**
Geoff Jameson
Marcus Jones*
Vedran Jovic*
Erin Leitao
Jerome Leveneur
Ben Mallett
Aaron Marshall
Michel Nieuwoudt
Emilia Nowak
Elke Pahl
Viji Sarojini
Tilo Söhnel
Krista Steenbergen*
James Storey
Charles Unsworth
Mark Waterland
Catherine Whitby
Stuart Wimbush

*Partial year – new Associate Investigator in 2019
**Partial year – left the MI in 2019

## Emeritus Investigators (20)

Richard Blaikie
Ian Brown
Bob Buckley
Sally Davenport
John Evans*
Juliet Gerrard
Simon Hall
Jim Johnston
Alan Kaiser
Tim Kemmitt
Ken MacKenzie
Andreas Markwitz
Jim Metson
Roger Reeves
Mike Reid
Cather Simpson
Jeff Tallon
Richard Tilley
Joe Trodahl
David Williams

*Partial year – retired in 2019

## Professional Staff

**Genevieve Fitzjames**
Administrator, MacDiarmid Institute
University of Auckland

**Catherine Gibbs**
Centre Manager, MacDiarmid Institute
Victoria University of Wellington

**Alice Girton***
Administrator, MacDiarmid Institute
Victoria University of Wellington

**Katy Groom**
Communications Support, MacDiarmid Institute
Victoria University of Wellington

**Kevin Sheehy***
Commercialisation Manager, MacDiarmid Institute
Victoria University of Wellington

**Gary Turner**
Research Engineer
University to Canterbury

**Rosie Wayte***
Administrator, MacDiarmid Institute
Victoria University of Wellington

**Carol Wheatley***
Administrator, MacDiarmid Institute
Victoria University of Wellington

**Vanessa Young**
Strategic Engagement Manager, MacDiarmid Institute
Victoria University of Wellington
*Partial year



MacDiarmid Institute
Annual Report
2019

## MI Students in 2019 (348)

### MSc (45)

| | | |
|---|---|---|
| **Bagley** | Mark | Victoria University of Wellington |
| **Berger** | Amanda | Victoria University of Wellington |
| **Brewster** | Diane | University of Auckland |
| **Butler** | Tane | Victoria University of Wellington |
| **Chen** | Queenie | University of Auckland |
| **Chen** | Xize | University of Auckland |
| **Cox** | Matthew | University of Otago |
| **Craig** | Tim | Massey University |
| **Data** | Shailja | University of Auckland |
| **Denys** | Mathew | University of Otago |
| **Ding** | Qituo | University of Canterbury |
| **Doonan** | William | Victoria University of Wellington |
| **Elashkar** | Ahmed | University of Canterbury |
| **Filatov** | Yuri | University of Canterbury |
| **Hardy** | Jake | Victoria University of Wellington |
| **He** | Jing | Massey University |
| **Ingle** | Max | Victoria University of Wellington |
| **Kuang** | Ze | University of Auckland |
| **Kumar** | Barath | Massey University |
| **Lagesse** | Natalie | University of Otago |
| **Liu** | Peng (Tony) | University of Auckland |
| **Lofroth** | Matthew | Massey University |
| **Luong** | Tuan Minh | University of Auckland |
| **Matthews** | Hannah | University of Auckland |
| **Newton-Vesty** | Michael | University of Canterbury |
| **Owen** | Jessie | Massey University |
| **Panjeta** | Madhu | Auckland University of Technology |
| **Patel** | Hamesh | University of Auckland |
| **Payet** | Fabien | University of Canterbury |
| **Pike** | Matthew | University of Canterbury |
| **Pitman** | Kira | Victoria University of Wellington |
| **Prime** | Helen | University of Otago |
| **Ring** | Jonathan | University of Canterbury |
| **Rov** | Rosanna | University of Auckland |
| **Sharma** | Vaibhav | Victoria University of Wellington |
| **Singh** | Arnold | University of Auckland |
| **Smith** | Anna | University of Canterbury |
| **Symon** | Nicholas | Massey University |
| **Tang** | Pui Yan | University of Auckland |
| **Thomas** | Annabella | University of Canterbury |
| **Tolentino** | Winter | Auckland University of Technology |
| **Warren** | Aran | University of Canterbury |
| **Weaver** | Nic | University of Canterbury |
| **Wild** | Eleonore | University of Auckland |
| **Xia** | Bangwei | University of Auckland |

### PhD (303)

| | | |
|---|---|---|
| **Abudayyeh** | Abdullah | University of Otago |
| **Agnieray** | Heiana | University of Auckland |
| **Ahangarpour** | Marzieh | University of Auckland |
| **Akogun** | Fola | University of Otago |
| **Alkas** | Adil | Massey University |
| **Allam** | Ravi Tej | Auckland University of Technology |
| **Altenhuber** | Nicola | University of Canterbury |
| **Anand** | Aljo | University of Auckland |
| **Andrew** | Phillippa-Kate (Kate) | Massey University |
| **Anil** | Anusree | University of Auckland |
| **Arshad** | Faiza | University of Otago |
| **Ashforth** | Simon | University of Auckland |
| **Ashraf** | Jesna | University of Auckland |

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|---|---|---|
| **Auer** | Bernhard | Massey University |
| **Ayed** | Zeineb | Victoria University of Wellington |
| **Ayupova** | Deanna | Victoria University of Wellington |
| **Bandara** | Nisansala | Massey University |
| **Bason** | Nic | University of Canterbury |
| **Beikzadeh Ghelejlou** | Sara | University of Auckland |
| **Bell-Tyler** | Joseph | University of Auckland |
| **Bernach** | Michal | University of Canterbury |
| **Bhugra** | Vaibhav | Victoria University of Wellington |
| **Bioletti** | Gabriel | Victoria University of Wellington |
| **Bjareborn** | Oscar | Victoria University of Wellington |
| **Board** | Amanda | University of Canterbury |
| **Bodman** | Samantha | University of Canterbury |
| **Bondi** | Luca | University of Otago |
| **Borah** | Rohan | Victoria University of Wellington |
| **Brant** | Nicola | University of Auckland |
| **Brett** | Matthew | Victoria University of Wellington |
| **Brooke** | Sam | Massey University |
| **Brooks** | Justin (Gus) | Victoria University of Wellington |
| **Broom** | Matheu | University of Auckland |
| **Browning** | Leo | Victoria University of Wellington |
| **Camacho** | Luis | University of Auckland |
| **Canever** | Nicolo | Victoria University of Wellington |
| **Carroll** | Liam | University of Canterbury |
| **Casey-Stevens** | Caitlin | University of Otago |
| **Cassie** | Erica | Victoria University of Wellington |
| **Chan** | Andrew | University of Auckland |
| **Chandrabose** | Sreelakshmi | Victoria University of Wellington |
| **Cheema** | Jamal | University of Auckland |
| **Chen** | Xiaohan | Victoria University of Wellington |
| **Chen** | Linda | University of Canterbury |
| **Choi** | Hans | University of Auckland |
| **Choudhury** | Minati | University of Otago |
| **Christopher** | Tim | University of Auckland |
| **Cink** | Ruth | University of Auckland |
| **Cleland** | Josiah | Massey University |
| **Clyde** | Daniel | University of Auckland |
| **Conroy** | Francesca | University of Auckland |
| **Coombes** | David | University of Canterbury |
| **Cornelio** | Rani | Massey University |
| **Cryer** | Matthew | Victoria University of Wellington |
| **Currie** | Michael | University of Canterbury |
| **Davies** | James | University of Canterbury |
| **Devese** | Samuel | Victoria University of Wellington |
| **Divya** | Shalini | Victoria University of Wellington |
| **Dong** | Yusong | University of Auckland |
| **Dosado** | Aubrey | University of Auckland |
| **Durrani** | Madeeha | University of Auckland |
| **Earl** | Andrew | University of Auckland |
| **Emeny** | Chrissy | University of Canterbury |
| **Fadakar** | Farzaneh | Victoria University of Wellington |
| **Ferris** | Shaun | University of Auckland |
| **Fisher** | Ewan | University of Auckland |
| **Francis** | Adam | Victoria University of Wellington |
| **Franke** | Christine | University of Canterbury |
| **Freeman** | Jared | University of Auckland |
| **Gaar** | Jakob | University of Auckland |
| **Galli** | Eduardo | University of Canterbury |
| **Gangotra** | Ankita | University of Auckland |
| **Ghosh** | Sunandita | University of Auckland |
| **Giglio** | Cannon | University of Auckland |
| **Gilkes** | Jenna | University of Canterbury |
| **Gilmour** | James | University of Auckland |





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|---|---|---|
| **Goodacre** | Dana | University of Auckland |
| **Grant** | Philip | University of Auckland |
| **Grant** | Thomas | University of Auckland |
| **Guehne** | Robin | Victoria University of Wellington |
| **Guo** | Lun | University of Auckland |
| **Gupta** | Arka | Massey University |
| **Hackett** | Alissa | University of Auckland |
| **Hall** | Thomas | University of Otago |
| **Hamonnet** | Johan | University of Canterbury |
| **Happe** | Erica | Victoria University of Wellington |
| **Harvey-Reid** | Nathan | University of Canterbury |
| **Haverkate** | Natalie | University of Auckland |
| **Hayali** | Ahmed | University of Canterbury |
| **Hedley** | Gavin | University of Canterbury |
| **Hermanspahn** | Lily | University of Canterbury |
| **Hermant** | Yann | University of Auckland |
| **Hindcapie Florez** | Edison | Massey University |
| **Holmes-Hewett** | Will | Victoria University of Wellington |
| **Horne** | Chris | University of Canterbury |
| **Horocek-Glading** | Miriana | University of Auckland |
| **Hosking** | Peter | University of Auckland |
| **Hou** | Caixia | University of Canterbury |
| **Howard** | Ben | University of Canterbury |
| **Howard** | Georgina | University of Auckland |
| **Hughson** | Fraser | Victoria University of Wellington |
| **Hung** | Jenny | University of Auckland |
| **Ilina** | Aleksandra | Victoria University of Wellington |
| **Itumoh** | Emeka | University of Auckland |
| **Jelley** | Rebecca | University of Auckland |
| **Ji** | Junghun | University of Auckland |
| **Joseph** | Delsa | University of Auckland |
| **Kanyan** | Deepika | University of Auckland |
| **Karabulut** | Fabrice | University of Otago |
| **Kariman** | Asad | University of Canterbury |
| **Kasim** | Johanes | University of Auckland |
| **Khadka** | Roshan | University of Auckland |
| **Khalil** | Bushra | University of Auckland |
| **Khan** | Wasim | University of Canterbury |
| **Kihara** | Shinji | University of Auckland |
| **Kleinjan (nee Bakker)** | Carline | University of Canterbury |
| **Ko** | Jason | University of Auckland |
| **Kollmetz** | Tarek | University of Auckland |
| **Kotulla** | Markus | Victoria University of Wellington |
| **Kovalenko** | Nadiia | University of Auckland |
| **Kumar** | Saawan | University of Auckland |
| **Kumar** | Vipin | University of Auckland |
| **Lacalendola** | Nicola | University of Auckland |
| **Lambie** | Stephanie | University of Auckland |
| **Landon-Lane** | Leatham | University of Canterbury |
| **Latif** | Qaisar | University of Auckland |
| **Laufersky** | Geoffry | Victoria University of Wellington |
| **Le Ster** | Maxime | University of Canterbury |
| **Lee** | Subo | Massey University |
| **Li** | Sheung Yin (Tony) | University of Auckland |
| **Li** | Si | University of Auckland |
| **Li** | Yang | Massey University |
| **Lisboa** | Lynn | University of Otago |
| **Lo** | Stephen | University of Auckland |
| **Lofroth** | Matthew Aaron | Massey University |
| **Lolohea** | Taniela | University of Auckland |
| **Love** | Michael | University of Canterbury |
| **Lu** | Ben | University of Auckland |
| **Lu** | Ziqi (Michael) | University of Auckland |

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|---|---|---|
| **Lucarelli** | Valentina | University of Auckland |
| **Luong** | Tuan Minh | University of Auckland |
| **Lya** | Crystal | University of Auckland |
| **Mackercher** | Hannah | University of Canterbury |
| **Maddah** | Mohsen | Victoria University of Wellington |
| **Maity** | Tanmay | Victoria University of Wellington |
| **Majic** | Matt | Victoria University of Wellington |
| **Makinde** | Zainab | University of Auckland |
| **Mallinson** | Joshua | University of Canterbury |
| **Manuguri** | Sesha | University of Auckland |
| **Mao** | Yubing | University of Auckland |
| **Mapley** | Joseph | University of Otago |
| **Marone-Hitz** | Ombéline | University of Otago |
| **Martin Treceno** | Samuel | University of Canterbury |
| **Mataira-Cole** | Ratu | Victoria University of Wellington |
| **Mautner** | Ira Nathan | University of Auckland |
| **McGowan** | John | University of Auckland |
| **Meffan** | Claude | University of Canterbury |
| **Menke** | Henri | University of Otago |
| **Metin** | Danielle | University of Auckland |
| **Miller** | Jackson | Victoria University of Wellington |
| **Mirzakhani** | Sara | University of Canterbury |
| **Mohandas** | Nimisha | Massey University |
| **Mohd Darbi** | Nur Maizura | University of Auckland |
| **Molloy** | Ellen | Victoria University of Wellington |
| **Monteiro** | Isabela | University of Auckland |
| **Moteshakeri** | Mahsa | University of Auckland |
| **Munro** | Ben | Massey University |
| **Murugathas** | Thanihaichelvan (Selvan) | Victoria University of Wellington |
| **Naiya** | Mohinder | University of Auckland |
| **Nalumaga** | Hellen | Victoria University of Wellington |
| **Narasimhan** | Badri Narayanan | University of Auckland |
| **Nawaz** | Tehreema | Victoria University of Wellington |
| **Neiman** | Alex | University of Canterbury |
| **Nesbitt** | Sam | University of Canterbury |
| **Nguyen** | Hong Phan (Jenna) | Victoria University of Wellington |
| **Nott** | Thomas | Victoria University of Wellington |
| **Onal** | Sevgi | University of Canterbury |
| **Onyema** | Chikwzie | University of Canterbury |
| **Opiyo** | George | University of Auckland |
| **Orcheston-Findlay** | Louise | University of Canterbury |
| **Ortega** | Kenneth | University of Otago |
| **Pandian** | Santhosh Kumar | University of Auckland |
| **Park** | Kun Woo (Woo) | University of Auckland |
| **Patel** | Sneh | University of Auckland |
| **Paulin** | Emily | University of Auckland |
| **Pearl** | Essie | University of Auckland |
| **Perl** | David | Massey University |
| **Peterson** | Danielle | University of Auckland |
| **Prabowo** | Sigit | Victoria University of Wellington |
| **Pradhan** | Susav | Massey University |
| **Prasad** | Shyamal | Victoria University of Wellington |
| **Pu** | Yuguang | University of Auckland |
| **Pugliese** | Silvina | Victoria University of Wellington |
| **Quach** | Megan | University of Auckland |
| **Rabanzo-Castillo** | Kristel Mae | University of Auckland |
| **Rajchakit** | Urawadee | University of Auckland |
| **Ramamirtham** | Sashikumar | Massey University |
| **Ramkrishna** | Mandal | University of Otago |
| **Randall** | George | University of Auckland |
| **Rani** | Aakanksha | University of Auckland |
| **Rees** | Shaun | University of Auckland |
| **Rehan** | Muhammad (Rehan) | Massey University |





| | | |
|---|---|---|
| **Reis** | Miguel | University of Canterbury |
| **Ren** | Zhijun (Chloe) | Auckland University of Technology |
| **Ridings** | Kannan | University of Auckland |
| **Ross** | Daniel | University of Otago |
| **Ruffman** | Charlie | University of Otago |
| **Safaei** | Sina | University of Auckland |
| **Salehitaleghani** | Sara | University of Canterbury |
| **Sarwar** | Mian Makhdoom (Mak) | University of Otago |
| **Savoie** | Maxime | University of Canterbury |
| **Schroeder** | Kathryn | Victoria University of Wellington |
| **Schuyt** | Joseph | Victoria University of Wellington |
| **Schweig** | Michael | Victoria University of Wellington |
| **Scott** | Jonty | University of Canterbury |
| **Sen** | Anindita | Victoria University of Wellington |
| **Service** | Erin | Victoria University of Wellington |
| **Sester** | Clement | Victoria University of Wellington |
| **Shaib** | Ali | Victoria University of Wellington |
| **Sharma** | Shailendra | University of Canterbury |
| **Shashidar** | Vinay | University of Auckland |
| **Sheikholeslami** | Sina | University of Auckland |
| **Shepperson** | Oscar | University of Auckland |
| **Shillito** | Georgina | University of Otago |
| **Shirai** | Shota | University of Canterbury |
| **Shojaei** | Maryam | University of Canterbury |
| **Siamaki** | Mohammad | Victoria University of Wellington |
| **Singh** | Harshpreet | University of Auckland |
| **Singh** | Sandhya | University of Otago |
| **Siu** | Christy | University of Auckland |
| **Smith** | Alexander | University of Auckland |
| **Smith** | Jordan | University of Otago |
| **Smits** | Odile | Massey University |
| **Solís Muñana** | Pablo | Auckland University of Technology |
| **Song** | Xin | University of Auckland |
| **Spasovski** | Martin | University of Auckland |
| **Steinmetz** | Kai | University of Auckland |
| **Stevenson** | Sarah | Victoria University of Wellington |
| **Sturov** | Efim | Victoria University of Wellington |
| **Sultana** | Nishat | University of Auckland |
| **Sun** | Yiling | University of Canterbury |
| **Sundaresan** | Sriram | University of Otago |
| **Suschke** | Konrad | Victoria University of Wellington |
| **Sutton** | Joshua | University of Otago |
| **Taheri Qazvini** | Omid | Massey University |
| **Taleshiahangari** | Hani | University of Canterbury |
| **Tamming** | Ronnie | Victoria University of Wellington |
| **Tan** | Shi Min | University of Auckland |
| **Tang** | Chhayly | Victoria University of Wellington |
| **Tesana** | Siriluck | University of Canterbury |
| **Thompson** | Kadin | Victoria University of Wellington |
| **Thorn** | Karen | Victoria University of Wellington |
| **Ting** | Sheng Hao (Matthew) | University of Auckland |
| **Tollemache** | Cherie | University of Auckland |
| **Tran** | Loc | Victoria University of Wellington |
| **Twidle** | Andrew | University of Auckland |
| **Uhrig** | David | Robinson Research Institute |
| **Ullstad** | Felicia | Victoria University of Wellington |
| **Vadakkedath** | Praveen | University of Auckland |
| **Van Hilst** | Quinn | University of Otago |
| **Vargas** | Matheus | University of Auckland |
| **Vasdev** | Roan | University of Otago |
| **Vella** | Joe | University of Auckland |
| **Vyborna** | Natalija | University of Auckland |
| **Wagner** | Isabella | Victoria University of Wellington |

| | | |
|---|---|---|
| **Wan** | Ziyao | University of Auckland |
| **Wang** | Jie | Victoria University of Wellington |
| **Wang** | Min | University of Auckland |
| **Wang** | Qing | University of Auckland |
| **Wang** | Xindi (Andy) | University of Auckland |
| **Wang** | Yi | University of Auckland |
| **Wang** | Yuxin | University of Auckland |
| **Wang** | Zifei | University of Auckland |
| **Watkin** | Serena | University of Canterbury |
| **Watkin** | Serena | University of Canterbury |
| **Weal** | Geoffrey | University of Otago |
| **Webster** | Kyle | University of Auckland |
| **Westberry** | Benjamin | Massey University |
| **Wildervanck** | Martijn | University of Auckland |
| **Williams** | Elyse | University of Auckland |
| **Wilson** | Ben | University of Canterbury |
| **Wong** | Andy | University of Auckland |
| **Wong** | Jin Xiang | Massey University |
| **Wood** | David | University of Canterbury |
| **Wu** | Jiazun | Victoria University of Wellington |
| **Wu** | Ting | University of Canterbury |
| **Xu** | Buzhe | University of Auckland |
| **Xu** | Guangyuan (Sam) | University of Auckland |
| **Xu** | Xiaoyi (Joy) | University of Auckland |
| **Yang** | Mingrui (Ray) | Massey University |
| **Yang** | Tingxuan | University of Auckland |
| **Ye** | Liu (Yasmin) | Victoria University of Wellington |
| **Ye** | Piao | University of Auckland |
| **Yim** | Victor | University of Auckland |
| **Yudhipratama** | Indra | University of Auckland |
| **Zhang** | Ao | Victoria University of Wellington |
| **Zhang** | Hongzhou | University of Auckland |
| **Zhang** | Karl | University of Auckland |
| **Zhang** | Peikai | University of Auckland |
| **Zhang** | Wen | University of Auckland |
| **Zhang** | Ethan | Victoria University of Wellington |
| **Zhang** | Yao | Victoria University of Wellington |
| **Zhoiu** | Huihua | University of Auckland |



MacDiarmid Institute
Annual Report
2019

## MI Postdoctoral Researchers & RAs in 2019 (125)

### Postdocs (81)

| | | |
|---|---|---|
| **Acharya** | Susant | University of Canterbury |
| **Akbarinejad** | Alireza | University of Auckland |
| **Anton** | Eva | Victoria University of Wellington |
| **Arif** | Tanzeel | Victoria University of Wellington |
| **Baek** | Paul | University of Auckland |
| **Balzan** | Miguel | University of Auckland |
| **Bodman** | Samantha | University of Canterbury |
| **Bose** | Saurabh | University of Canterbury |
| **Calvert** | Matthew | University of Auckland |
| **Cameron** | Alan | University of Auckland |
| **Cavanagh** | David | University of Otago |
| **Chalard** | Anaïs | University of Auckland |
| **Chan** | Eddie | University of Auckland |
| **Chan** | Jay | Victoria University of Wellington |
| **Chen** | Kai | Victoria University of Wellington |
| **Chen** | Wan-Ting | University of Auckland |
| **Cink** | Ruth | University of Auckland |
| **Clements** | John | Massey University |
| **Cornuault** | Valerie | Massey University |
| **Cotton** | Gemma | University of Otago |
| **Davison** | Emma | University of Auckland |
| **Ding** | Xiaobo | University of Auckland |
| **Dolamore** | Fabian | University of Canterbury |
| **Falconer** | Jonathan | University of Otago |
| **Furkert** | Daniel | University of Auckland |
| **Ghaus** | Zahraa Al | University of Auckland |
| **Grand** | Johan | Victoria University of Wellington |
| **Harper** | Andrew | University of Auckland |
| **Hashemi** | Azadeh | University of Canterbury |
| **Hayat** | Muhammad Dilawer (Dilawer) | University of Auckland |
| **Healy** | Colm | University of Canterbury |
| **Holtkamp** | Hannah | University of Auckland |
| **Hume** | Paul | Victoria University of Wellington |
| **Kammermeier** | Michael | Victoria University of Wellington |
| **Kaur** | Manmeet | University of Auckland |
| **Kavianinia** | Iman | University of Auckland |
| **Kee** | Seyoung | University of Auckland |
| **Kurian** | Mima | Victoria University of Wellington |
| **Lefebvre** | Denis | Victoria University of Wellington |
| **Li** | Freda | University of Auckland |
| **Lowrey** | Sam | University of Otago |
| **Macreadie** | Lauren | Massey University |
| **Maerkl** | Tobias | University of Canterbury |
| **Martinez Gazoni** | Rodrigo | University of Canterbury |
| **Menges** | Julian | University of Canterbury |
| **Minnee** | Thomas | University of Auckland |
| **Monahan** | Nicholas | Victoria University of Wellington |
| **Mowla** | Alireza | University of Auckland |
| **Nam** | Seong | University of Auckland |
| **North** | Rachel | University of Canterbury |
| **Novikova** | Nina | University of Auckland |
| **Patil** | Komal | University of Canterbury |
| **Pilkington** | Lisa | University of Auckland |
| **Preston** | Daniel | University of Canterbury |
| **Price** | Mike | Victoria University of Wellington |
| **Rennison** | David | University of Auckland |
| **Rodriguez Jimenez** | Santiago | University of Otago |
| **Rodriguez-Otazo** | Mariela | Massey University |
| **Salkeld (nee Hyland)** | Alana | University of Canterbury |
| **Schebarchov** | Dmitri | Victoria University of Wellington |
| **Scott** | Hayley | University of Canterbury |
| **Seal** | Christopher | University of Auckland |

| | | |
|---|---|---|
| **Sikorska** | Celina | University of Auckland |
| **Soffe** | Rebecca | University of Canterbury |
| **Sommerville** | Walter | Victoria University of Wellington |
| **Sparrow** | Kevin | University of Auckland |
| **Steenbergen** | Krista | Victoria University of Wellington |
| **Stubbing** | Louise | University of Auckland |
| **Sun-Waterhouse** | Dongxiao | University of Auckland |
| **Swain** | Jon | University of Auckland |
| **Tay** | Aaron | University of Otago |
| **Ullah** | Rifat | Victoria University of Wellington |
| **Van der Heijden** | Nadine | University of Auckland |
| **Ward** | Rob | Massey University |
| **Weissert** | Lena | University of Auckland |
| **Wells** | Frederick (Steve) | University of Auckland |
| **Williams** | Geoffrey | University of Auckland |
| **Wilson** | Zoe | University of Auckland |
| **Yang** | Sunghyun | University of Auckland |
| **Yin** | Hang (Ben) | Massey University |
| **Zeng** | Chunyan | Victoria University of Wellington |

## RAs (44)

| | | |
|---|---|---|
| **Aguergaray** | Claude | University of Auckland |
| **Akbarinejad** | Alireza | University of Auckland |
| **Alkas** | Adil | Massey University |
| **Arena** | Giada | Auckland University of Technology |
| **Bason** | Nic | University of Canterbury |
| **Bennington** | Michael | University of Otago |
| **Brind** | Thomasin | University of Otago |
| **Chen** | Wan-Ting | University of Auckland |
| **Chen** | Queenie | University of Auckland |
| **Deijs** | Sjoerd | University of Auckland |
| **Falconer** | Jonathan | MacDiarmid Institute/VUW |
| **Findlay*** | James Alan | University of Otago |
| **Gangotra** | Ankita | University of Auckland |
| **Gillard** | Rachel | University of Auckland |
| **Gilmour** | James | Victoria University of Wellington |
| **Glasson** | Judith | University of Auckland |
| **Hernandez** | Pablo | Massey University |
| **Huang** | Saifang | University of Auckland |
| **Huntington** | Jacob | Victoria University of Wellington |
| **Irani** | Amir | Massey University |
| **Jia** | Vincent | University of Canterbury |
| **Karabulut** | Fabrice | University of Otago |
| **Kolathodi** | Muhamed Shareef (Shareef) | University of Auckland |
| **Lambie*** | Stephanie | University of Otago |
| **Laufersky*** | Geoffry | Victoria University of Wellington |
| **Lu** | Benjamin | University of Auckland |
| **Manuguri** | Sesha | University of Auckland |
| **Maslova** | Kate | Massey University |
| **Munro** | Ben | Massey University |
| **Najafabadi** | Atefeh Fazel | Victoria University of Wellington |
| **Opiyo** | George | University of Auckland |
| **Orcheston-Findlay** | Louise | University of Canterbury |
| **Robinson** | John | Victoria University of Wellington |
| **Siow** | Andrew | University of Auckland |
| **Sodavaram*** | Nireekshan | Victoria University of Wellington |
| **Taleshiahangari** | Hani | University of Canterbury |
| **Tayagui** | Ayelen | Univesity of Canterbury |
| **Thompson** | Kadin | Victoria University of Wellington |
| **Tollemache** | Cherie | University of Auckland |
| **Varnava*** | Kyriakos | University of Auckland |
| **White** | Joni | University of Auckland |
| **Woolly** | Ethan | Victoria University of Wellington |
| **Xu** | Buzhe | University of Auckland |
| **Zhang** | Allan | University of Auckland |

* indicates held more than one RA post





# Journal covers


**Sally Brooker**
Guest editor for Special Issue: Chemistry in New Zealand
*Chemistry – An Asian Journal* **14**, 1084-1303 (2019)


**Sally Brooker and George Kostakis**
Modern coordination chemistry
*Dalton Transactions* **48**, 15318–15320 (2019)


**Margaret Brimble and co-workers**
Synthesis of Endolides A and B; Naturally Occurring N-Methylated Cyclic Tetrapeptides
*MedChemComm* **10**, 693-698 (2019)


**Margaret Brimble and co-workers**
A Versatile Boc Solid Phase Synthesis of Daptomycin and Analogues using Site Specific, On-resin Ozonolysis to Install the Kynurenine Residue
*Chemistry: A European Journal* **25**, 14101-14107 (2019)


**Jadranka Travas-Sejdic and co-workers**
Neural Tissue Engineering: Human Neural Tissues from Neural Stem Cells Using Conductive Biogel and Printed Polymer Microelectrode Arrays for 3D Electrical Stimulation
*Advanced Healthcare Materials* **8**, 1970062 (2019)

# Journals

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| Wood, J. M., Furkert, D. P., **Brimble, M. A.** | 2-Formylpyrrole Natural Products: Origin, Structural Diversity, Bioactivity and Synthesis. | *Natural Product Reports* **36**, 289-306, 2019 |
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| Freeman, J. L., Furkert, D. P., **Brimble, M. A.** | A Chiral Auxiliary-Based Synthesis of the C5-C17 trans-Decalin Framework of Anthracimycin. | *Organic Chemistry Frontiers* **6**, 2954-2963, 2019 |
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| AUTHORS | TITLE | JOURNAL |
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| AUTHORS | TITLE | JOURNAL |
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| AUTHORS | TITLE | JOURNAL |
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| Fusi, F., Bova, S., Saponara, S., Trezza, A., Spiga, O., Hopkins, B., Rennison, D., **Brimble, M. A.** | The Selective Rat Toxicant Norbormide Blocks $K_{ATP}$ Channels in Smooth Muscle Cells but not in Insulin-Secreting Cells. | *Frontiers in Pharmacology* **10**, 598, 2019 |
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MacDiarmid Institute
Annual Report
2019

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| Mukherjee, S., Sikdar, N., O'Nolan, D., Franz, D. M., Gascón, V., Kumar, A., Kumar, N., Scott, H. S., Madden, D. G., **Kruger, P. E.**, Space, B., Zaworotko, M. J. | Trace $CO_2$ capture by an ultramicroporous physisorbent with low water affinity. | *ScienceAdvances* **5**, eaax9171, 2019 |
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| Alkaş, A., Cornelio, J., **Telfer, S. G.** | Tritopic Triazatruxene Ligands for Multicomponent Metal-Organic Frameworks. | *Chemistry - An Asian Journal* **14**, *74, 2018* |
| **Evans, J. J., Alkaisi, M. M.**, Sykes, P. H. | Tumour Initiation: a Discussion on Evidence for a "Load-Trigger" Mechanism. | *Cell Biochemistry and Biophysics* **77**, 293-308, 2019 |
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| Zhang, Q., Webster, R.F., Cheong, S., **Tilley, R.D.**, Lu, X., Amal, R. | Ultrathin Fe-N-C Nanosheets Coordinated Fe-Doped CoNi Alloy Nanoparticles for Electrochemical Water Splitting. | *Particle and Particle Systems Characterization* **36**, 1800252, 2019 |
| Zhang, H., Yang, Z., Wang, X., Yan, S., Zhou, T., Zhang, C., **Telfer, S. G.**, Liu, S. | Uniform copper-cobalt phosphides embedded in N-doped carbon frameworks as efficient bifunctional oxygen electrocatalysts for rechargeable Zn-air batteries. | *Nanoscale* **11**, 17385-17395, 2019 |
| Guehne, R., Chlan, V., **Williams, G. V. M., Chong, S. V.**, Kadowaki, K., Pöppl, A., Haase, J. | Unusual $^{209}$ Bi NMR quadrupole effects in topological insulator $Bi_2Se_3$. | *Journal of Magnetic Resonance* **302**, 34-42, 2019 |
| Sultana, N., Al Amin, A., Metin, D. Z., **Gaston, N.** | Unveiling the structures and electronic properties of $CH_3NH_3PbI_3$ interfaces with $TiO_2$, ZnO, and $SnO_2$: a first-principles study. | *Journal of Materials Science* **54**, 13594-13608, 2019 |
| Gangotra, A., Biviano, M., Dagastine, R. R., Berry, J. D., **Willmott, G. R.** | Use of microaspiration to study the mechanical properties of polymer gel microparticles. | *Soft Matter* **15**, 7286, 2019 |
| Cairns, M. J., Mesic, B., **Johnston, J. H.**, Herzog, M. B. | Use of spherical silica particles to improve the barrier performance of coated paper. | *Nordic Pulp and Paper Research Journal*, 2019 |
| Li, F. F., **Brimble, M. A.** | Using Chemical Synthesis to Optimise Antimicrobial Peptides in the Fight against Antimicrobial Resistance. | *Pure and Applied Chemistry* **91**, 181-198, 2019 |

| AUTHORS | TITLE | JOURNAL |
|---|---|---|
| James, A., McLeod, J., **Hendy, S.**, Marks, K., Rusu, D., Nik, S., Plank, M. J. | Using family network data in child protection services. | *PLOS ONE* **14**, e0224554, 2019 |
| Doroshenko, A., Budarin, V., McElroy, R., Hunt, A. J., Rylott, E., Anderson, C., **Waterland, M.**, Clark, J. | Using in vivo nickel to direct the pyrolysis of hyperaccumulator plant biomass. | *Green Chemistry* **21**, 1236-1240, 2019 |
| Webb, D., **Fulton, J. R.** | Utilising an anilido-imino ligand to stabilise zinc-phosphanide complexes: reactivity and fluorescent properties. | *Dalton Transactions* **48**, 8094-8105, 2019 |
| Sutton, J. J., Nguyen, T. L., Woo, H. Y., **Gordon, K. C.** | Variable-Temperature Resonance Raman Studies to Probe Interchain Ordering for Semiconducting Conjugated Polymers with Different Chain Curvature. | *Chemistry - An Asian Journal* **14**, 1175-1183, 2019 |
| Jia, C., **Waterhouse, G. I. N.**, Sun-Waterhouse, D., Sun, Y. G., Wu, P. | Variety–compound–quality relationship of 12 sweet cherry varieties by HPLC-chemometric analysis. | *International Journal of Food Science and Technology* **54**, 2897-2914, 2019 |
| Svendsen, J., Grant, T., Rennison, D., **Brimble, M. A.** | Very Short and Stable Lactoferricin Derived Antimicrobial Peptides: Design Principles and Potential Uses. | *Accounts of Chemical Research* **52**, 749-759, 2019 |
| Hedwig, G. R., **Jameson, G. B.**, Høiland, H. | Volumetric Properties of the Nucleosides Adenosine, Cytidine, and Uridine in Aqueous Solution at T = (288.15 and 313.15) K and p = (10 to 100) MPa. | *Journal of Solution Chemistry* **48**, 180-199, 2019 |
| Barnsley, J. E., Pelet, W., McAdam, J., Wagner, K., Hayes, P., Officer, D. L., Wagner, P., **Gordon, K. C.** | When 'donor-Acceptor' Dyes Delocalize: A Spectroscopic and Computational Study of D-A Dyes Using 'michler's Base'. | *Journal of Physical Chemistry A* **123**, 5957-5968, 2019 |
| Li, Y., Xu, M., Yin, H., Shi, W., **Waterhouse, G. I. N.**, Li, H., Ai, S. | Yolk-shell $Fe_3O_4$ nanoparticles loaded on persimmon-derived porous carbon for supercapacitor assembly and As (V) removal. | *Journal of Alloys and Compounds* **810**, 151887, 2019 |
| Ge, Y., Li, C., Jiang, X., **Waterhouse, G. I. N.**, Zhang, L., Zhang, Z., Yu, L. | $ZnFe_2O_4$ @ Polypyrrole nanocomposites as an efficient broadband electromagnetic wave absorber at 2–40 GHz. | *Ceramics International* **45**, 13883-13893, 2019 |





# Chapters

| AUTHORS | CHAPTER TITLE | BOOK TITLE |
|---|---|---|
| Kalsi, S. S., **Storey, J.**, Hamilton, K. & Badcock, R. A. | Propulsion motor concepts for airplanes | *AIAA Propulsion and Energy 2019 Forum* |
| Cotton, G. C., Lagesse, N. R., Parke, L. S. & **Meledandri, C. J.** | 3.04 - Antibacterial Nanoparticles | *Comprehensive Nanoscience and Nanotechnology (Second Edition)* |
| **Whitby, C. P.** | 3.07 - Nanoparticles at fluid interfaces: from surface properties to biomedical applications | *Comprehensive Nanoscience and Nanotechnology (Second Edition)* |
| Gangotra, A. & **Willmott, G. R.** | 3.12 - Cellular and Sub-Cellular Mechanics: Measurement of Material Properties | *Comprehensive Nanoscience and Nanotechnology (Second Edition)* |

# Books

| AUTHOR | BOOK TITLE | PUBLISHER |
|---|---|---|
| **Hendy, S.C.** | #NoFly: Walking the Talk on Climate Change | Bridget Williams Books |

# Conference papers

| AUTHORS | PAPER TITLE | TITLE OF PROCEEDINGS |
|---|---|---|
| Sun, Y., Tayagui, A., Shearer, H., Garrill, A., **Nock, V.** | A microfluidic platform with integrated sensing pillars for protrusive force measurements on neurospora crassa | Proceedings of the IEEE International Conference on Micro Electro Mechanical Systems (MEMS) (2018) |
| Aref, S., Friggens, D., **Hendy, S.** | Analysing scientific collaborations of New Zealand institutions using scopus bibliometric data | ACM International Conference Proceeding Series (2018) |
| Risos, A., Broderick, N.G.R., **Williams, D.E.**, **Simpson, M.C.** | Critical setup parameter for ultrafast whitelight coherent antistokes raman scattering spectroscopy of living plankton in sea water | Proceedings of SPIE - The International Society for Optical Engineering (2018) |
| Prabowo, S., **Bumby, C.**, Monaghan, B., Del Puerto, D., Ryan, M., Longbottom, R. | Design and Commissioning of an Experimental Fluidized Bed Reactor for the Hydrogen Reduction of Titanomagnetite Ironsand | Proceedings of the 8th international congress on the science and technology of ironmaking (2018) |
| Moghaddam, S.M., Piraghaj, S.F., O'Sullivan, M., Walker, C., **Unsworth, C.P.** | Energy-efficient and SLA-aware Virtual Machine Selection Algorithm for Dynamic Resource Allocation in Cloud Data Centers | 11th IEEE/ACM Conference on Utility and Cloud Computing (2018) |
| Amalathas, A.P., **Alkaisi, M.M.** | Enhancing the performance of solar cells with inverted nanopyramid structures fabricated by UV nanoimprint lithography | 2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC) (2018) |
| Mehta, M., **Waterland, M.R.** | Highly sensitive surface-enhanced Raman scattering detection of brodifacoum and 1080 rodenticide in milk | Proceedings of SPIE - The International Society for Optical Engineering (2018) |
| McIntosh, G.J., Wijayaratne, H., Agbenyegah, G.E.K., Hyland, M.M., **Metson, J.B.** | Impacts of sodium on alumina quality and consequences for current efficiency | Minerals, Metals and Materials Series (2018) |
| Sturov, E., **Bumby, C.W.**, Rayudu, R., Badcock, R.A. | Influence of fluid selection on synchronous generators power output in compressed air energy storage systems | 2017 IEEE Innovative Smart Grid Technologies - Asia: Smart Grid for Smart Community |
| Panya Panya, S.N., Galmed, A.H., Maaza, M., Mothudi, B.M., Harith, M.A., **Kennedy, J.** | Laser-Induced Breakdown Spectroscopy (LIBS) on Geological Samples: Compositional Differentiation | MRS Advances (2018) |
| Hassan Sk, M., Abdullah, A.M., Ryan, M.P., Ko, M., **Williams, D.E.**, Laycock, N., **Ingham, B.** | Mo-mediated corrosion behaviour of 1 Cr - Carbon steel in sweet medium under hydrodynamic control | NACE - International Corrosion Conference Series (2018) |
| Makin, R.A., York, K., Senabulya, N., Mathis, J., Clarke, R., Feldberg, N., Miska, P., Jones, C.M., Williams, L., Kioupakis, E., **Reeves, R.**, Durbin, S.M. | Order Parameter and Band Gap of $ZnSnN_2$ | 7th IEEE World Conference on Photovoltaic Energy Conversion (2018) |
| Bjareborn, O., **Bumby, C.**, Ryan, M., Longbottom, R., Mongagan, B. | Phase Development of Titanomagnetite Ironsand During Oxidizing Conditions. | Proceedings of the 8th international congress on the science and technology of ironmaking (2018) |
| Khadka, R., Zondaka, Z., **Travas-Sejdic, J.**, Tamm, T., Kiefer, R. | Polypyrrole with polyethylene oxide: Linear actuation in organic and aqueous electrolytes | Proceedings of SPIE - The International Society for Optical Engineering (2018) |
| Sturov, E., **Bumby, C.W.**, Rayudu, R., Badcock, R.A. | Rapid synchronisation procedure for a pneumo-hydraulically driven synchronous generator | 2017 IEEE Innovative Smart Grid Technologies - Asia: Smart Grid for Smart Community |
| Zhang, A., Nusheh, M., Longbottom, R., **Bumby, C.**, Monaghan, B. | Reduction of Titanohematite Pellets by Hydrogen Gas | Proceedings of the 8th international congress on the science and technology of ironmaking (2018) |
| **Mallett, B.P.P.**, Marsik, P., Khmaladze, J., Arul, R., **Simpson, M.C.**, Bernhard, C. | Superconductor sandwiches: Cuprate-manganite multilayers with a remarkable new ground state | Proceedings of SPIE - The International Society for Optical Engineering (2018) |





# Keynote & invited speaker addresses

| NAME | DETAILS |
|---|---|
| **David Barker** | Keynote talk at the 24th International Clean Air and Environment conference (CASANZ 2019). 16-18 September 2019, Queenstown, New Zealand |
| **Margaret Brimble** | Plenary lecture at 9th International Conference on Advanced Materials and Nanotechnology (AMN9). 10-14 February 2019, Wellington, New Zealand |
| | Plenary lecture at 44th Lorne Conference on Protein Structure and Function. 10-14 February 2019, Lorne, Australia |
| | Plenary lecture at Dewar Lectureship. 5 May 2019, Queen Mary University London, UK |
| | Plenary lecture at RSC George and Christine Sosnovsky Award Lectureship. 26 April 2019, Newcastle, Warwick, UK |
| | Plenary lecture at Sosnovsky Distinguished Lectureship. 26 April 2019, University of Wisconsin, Milwaukee, United States |
| | Plenary lecture at XXth Tetrahedron Symposium. 18-21 June 2019, Bangkok, Thailand |
| | Plenary lecture at ACS MEDICHEM Hall of Fame Ceremony. August 2019, San Diego, United States |
| | Plenary lecture at American Chemical Society Fall Meeting MedChem Toolbox Session Privileged and Under-privileged Functional Groups in Drug Design; American Chemical Society Journal of Organic Chemistry/Organic Letters Symposium. August 2019, San Diego, United States |
| | Plenary lecture at European Federation of Medicinal Chemistry International Symposium on Advances in Synthetic and Medicinal Chemistry (EFMC-ASMC19). 1-5 September 2019, Athens, Greece |
| | Plenary lecture at 13th Australian Peptide Conference. 8-13 September 2019, Port Douglas, Australia |
| | Plenary lecture at the New Zealand Institute of Chemistry Conference 2019. 24-28 November 2019, Christchurch, New Zealand |
| | Plenary lecture at 5th Annual Peptides and Proteins Symposium. 12-13 December 2019, Singapore |
| **Chris Bumby** | Invited lecture at the 32nd International Superconductivity Symposium (ISS2019). 3-5 December 2019, Kyoto, Japan |
| **Matthew Cowan** | Keynote talk at the New Zealand Institute of Chemistry Conference 2019. 24-28 November 2019, Christchurch, New Zealand |
| **James Crowley** | Keynote talk at the at New Zealand Institute of Chemistry Conference 2019. 24-28 November 2019, Christchurch, New Zealand |
| | Keynote talk at the RSC Macrocyclic and Supramolecular Chemistry Meeting 2019. 16-17 December 2019, Canterbury, UK |
| **Alison Downard** | Keynote talk at the New Zealand Institute of Chemistry Conference 2019. 24-28 November 2019, Christchurch, New Zealand |
| **Petrik Galvosas** | Invited speaker at 21st ISMAR – 15th EUROMAR joint conference. 25-30 August 2019, Berlin, Germany |
| | Invited speaker at the Farewell Symposium for dr. Henk Van As "NMR/MRI, Plants and Foods: Does Size Matter?" 25 October 2019, Wageningen, the Netherlands |
| | Keynote talk at the 2nd workshop on novel applications for low field Nuclear Magnetic Resonance (NMR). 5-6 November 2019, Rio de Janeiro, Brazil |
| **Keith Gordon** | Invited speaker at the New Zealand Institute of Chemistry Conference 2019. 24-28 November 2019, Christchurch, New Zealand |
| | Invited speaker at the 8th Asian Spectroscopy Conference 2019 (ASC 2019). 1-4 December 2019, University of Hong Kong, Hong Kong |
| | Invited speaker at SciX 2019 Conference. 13-19 October 2019, Palm Springs, USA (2 talks) |
| | Invited speaker at pre-conference workshop at the 10th International Conference on Advanced Vibrational (ICAVS10). 7-12 July 2019, Auckland, New Zealand |
| | Invited lectures as part of the Royal Society of Chemistry (UK) Australasian lectureship 2019 and 2020. Includes lectures in Brisbane, Darwin, Adelaide, Melbourne, Sydney, Wollongong, Canberra, Perth, Auckland, Hamilton, Palmerston North, Wellington, Dunedin, Christchurch |
| **Justin Hodgkiss** | Invited lecture at the 20th International Conference on Dynamical Processes in Excited States of Solids. 26-30 August, 2019, Christchurch, New Zealand |

| NAME | DETAILS |
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| **Eric Le Ru** | Plenary lecture in the opening session of the 2nd International Conference on SERS. 2-9 November 2019, Suzhou, China |
| **Carla Meledandri** | Keynote talk at the 9th International Colloids Conference. 16-19 June 2019, Sitges, Spain |
| **Jim Metson** | Keynote talk at the IUPAC 50th General Assembly and 47th World Chemistry Congress. 5-12 July 2019, Paris, France |
| **Cather Simpson** | Keynote talk at 9th International Conference on Advanced Materials and Nanotechnology (AMN9). 10-14 February 2019, Wellington, New Zealand |
| | Public lecture for the Perimeter Institute for Theoretical Physics. 6 March 2019, Waterloo, Canada |
| | Keynote talk at the Perimeter Institute for Theoretical Physics Inspiring Future Women in Science Conference 2019. 7 March 2019, Waterloo, Canada. |
| | Keynote talk at 19th New Zealand Institute of Physics (NZIP) Conference and Physikos, the New Zealand Physics' Teachers Conference. 15-17 April 2019, Christchurch, New Zealand |
| | Invited speaker at 2019 UNESCO-ICTP Illuminating Education Conference. 16 May 2019, Trieste, Italy |
| | Keynote talk at 2019 IEEE International Instrumentation & Measurement Technology Conference (I2MTC). 20-23 May 2019, Auckland, New Zealand |
| | Keynote talk at ConSTANZ19. 8-10 October 2019, Wellington, New Zealand |
| | Keynote talk at MESA Bootcamp 2019. 22-25 October 2019, Waihi, New Zealand |
| **Shane Telfer** | Keynote talk at the Inorganic Chemistry Conference IC19. 15-19 December 2019, Wollongong, Australia |
| **Catherine Whitby** | Keynote talk at Okinawa Colloids 2019. 3-8 November 2019, Okinawa, Japan |

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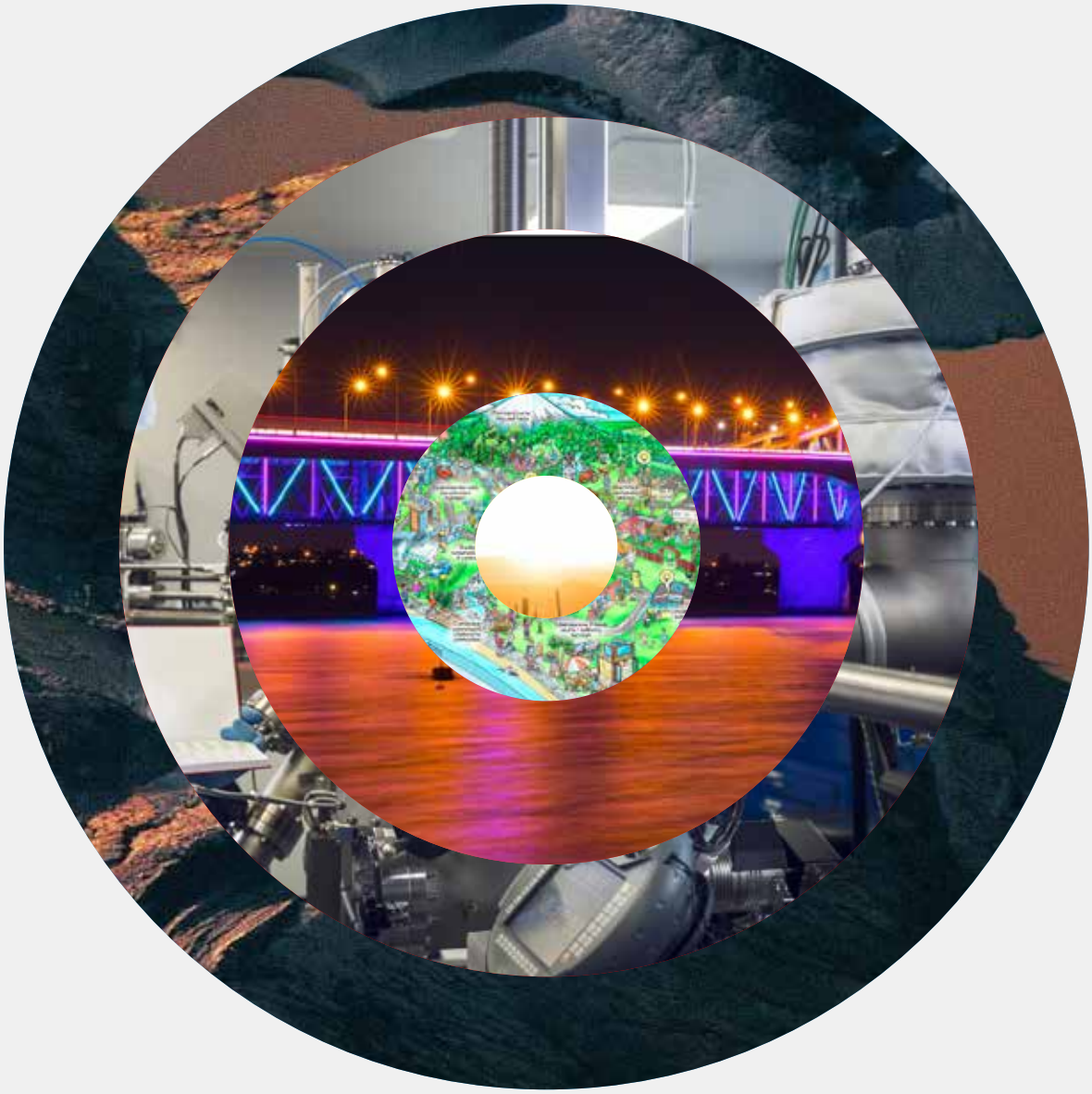

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