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The MacDiarmid Institute
for Advanced Materials and Nanotechnology

Annual Report 2014

The MacDiarmid Institute
for Advanced Materials and Nanotechnology

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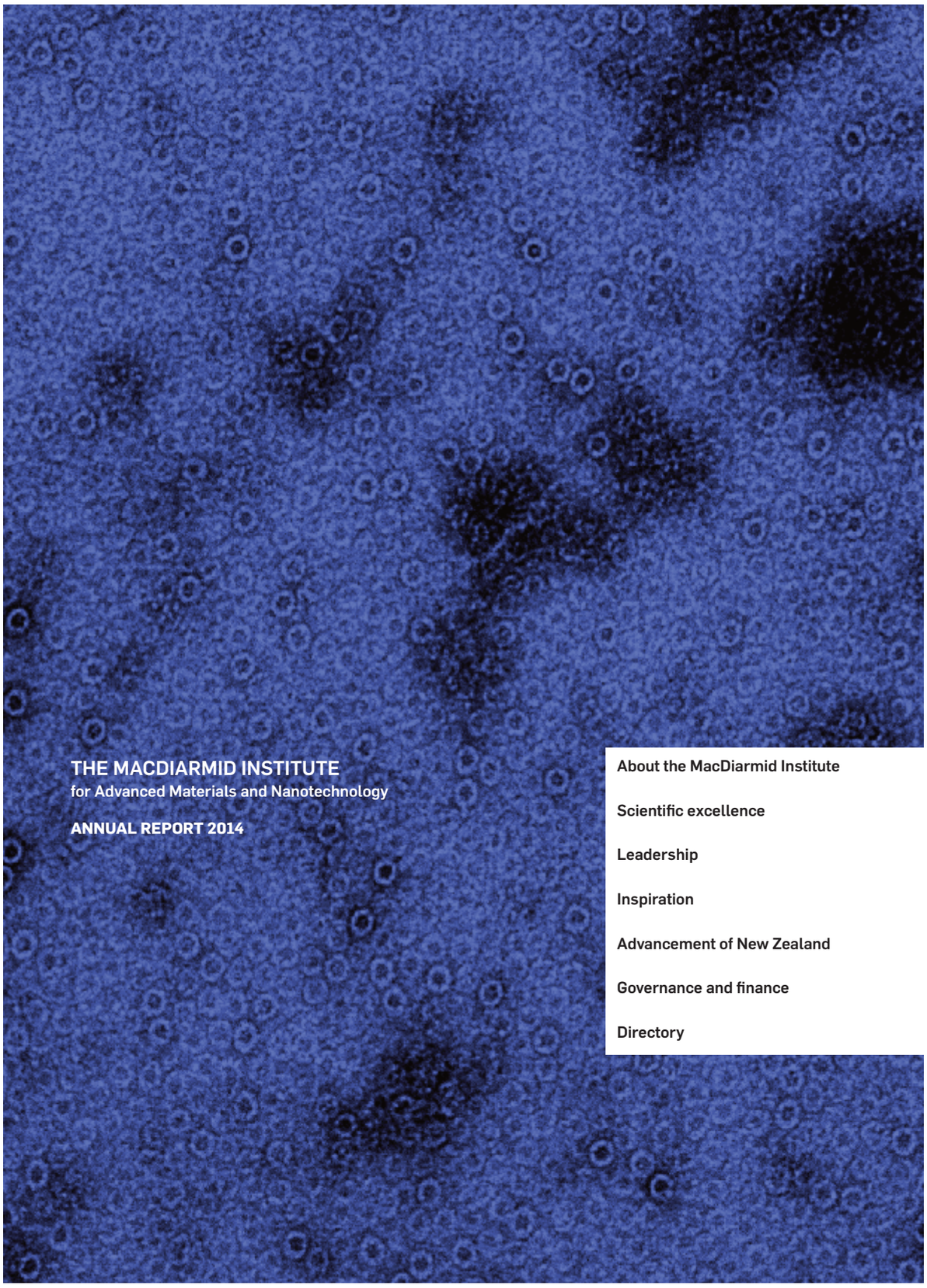
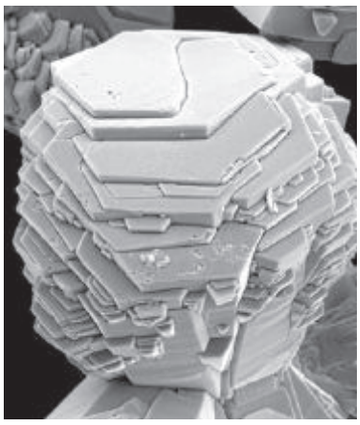


THE MACDIARMID INSTITUTE
for Advanced Materials and Nanotechnology

ANNUAL REPORT 2014

ABOUT THE MACDIARMID INSTITUTE

OVERVIEW



The MacDiarmid Institute for Advanced Materials and Nanotechnology is a Centre of Research Excellence (CoRE) and a partnership between five universities, a Crown Research Institute and a Crown entity. Our leading-edge researchers are based in Auckland, Palmerston North, Wellington, Christchurch and Dunedin.

Our university research partners are:

The University of Auckland

The University of Canterbury

Massey University

The University of Otago

Victoria University of Wellington

Our Crown Research Institute and Crown entity partners are:

Callaghan Innovation

GNS Science

The MacDiarmid Institute research teams have also established collaborations with educational and research institutions internationally, including in the United States, Italy, France, Japan, Switzerland, the United Kingdom, Australia, China, Spain, Germany, South Korea and Taiwan.

OUR STRATEGY

OUR **VISION**

SCIENTIFIC EXCELLENCE
+
LEADERSHIP
+
INSPIRATION
=
ADVANCEMENT OF NEW ZEALAND

OUR **MISSION**

TO DELIVER EXCELLENT SCIENTIFIC RESEARCH AND EDUCATION

Creative, ambitious, innovative research in advanced materials and nanotechnology.

TO FORGE NEW ZEALAND'S FUTURE LEADERS

Scientifically astute, entrepreneurial and socially aware leaders.

TO INSPIRE NEW ZEALANDERS

Engendering passion for science and innovation across society.

TO ADVANCE A NEW FUTURE FOR NEW ZEALAND

Deliver and support responsible economic development.

OUR **VALUES**

- **EXCELLENCE**
- **COLLABORATION**
- **ENTREPRENEURSHIP**
- **INTEGRITY**
- **CREATIVITY**
- **COMMITMENT**
- **COLLEGIALITY**

OUR PEOPLE

In 2014, the MacDiarmid Institute team was:

Administration and governance

1 Director

1 Deputy Director for Commercialisation and Industry Engagement

1 Deputy Director for Stakeholder Engagement

1 Centre Manager

3 Centre Professional support staff

1 Innovation Agent

1 Board of Directors of 13 members and three ex-officio members

Scientific research

10 Science Executives

3 Emeritus Investigators

36 Principal Investigators

40 Associate Investigators (including two new appointments)

237 PhD Students

39 Postdoctoral Fellows

25 Masters Students

35 Research Fellows and Technical Assistants

393 Alumni

Advisory groups

13 International Science Advisory Board

6 Industry Advisory Group

12 Members of The MacDiarmid Emerging Scientist Association (MESA)

OUR SCIENCE

In 2014, our scientific research was divided into four themes:

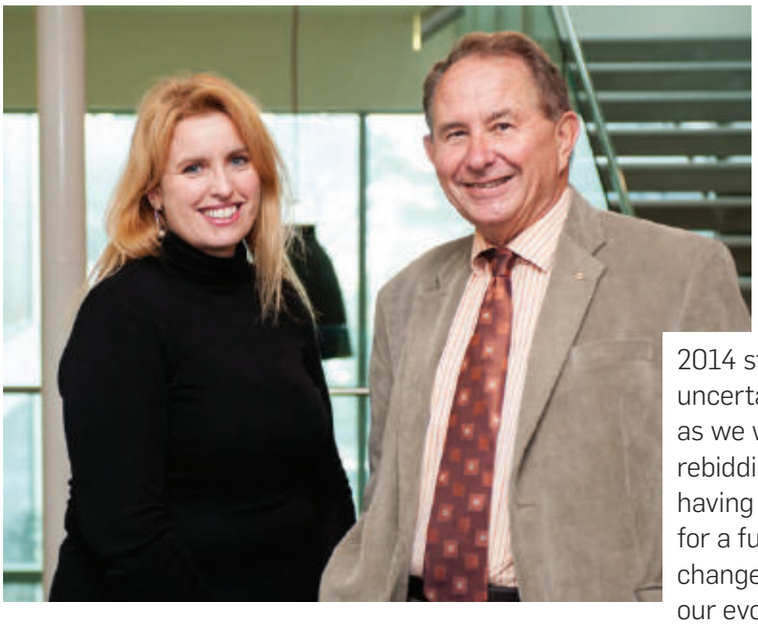
NANOFABRICATION AND DEVICES

ELECTRONICS AND OPTICAL MATERIALS

MOLECULAR MATERIALS

NANOBIO/BIONANO AND SOFT MATTER

DIRECTOR & CHAIR FOREWORD



2014 started with considerable uncertainty with regard to our future as we were in the middle of the CoRE rebidding round. We finished the year having successfully secured funding for a further six years, and initiating the changes to enter into the next phase of our evolution.

With renewed commitment, new strategic direction and greatly strengthened links to our stakeholders, we have positioned ourselves to make a lasting contribution to the advancement of the country.

Many key initiatives began to take real form during 2014 and set the foundation for the next steps of our development:

- We completed our PhD industry internship pilot programme;
- Five of our PhD students spent 3-6 months in industry;
- These included four New Zealand companies (Publons, Fisher and Paykel Health Care, Rakon and Pyrotek) and one international company (Hitachi).

During this time the students actively transferred the skills and knowledge learned during their PhDs to the company, and in turn learned new skills and

It has been an honour to lead the Institute during this time and to have been able to work with everyone to deliver the enormous success of securing a further six years of funding.

knowledge while working with the companies which can add value and expertise back into their PhD work. In this way the activities and outcomes of both student and company were strengthened.

As part of our Kōrero with Scientists initiative, in partnership with the New Zealand Education Institute, Te Rui Roa we held kōrero around the country, with our Investigators working with Early Childhood and Primary School Teachers as they learned to navigate science themselves. Teachers were encouraged and equipped to teach science with more confidence with their own students.

In November, in partnership with our host Victoria University of Wellington, we held the Public Forum – A Place to Live, in Whanganui, our follow up to the 2012 Transit of Venus Forum. We focused on the role of science and the regions in driving forward New Zealand. The many impassioned presentations over the following two days showed the power we all hold and how it can be used.

We also began working with Ngā Hononga Marae Trust; a relationship that will continue to grow, based on our shared vision in science, education and connecting our communities to deliver benefit.

The calibre of many of our investigators was formally recognised nationally and internationally. Prof Alison Downard was awarded an Honarary Doctorate by l'University de Rennes 1, France and welcomed into the Royal Society of New Zealand as a Fellow. Prof Grant Williams was awarded Member of the New Zealand Order of Merit. Dr Michelle Dickinson was presented with the Prime Minister's Science Media Communication Prize. Prof David Williams was awarded the UR Evans award by the UK Institute of Corrosion, its highest honour.

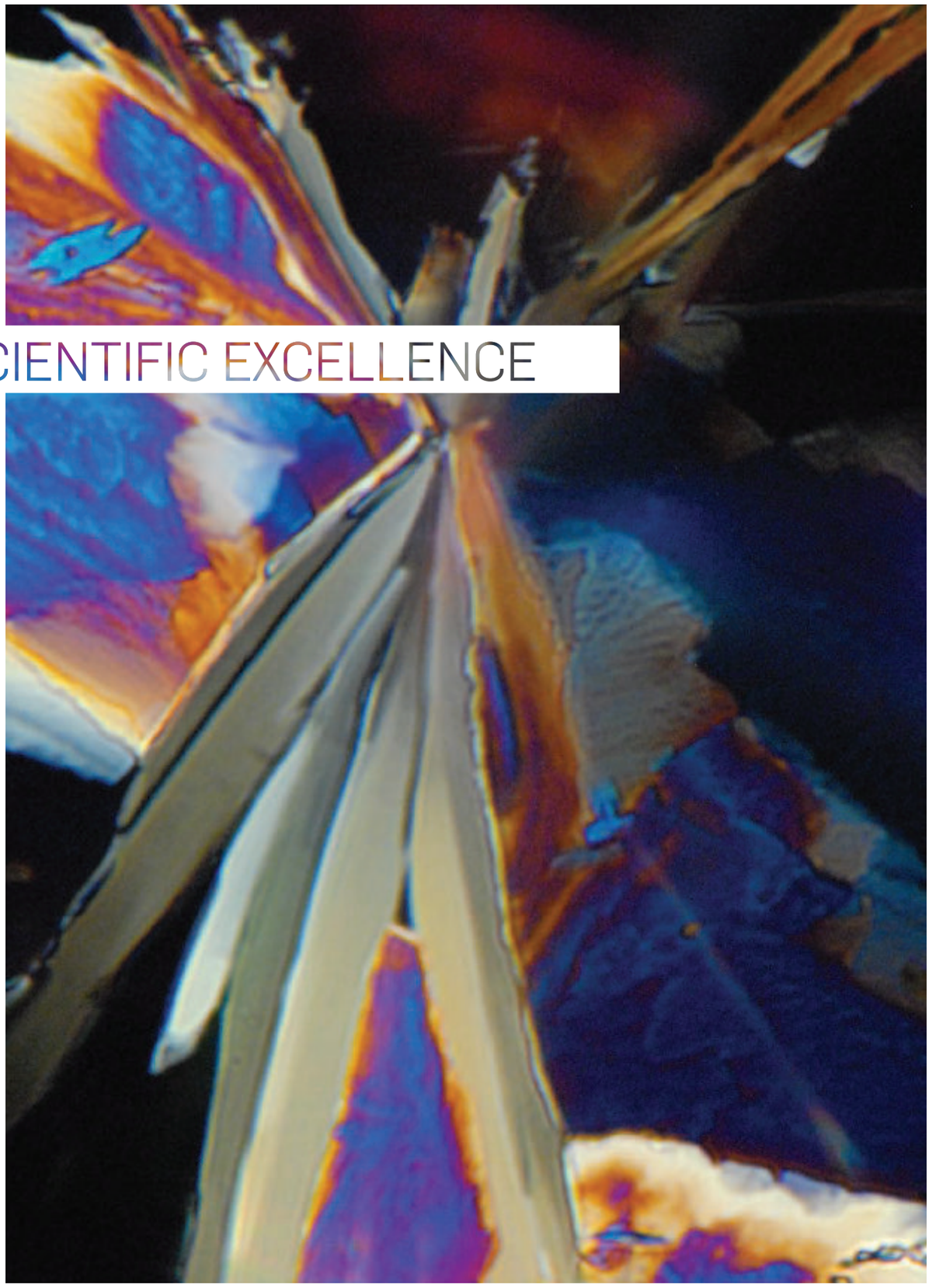
At the end of the year, due to the restructure and downsizing of the Board, an element of the new Partnership Framework for the new contract, we said goodbye to several of our Board Members; Chair Dr Steve Thompson, Roger Ridley, Prof Jane Harding, Dr Fred Samandari, and Prof Charles Daugherty.

These five, along with the other members of the Board worked with us as we developed our strategic plan and the approach for the rebid. They, like all our Investigators and Business Support Team were part of our success. Thank you to each of our departing Board members for the support and engagement that you have provided.

It has been an honour to lead the Institute during this time and to have been able to work with everyone to deliver the enormous success of securing a further six years of funding. Well done everyone and thank you.

KATE MCGRATH
Director
The MacDiarmid Institute

STEVE THOMPSON
Chair
The MacDiarmid Institute Board



SCIENTIFIC EXCELLENCE

VISION

SCIENTIFIC EXCELLENCE

LEADERSHIP

INSPIRATION

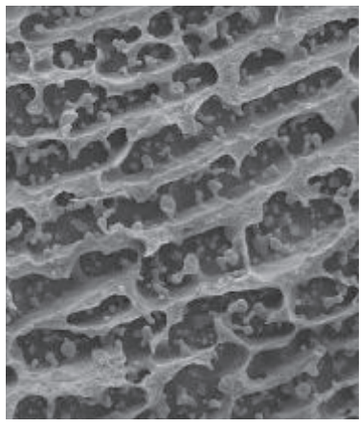
ADVANCEMENT OF NEW ZEALAND

SCIENTIFIC COLLABORATIONS

SCIENTIFIC LEADERSHIP & IMPACT

RECOGNISING & SUPPORTING EXCELLENCE

ENSURING EXCELLENCE



TO DELIVER EXCELLENT SCIENTIFIC RESEARCH AND EDUCATION

Creative, ambitious, innovative research in advanced materials and technology

The MacDiarmid Institute is focused on achieving and maintaining scientific excellence through:

- Delivering multi-institutional scientific collaborations that embrace the best researchers in advanced materials and nanotechnology and provide excellent scientific research infrastructure.
- Demonstrating scientific leadership and impact to ensure the MacDiarmid Institute is internationally recognised as the exemplar of a successful scientific research organisation that is among the very best in the field.
- Ensuring that our scientific leadership and impact is sustainable by balancing support for established and emerging research and researchers.
- Maintaining our excellence in science by rigorously and regularly measuring the performance and quality of the research outputs of the Institute as well as those of individual researchers.

SCIENTIFIC COLLABORATIONS

A YEAR IN NUMBERS

75	PhD students and postdoctoral fellows attended a face-to-face symposium
50	Investigators attended annual investigator meeting
168	Alumni joined the Institute's LinkedIn group (262 in total)
19	Students and postdoctoral fellows attended the MESA bootcamp
4	Students travelled to overseas institutions for internships
43	International visitors hosted by The MacDiarmid Institute
7	Investigators who had a long term stay at a research facility
17	Investigators who had a short research trips to overseas facilities

International conferences

5	Plenary speaker addresses given
6	Key note addresses given
64	Invited speaker presentations given
14	Published conference papers

To foster collaboration within the organisation and with collaborators in other research institutions in New Zealand and internationally, the MacDiarmid Institute:

- Holds regular face-to-face subject and capability-based meetings and whole-institute meetings to facilitate collaboration
- Uses interactive electronic discussion forums to facilitate collaboration and development of new ideas
- Integrates strategic science priorities and objectives through a programme-based approach
- Ensures balanced pathways for implementation of new ideas by individual researchers and large-scale high-impact collaborative projects

MACDIARMID CO-HOSTS INAUGURAL CROSS-CoRE MEETING

In 2014, for the first time ever, a meeting was held that brought together investigators from New Zealand's eight Centres of Research Excellence (CoRE). The two-day meeting, held in Auckland in November, was organised jointly and co-hosted by the MacDiarmid Institute and the Maurice Wilkins Centre. On day one, Investigators presented areas of research and research capability that could inspire cross-CoRE science collaboration and that was followed up on day two with sessions to come up with a list of areas in which collaborative research could be practical.

The meeting agreed to explore ways to ensure more CoRE research that moves from the laboratory to be applied in the real world.

Among the potential research projects identified for collaboration were: the development of microfluidic systems to allow migration of cells to be interrogated; tools and models for applications in medical diagnosis, such as pre-diabetics and micro-environments in tumours; imaging and rapid imaging techniques; and signalling networks.

The meeting also discussed how the CoREs might work together in the other important areas of their mandate, including student education and experience, research translation and outreach initiatives.

The meeting decided to explore the development of an education framework for CoRE students and to look at setting up cross-CoRE initiatives like the MacDiarmid Institute student bootcamps, where the ideas for topics come from the students and postdoctoral fellows themselves.

The meeting agreed to explore ways to ensure more CoRE research that moves from the laboratory to be applied in the real world. The initiatives that will be considered to achieve this include: sharing and developing best practice systems and the right environment for translating research results into commercial products and processes; improving the way CoREs work with emerging scientists who have ideas with commercial potential so that those ideas can be captured and developed; and providing role models of researchers who are working on discovery science, but at the same time coming up with outcomes that have commercial applications.

Those at the meeting also discussed how the collective expertise of the CoREs could play a part in guiding and developing New Zealand's research system to ensure greater stability so that scientific research can reach its full potential for the benefit of New Zealand.

Michele Governale

MAINTAINING COLLABORATIVE LINKS

Michele Governale, Principal Investigator at Victoria University of Wellington, spent about six weeks on research and study leave at the Scuola Normale Superiore in Pisa Italy at the end of 2014—one of the MacDiarmid Institute's international research partners.

During his time in Pisa, Dr Governale worked with Drs Rosario Fazio and Fabio Taddei on research relevant to a MacDiarmid Institute project on the theory and modelling of unconventional materials. In particular, they looked at the fluctuations of the current flowing in what is called a quasi-one-dimensional topological superconductor. In this system, the properties of a semiconductor nanowire are manipulated in proximity to a conventional superconductor. The knowledge coming out of this project could be significant in producing more robust quantum-computing devices.

Dr Governale's research studying the basic electronic properties of nanostructured systems is a prerequisite for the ultimate development of nanoelectronics and the design of new devices in the nanometre size range.

SCIENTIFIC LEADERSHIP AND IMPACT

The MacDiarmid Institute recognises that, in order to have impact, it must ensure a stable environment for its researchers and encourage the national and international networks that allow them to take advantage of the very latest developments, and likely future shifts, in their specialist fields. It does this by:

- Providing resource stability and flexibility to investigators to encourage creativity and innovation in MacDiarmid Institute research and drive ambitious research programmes.
- Holding a biennial international conference—the AMN series—attracting the best international researchers to New Zealand and showcasing our research and researchers. (In 2014, this has involved planning for the 2015 AMN conference held in Nelson—the first time it has been held in a regional centre.)
- Branding all our outputs and outcomes
- Undertaking annual analysis of outputs to benchmark it nationally and internationally.

AWARDS AND OTHER RECOGNITION

In 2014, MacDiarmid Institute scientists were recognised by their peers nationally and internationally.

Institute Deputy Director and Principal Investigator at the University of Canterbury, Professor Alison Downard received three international honours. She won the RH Stokes medal for distinguished research in the field of electrochemistry carried out mainly in Australasia awarded annually by the Electrochemical division of the Royal Australian Chemical Institute. As well, Professor Downard was made an Honorary Professor by Qilu University of Technology in China's Shangdong province and received a Docteur Honoris Causa – the French equivalent of an honorary degree—from the Université de Rennes 1 in France. Closer to home, Professor Downard was made a Fellow of the Royal Society of New Zealand.

Dr John Kennedy, a MacDiarmid Principal Investigator based at GNS Science, was one of the recipients of the KiwiNet AJ Park Commercialisation Collaboration Award for 2014 for his work with Titanium Technologies New Zealand (TiTeNZ). This is a collaboration between the University of Waikato, Callaghan Innovation, GNS Science, the University of Auckland, the Titanium Industry Development Association (TIDA) and a number of industry partners. Dr Kennedy is an ion beam physicist. His current field of research is in understanding the fundamental mechanisms behind the propagation of metal and metal oxide nanoparticles and how their remarkable electronic, optical and magnetic properties can be tailored for specific applications.

Principal Investigator Professor Jeff Tallon, who is also Chair of the MacDiarmid Institute International Science Advisory Board, was named a 2014 distinguished lecturer by the Institute of Electrical and Electronic Engineers (IEEE) Superconductivity Council. The IEEE is the world's largest professional association for the advancement of technology. Distinguished lecturers are

Michelle Dickinson with Prime Minister John Key

leaders in their field and are promoted by IEEE to speak at educational institutions and other organisations with an interest in the field. Professor Tallon has been invited to present at least ten lectures all over the world over the course of 2015, including in the United Kingdom, the United States and France. He will also give a series of talks around New Zealand.

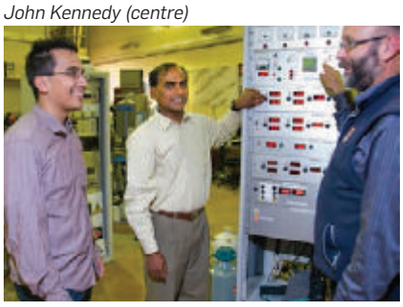
Associate Investigator Dr Michelle Dickinson won the 2014 Prime Minister's Science Media Communication prize for her success in making the serious subject of science fun and accessible through regular radio and television appearances, tweets, blogs, and her alter ego—'Nanogirl'. She recently completed a project that involved carrying out a daily science experiment with a member of the public for 100 days. She has also established a charity which provides technology-filled days for disadvantaged young people to learn computer coding, 3D-printing and robotics.

"Children adore Nanogirl because she's their science superhero. It helps me show that science does not need to be confined to the classroom or textbooks, and it doesn't need to be boring," she says.

In 2014 she was also named a 'STEM Superstar' by the US public broadcaster PBS.

Dr Dickinson is a biomedical and materials scientist based at the University of Auckland. She set up and runs Australasia's only nanomechanical testing laboratory. Her research focuses on building new ways to test tiny, nano-sized materials for the high-tech industry and biomaterials to help understand how disease can affect biological cells and tissues.

John Kennedy (centre)



Jeff Tallon

David Williams

MacDiarmid Institute Deputy Director Professor David Williams of the University of Auckland received the 2014 UR Evans Award of the Institute of Corrosion, in the United Kingdom. The award dates back to 1976 and is made for outstanding international achievements in pure or applied corrosion science. In Professor Williams' case it recognises his work over the past two decades in electrochemistry and corrosion science. By studying localised corrosion of stainless steel such as holes in chemical plants, rudders falling off yachts and the corrosion of stainless steel shafts, he developed new types of experimental methods and prompted a change in the understanding of how steel corrodes.

MOST CITED PAPER 2014

Feltham, H.L.C.; Brooker, S. Review of Purely 4f and Mixed-Metal nd-4f Single-Molecule Magnets Containing Only One lanthanide Ion. Coordination Chemistry Reviews, 2014, 276, 1–33.

MOST CITED AUTHOR 2014

Professor Jadranka Travas-Sejdic.

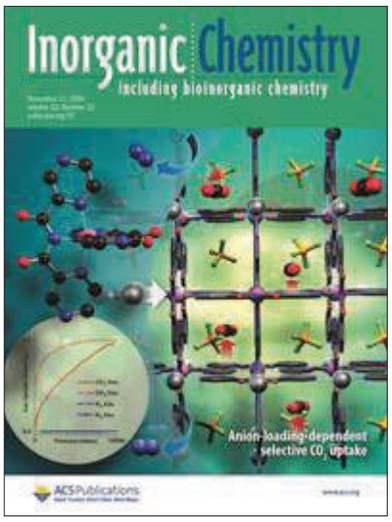
FRONT COVER OF INORGANIC CHEMISTRY

17 November 2014

"Doubling the anion occupancy in the channels of the metal organic framework (NiII-based MOF → CoIII-based MOF) increases the observed adsorption selectivity for CO2 over N2. These robust isostructural MOFs were assembled using AgBF4 to activate the secondary coordination instructions present in the carefully designed monometallic pyrazine imide complexes of nickel(II) and cobalt(II or III)."

Cover created by Michael Crawford (Dunedin) from a concept provided by Sally Brooker.

(Cowan, M.G.; Miller, R.G.; Southon, P.D.; Price, J.R.; Yazaydin, O.; Lane, J.R.; Kepert, C.J.; Brooker, S. Selective Gas Adsorption in a Pair of Isostructural MOFs Differing in Framework Charge and Anion Loading. Inorganic Chemistry, 2014, 53, 12076–83.)



IMPACT

In 2014, MacDiarmid Institute researchers had:

284	Papers published in leading scientific journals
13	Conference papers published
70	Invited conference presentations
12	Industry consulting reports
14	Invention disclosures

David Williams

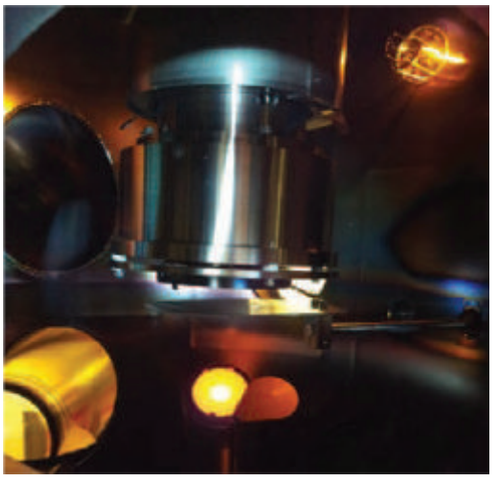
PLENARY ADDRESS

Professor David Williams, Deputy Director of the MacDiarmid Institute and Principal Investigator based at the University of Auckland, was a plenary speaker at a Gordon Research Conference on tools and techniques for corrosion assessment held in New Hampshire in the United States in July. The Gordon Conferences provide an international forum for the presentation and discussion of frontier research in the biological, chemical, and physical sciences, and their related technologies, giving scientists an opportunity to discuss pre-publication research. Professor Williams' presentation was entitled "Synchrotron X-Ray Studies of Protective Scale Formation During CO2 Corrosion of Steels" and discussed research he has carried out with Dr Bridget Ingham (Associate Investigator, Callaghan Innovation), Dr Monika Ko (Quest Integrity Ltd.) and Dr Nick Laycock (Shell, Qatar) directed at understanding critical factors in the early stages of corrosion of oil and gas production pipelines.

RECOGNISING AND SUPPORTING EXCELLENCE

We recognise the need for balance in our research activities between sustaining existing work programmes and the need to encourage new research ideas. To do this we:

- Reassess our strategic science priorities three yearly working with our International Science Advisory Board
- Maintain balance of emerging and established investigators within the Principal Investigator cohort
- Balance resource stability for current research programmes with discretionary funding to support new initiatives.



2014 SCIENCE THEME HIGHLIGHTS

NANOFABRICATION AND DEVICES

10	Principal Investigators
2	Associate Investigators
11	Postdoctoral Fellows
42	PhDs
4	Master's
30	Published papers
13	Plenary and invited speakers
4	New grants

Partners: University of Auckland, University of Canterbury, GNS Science, University of Otago, Victoria University of Wellington.

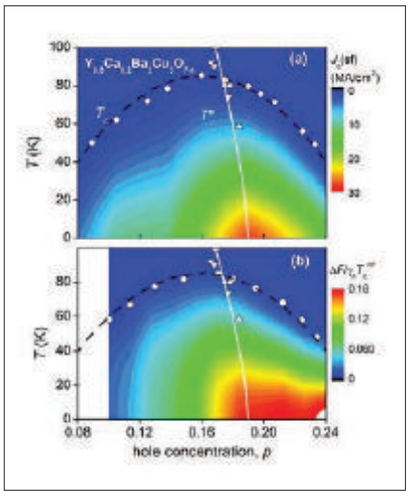
Fabrication is the key to transforming new materials into practical products and this programme of research is exploring both top-down (miniaturisation) and bottom-up (building atom-by-atom) fabrication to try to overcome the strengths and weaknesses in each approach. The research teams are using new approaches to optical and imprint lithography at the nano scale as well as atomic- and molecular-scale self-assembly for nanofabrication. They also apply more traditional bottom-up micro- and nano-fabrication techniques to explore electronic, optical and magnetic materials and devices.

ELECTRONICS AND OPTICAL MATERIALS

2	Emeritus Investigators
8	Principal Investigators
16	Associate Investigators
6	Postdoctoral Fellows
43	PhDs
44	Published papers
1	Conference proceeding
17	Keynote, plenary and invited speakers
3	New grants

Partners: University of Auckland, University of Canterbury, Callaghan Innovation, Victoria University of Wellington and GNS Science with Macquarie University, NSW Australia, Robinson Research Institute.

The cutting-edge of solid-state material science is dominated by the problems and possibilities that arise from the lack of homogeneity of materials and electron-with-electron interactions at the nanoscale. Using experimental and theoretical work, this research theme explores materials displaying novel or exploitable properties that do not fit within the conventional theories governing optical and electronic properties.

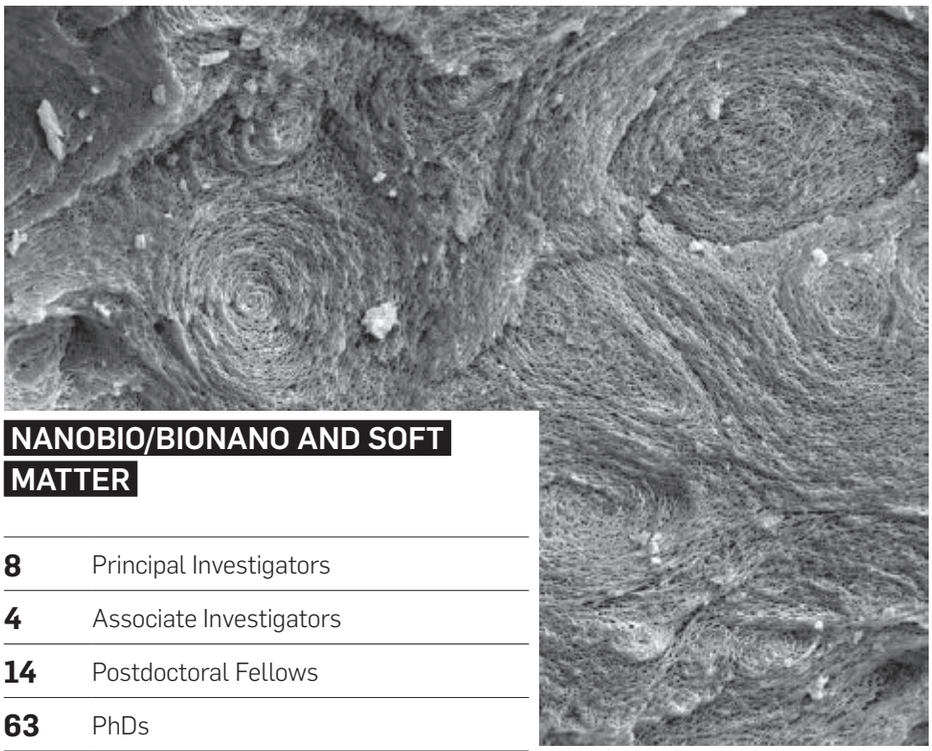


MOLECULAR MATERIALS

1	Emeritus Investigators
9	Principal Investigators
9	Associate Investigators
6	Postdoctoral Fellows
59	PhDs
10	Master's
72	Published papers
3	Book chapters
6	Conference proceedings (Jim Johnston)
18	Keynote and invited speakers
12	New grants

Partners: University of Auckland, University of Canterbury, Callaghan Innovation, Massey University, University of Otago, Victoria University of Wellington.

Molecular materials show promise for diverse applications, including molecular magnets, solar energy and electroluminescent materials, sensors, catalysts and adsorbents. Such applications rely on single molecules or collections of molecules in the form of 3-D structures or thin films that exhibit specific functions. This research theme explores the chemistry essential to the design, synthesis, assembly and activation of materials, including new materials that have interesting and potentially useful functionality.



NANOBIO/BIONANO AND SOFT MATTER

8	Principal Investigators
4	Associate Investigators
14	Postdoctoral Fellows
63	PhDs
3	Master's
29	Published papers
1	Book chapters
18	Keynote, plenary and invited speakers
9	New grants

Partners: University of Auckland, Callaghan Innovation Ltd., University of Canterbury, Massey University, University of Otago, and Victoria University of Wellington along with Tsinghua University, Beijing.

This research theme brings together the disciplines of bionanotechnology, nanobiotechnology and the interdisciplinary field of soft matter science. Biological systems can be the inspiration for the application of the special physics governing nanoscience to undertake 'bottom-up' processing to generate smart, functional viscoelastic matrices. Interdisciplinary teams are also involved in the top-down development of new soft materials and complex fluids for biological and biotechnological applications, as well as for industrial use in areas as diverse as oil recovery, food technology, cosmetics and personal care products and electronic devices.

2014 SCIENCE HIGHLIGHTS

NEW MILESTONE IN DOSIMETER RESEARCH

In 2014, Principal Investigator Dr Grant Williams of Victoria University of Wellington developed an idea for a new remote radiation dosimeter detection system that he is in the process of patenting and researching. The dosimeter system is designed to assist medical physicists in verifying and validating their medical linear accelerators that are used in the treatment of cancer.

Working closely with medical experts at Wellington Hospital, Dr Williams and his team have been focusing on developing 2D and 3D dosimeters that use optics technology and detection materials that react to radiation in much the same way as human tissue does. In the latest breakthrough, they have come up with a model to explain how the

response from those dosimeter materials depends on the radiation dose—and that will potentially allow them to correct the instrument for gradual radiation damage over time.

They have also developed 2D dosimeter plates using their patented fluoroperovskite compounds—minerals consisting of sodium magnesium fluoride and rubidium magnesium fluoride, which light up when they are subject to radiation and can store information on the dose given.

Another stream of research is using the optics-based approach to develop portable, robust and inexpensive x-ray imaging systems that can be used in the industrial setting, such as checking for rust, blockages and defects in pipes.

PRINTING 3D CONDUCTING POLYMER MICROSTRUCTURES

Using a scanning micropipette instrument made in-house, Jadranka Travas-Sejdic and David Williams, both Principal Investigators at the University of Auckland are now able to 'write' conducting polymer 1D, 2D and 3D microstructures.

In collaboration with colleges from School of Engineering at the University of Auckland they have utilised so-made 'microhairs' to develop a sensitive airflow digital sensor. A computer program to be used for nanopipette deposition of even smaller structures of conducting polymers has been developed. Nanopipettes with a diameter in the range of 100–150 nm have been fabricated using a laser-pulling technique.

They are currently developing a novel sensing protocol to detect multiple target DNA sequences simultaneously that will ultimately be fabricated by our micro/nanopipette guided conducting polymer deposition technique. Proof of the principle is about to be completed by using macro-size electrodes.

UNDERSTANDING SUPERCONDUCTORS

Superconducting materials offer many advantages over the semiconductors that currently dominate electronics and other electrical devices. For example, superconductors are more effective in detecting magnetic fields and their high level of sensitivity makes them better at amplifying electrical signals. However, our understanding of why this is so and how it happens has been incomplete.

Now, Principal Investigator Professor Simon Brown and his team at the University of Canterbury have turned up new knowledge that is attracting international attention.

The team has fabricated a series of superconducting devices that have built in the enormous range of resistance that would be found in normal circumstances. From that work, they have been able to identify the key physical process that is dominant in each of the superconducting, metallic and insulating regimes and produce phase diagrams for the various phenomena they have observed.

Professor Simon Brown was invited to speak to the 17th International Symposium on Small Particles and Inorganic Clusters held in Japan in September 2014—the most important conference of its kind in the year.

The Canterbury team has worked very closely with researchers at the Katholieke Universiteit Leuven in Belgium on the project as well as Professor Konstantin Arutyuov of Moscow State University, who visited the University of Canterbury during 2014.

NANOMATERIALS FOR BIOLOGICAL APPLICATIONS

Gold-palladium nanoparticles have been developed for photothermal hyperthermia treatment in Principal Investigator Richard Tilley's group at Victoria University of Wellington. This study demonstrates the efficacy of a new type of bimetallic nanomaterial in cancer therapy, and provides a starting point for future work combining these materials' efficacy in NIR hyperthermia therapy with drug release or chemotherapy.

CROSS-CoRE COLLABORATION

A cross-CoRE programme was undertaken between the Riddet Institute and MacDiarmid Institute, led by three MacDiarmid Institute Principal Investigators who are also named investigators of the Riddet Institute—Bill Williams, Massey University, Kate McGrath, Victoria University of Wellington and Juliet Gerrard, University of Auckland (previously University of Canterbury) and Callaghan Innovation.

Both CoREs have an interest in using proteins to make nanofibrillar structures: the Riddet Institute because they offer useful properties in foods and the MacDiarmid Institute as they are nanocomponents with broad material applications beyond food.

A food protein from whey was to make structures that were of interest in both a food and materials context. These protein nanofibrils offer advantages over other nanostructures due to the ease in their self-assembly and the versatility of surface chemistry available. Yet, an efficient and general methodology for their post-assembly functionalization remains a significant challenge. The team introduced a generic approach, based on biotinylation and thiolation, for the multi-functionalization of protein nanofibrils self-assembled from whey proteins and showed how these methods can be used to decorate whey protein nanofibrils with several components such as fluorescent quantum dots, enzymes, and metal nanoparticles. (Sasso, L.; Suei, S.; Domigan, L.; Healy, J.; Nock, V.; Williams, M.A.K.; Gerrard J.A. Versatile Multi-Functionalization of Protein Nanofibrils for Biosensor Applications, Nanoscale, 2014, 6, 1629–1634.)

These functionalised fibrils have been investigated mechanically using optical tweezers and studies have been undertaken in November 2014 at the Australian Synchrotron on gels assembled from such mechanically characterised fibrils.

Finally, computer simulations are underway to close the circle, linking the microscopic fibril structure to their mesoscopic mechanical properties and ultimately to bulk materials behaviour.

TRANSPORT IN THE NANOWORLD

Principal Investigator Geoff Willmott's team have developed a new method for studying individual nanoparticles suspended in aqueous solution. In this new method, two existing techniques are performed at the same time, so that a single measurement can provide very rich information regarding an individual nanoparticle. The first of the two existing techniques (fluorescence microscopy) allows the user to discriminate between particles with different surface chemistry. The second technique, tunable resistive pulse sensing (TRPS), measures of the size and charge of individual particles. TRPS instruments are manufactured in Christchurch by the nanotechnology company Izon Science Ltd. This combination of chemical and physical information could be useful for biosensing, quality control for nanoparticle manufacturers, and for fundamental studies into biological entities such as exosomes or large protein complexes.

This new method has been developed by PhD student Peter Hauer, who is based in the Raman group at Victoria University of Wellington. Co-ordination of the two techniques is not straightforward, and Peter initially had to rearrange the optical system used for fluorescence microscopy. It is also important to understand exactly how particles are moved ('transported') through the experimental system, especially through those regions most sensitive to the incident laser (for fluorescence), and to TRPS. Therefore, computational simulations of particle motion have been carried out to guide the experimental arrangement. Good results have been forthcoming: simultaneous measurements of 1–2 micrometre beads have now been reported, and the technique has since been extended to particles as small as 200 nm, with clear discrimination between particles of different surface chemistry.

THE ROLE OF MICRO AND NANO ENVIRONMENT ON THE BIOLOGICAL CELLS BEHAVIOUR

With increasing interest in BioMEMs and Lab-on-a-Chip for medical diagnostics and analysis and the expected wide spread of medical implants and tissue engineering, understanding the roles of materials and topography on cell response is becoming very important. The team of Maan Alkaisi, Principal Investigator, University of Canterbury, John Evans, Associate Investigator, University of Otago and Volker Nock, Associate Investigator, University of Canterbury, have developed a unique capability of replicating cells in hard polymers with high resolution called bioimprint. These replicas are being used to study the interactions of cells with patterns that resemble themselves.

This is helping with identifying the influence of surface chemistry and that of physical topography on cell behaviour and growth. Maan and his team found that cancer cells, for example, can be guided by their footprint. There is an emerging need to understand the role of physical forces on cancer spread and growth. Differentiation can also be guided by platform topography and can be accelerated by the right choice of platform materials .

Cells can also be guided physically using grating patterns with periods of cell size or chemically using polyHEMA.

This work might lead to new cell culture platforms where it mimics the in vivo micro- and nanoenvironment.

ENSURING EXCELLENCE

Since the reputation of the MacDiarmid Institute rests on the continuing excellence and currency of our scientific research, the Institute ensures it regularly reviews and assesses the quality and relevance of the work it is doing. It does this by:

- Conducting an international review of the Institute every three years, the focus of which is directed by the issues of the day
- Reviewing Principal and Emeritus Investigators and calling for new Principal Investigators every three years, considering depth, breadth and career demographics across the Institute and ability to deliver on the strategic plan in finalising the cohort
- Conducting Associate Investigator censuses every three years with a continuous open call for Associate Investigators
- Upholding rigorous recruitment standards for Postdoctoral Fellows and Doctoral students.

FUNDING SUCCESSES

In 2014, research projects related to the MacDiarmid Institute were granted[1] a total of just over $11.08 million in New Zealand Government funding and $4.6 million in overseas funding.

The funding includes five successful bids for funding from New Zealand's pre-eminent discovery science fund—the Marsden Fund administered by the Royal Society of New Zealand.

They were:

Shane Telfer (Principal Investigator, Massey University): Nanoparticle-Nanorod Frameworks. $870,000 for April 2015–18. With Associate Professor Richard Tilley (Principal Investigator, Victoria University of Wellington).

Paul Kruger (Associate Investigator, University of Canterbury): Spin-switchable, externally addressable functional molecular cages. $750,000 for March 2015–18. With Professor Rodolphe Clérac (National Scientific Research Centre—CNRS, University of Bordeaux, France) and Professor Nathan McClenaghan (CNRS, University of Bordeaux France).

Jadranka Travis-Sejdic (Principal Investigator, University of Auckland): Creating neural bridges: a conducting polymer neurotransmitter releasing system. $300,000 for February 2015–18.With Darren Svirskis (Principal Investigator, University of Auckland).

Jonathan Halpert (Associate Investigator, Victoria University of Wellington); Novel organic metal halides for perovskite sensitised solar cells. $300,000 over two years from 1 March 2015.

1 These totals represent the amounts granted to MacDiarmid investigators during the 2014 year and do not reflect the amounts received during the year.

Jonathan Halpert

A SUCCESSFUL 2014 FOR NEW ASSOCIATE INVESTIGATOR

For Dr Jonathan Halpert, MacDiarmid Associate Investigator based at Victoria University of Wellington, 2014 was a notable year. Along with Marsden funding, he was also one of the recipients of a Rutherford Discovery Fellowship for his research into novel semiconductor nanocrystals that can be used to build devices for solar cells and light-emitting diodes (LEDs).

Ten of the Fellowships are awarded each year to support the development of future research leaders and assist with the retention and repatriation of New Zealand's talented early-to-mid-career researchers.

Dr Halpert's work builds on research over the past five years into the unique light-absorbing properties of nanostructured materials such as quantum dots, semiconductor nano-crystals, metal clusters and ammonium metal halide perovskites and the fact that they can be deposited by solution rather than vacuum processes.

"Using these new materials has the potential to produce cheaper, greener nanomaterials for energy generation instead of the toxic, rare or energy-intensive minerals traditionally used in these applications," he says.

Dr Halpert's work builds on research over the past five years into the unique light-absorbing properties of nanostructured materials

Dr. Halpert came to New Zealand from postdoctoral research in the Optoelectronics Group in the Cavendish Laboratory of the Department of Physics at the University of Cambridge where his work focused on green nanomaterials and solar cells. In 2010 he was a visiting Fellow at the Institute for Process Engineering Nanomaterials Division at the Chinese Academy of Sciences in Beijing.

He joined Victoria University of Wellington's School of Chemical and Physical Sciences as a lecturer in October 2013 and in 2014 joined the MacDiarmid Institute as an Associate Investigator.

EXCELLENT<<<<<<<<<
LEADERSHIP<<<<<<<<
ON<AN<<<<<<<<<<<<<
INTERNATIONAL<<<<<
STAGE<<<<<<<<<<<<<

To say that 2014 was a good year for Alison Downard is a bit of an understatement. Even her admission that it was 'really good' is somewhat shy of the mark, given that she was made an Honorary Professor at one university, received a Docteur Honoris Causa at another, was awarded the RH Stokes medal from the Royal Australian Chemical Institute, and made a Fellow of the Royal Society of New Zealand. So, 2014 was a really, really good year.

It wasn't surprising that the international honours preceded the home-grown ones. "In my specific research area there's a very small community in New Zealand," she explains.

France has always has a significant involvement in electrochemistry since the founding of the discipline, and the mining industry gave Australia a strong basis for electrochemical research and applications.

It all seems a long way for the young Alison who headed south from her Te Puke high school to start a Bachelor's degree in Home Science at Otago University. An early interest in cooking had led to plans to become a dietician, but the compulsory science subjects took her fancy and she graduated with a BSc(Hons) from Otago in 1979.

Her career in electrochemistry got its kick-start during her subsequent PhD studies, when she found a fascination with instrumentation, measurement and analysis. Postdoctoral work followed at Southampton and the University of North Carolina; she began lecturing at Canterbury in 1988 and is now Professor of Chemistry there and a Principal Investigator with The MacDiarmid Institute.

The French Honorary Doctorate came as a result of strong connections with the Université de Rennes 1 by way of the Dumont d'Urville New Zealand-France Science & Technology Support Programme designed to encourage collaborative work.

"We did a lot of good science and published a lot of good papers," recalls Alison. Her visits to France in the early-2000s saw her invited to teach an international Masters class in nanotechnology at the Université Joseph Fourier in Grenoble. One of the things that Alison particularly appreciated about the Dumont d'Urville programme was that it allowed her to send students to the overseas institutions. Two of her PhD students spent three months at the Université de Rennes 1 and when Canterbury University's facilities were unavailable following the 2011 spate of large earthquakes, another student was able to pick up their studies in Grenoble.

Other connections led to a position at the Qilu University of Technology in China's Shandong Province. While that involved an undergraduate class in Applied

She was made an Honorary Professor at one university, received a Docteur Honoris Causa at another, was awarded the RH Stokes medal from the Royal Australian Chemical Institute, and made a Fellow of the Royal Society of New Zealand.

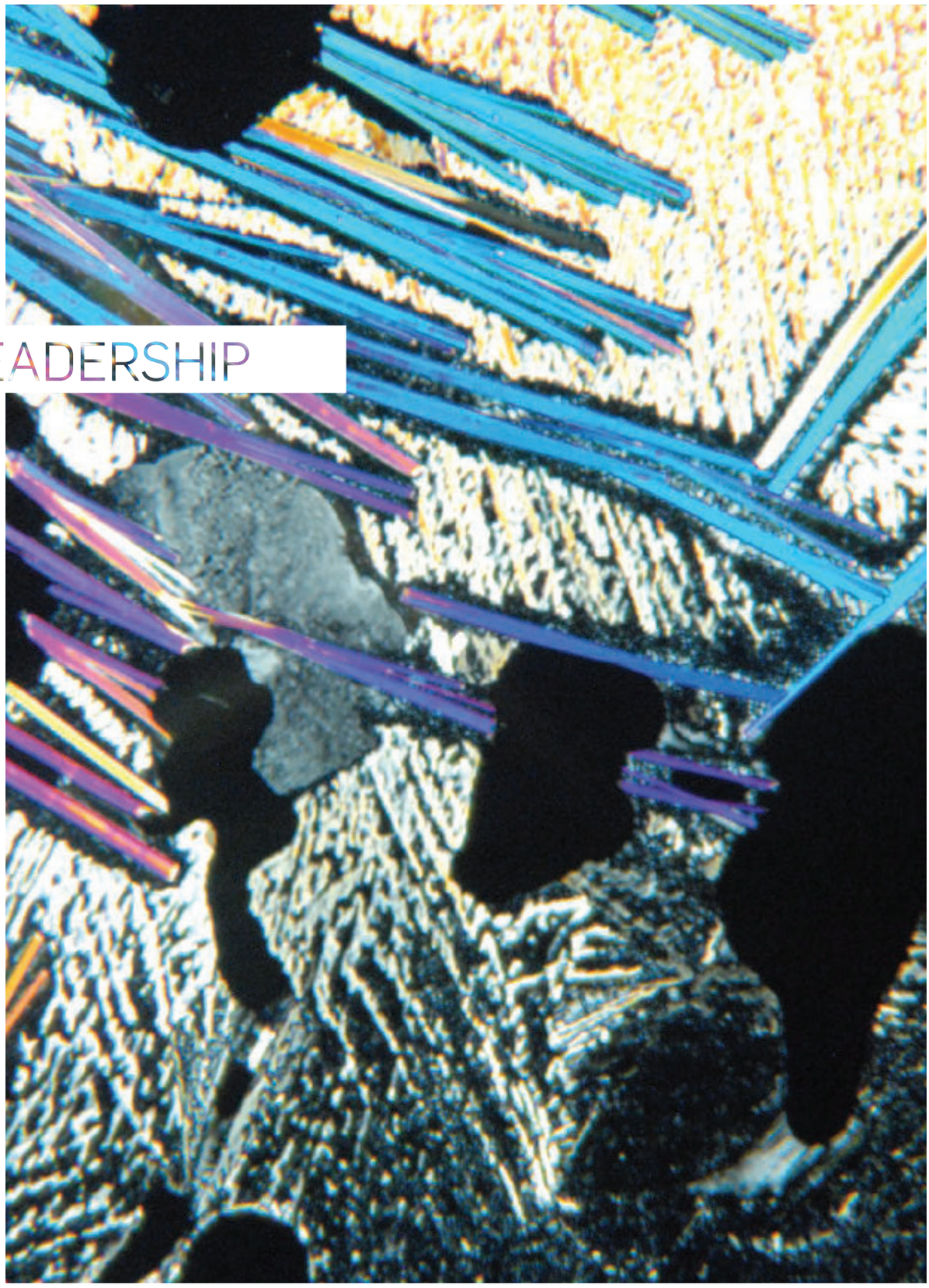
Chemistry, Alison found herself concentrating as much on teaching specialist English as Chemical Nanotechnology. She found the students there friendly yet respectful, keen to learn and become a part of the international science world, and is looking forward to returning for another stint.

Alison sees mentoring students, refereeing papers, visiting labs, attending conferences—'seeing what's going on around the world'—as vitally important in developing as a researcher. Seeing different ways of doing things is a necessity, she believes, whether the basic practicalities of lab arrangements and equipment choice or the more intangible differences of cultural approaches and how differing mixes of expertise can enhance a research programme. All these things have contributed to the development of a highly-regarded scientific leader, a leadership recognised by her place on a number of international boards and advisory groups.

Not all the roles are high-flying international ones however. One of the things that Alison is most passionate about is the MacDiarmid Institute's new outreach programme Kōrero with Scientists. She's hoping that the ties with the New Zealand Educational Institute (NZEI Te Riu Roa), on working with primary and early childhood educators in their science teaching will see better resources and activities help educators instil an early interest in science and technology.

"I think that a basic science understanding—the more, the better—is absolutely crucial for the benefit of the country as well as individuals. Hopefully we can help provide the scientists of the future and improve decision-making across society."

LEADERSHIP



VISION

SCIENTIFIC EXCELLENCE

LEADERSHIP

INSPIRATION

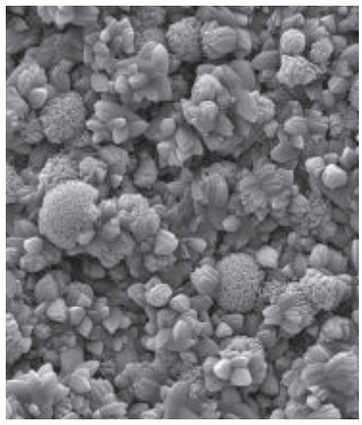
ADVANCEMENT OF NEW ZEALAND

LEADERSHIP DEVELOPMENT

INTEGRATED COMMUNITY

OPTIMAL LEARNING ENVIRONMENT

LEADERSHIP IN SCIENCE & SOCIETY



TO FORGE NEW ZEALAND'S FUTURE LEADERS

Scientifically astute, entrepreneurial and socially active leaders

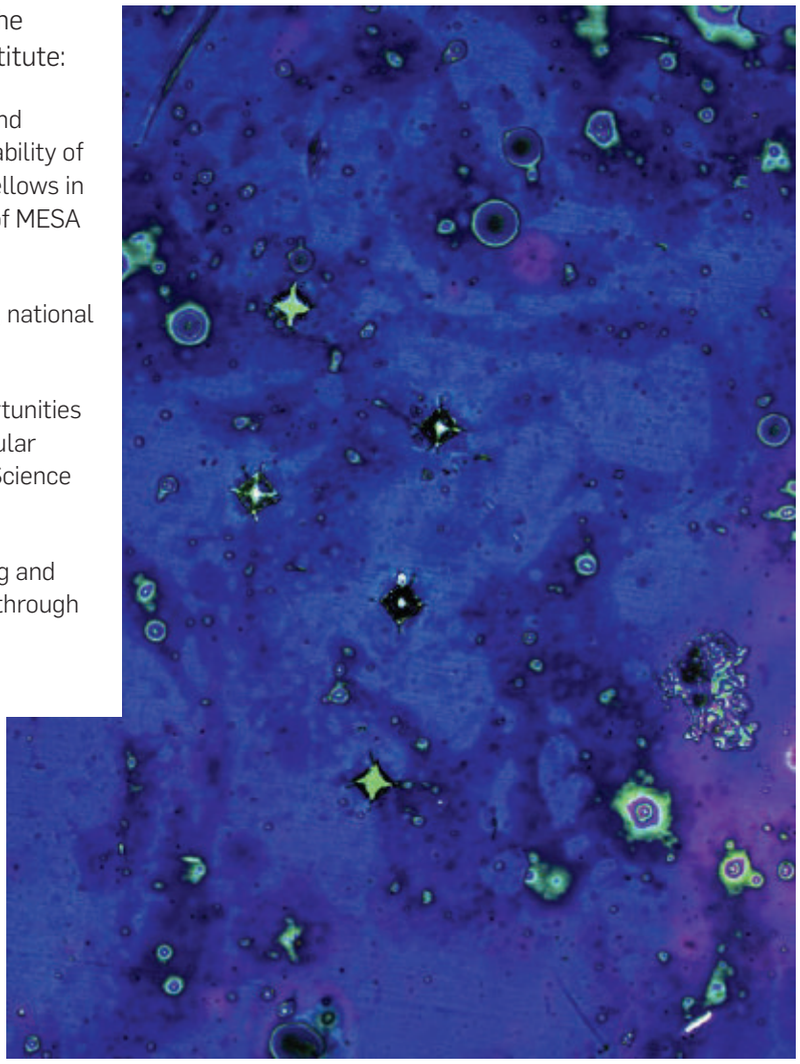
The MacDiarmid Institute recognises the importance of strong leadership to its position as a centre of research excellence and, to achieve this, focuses on:

- Developing and fostering leadership at all levels of the MacDiarmid Institute
- Creating a strong, integrated community of Investigators, students and alumni
- Demonstrating active leadership in the relationship between science and society.

LEADERSHIP DEVELOPMENT

In developing leadership across the organisation, the MacDiarmid Institute:

- Ensures broad participation by, and continuity of knowledge and capability of our students and Postdoctoral Fellows in MESA, including representation of MESA on the Science Executive
- Promotes our members for local, national and international opportunities
- Provides formal leadership opportunities for our Investigators through regular turnover of science leaders and Science Executive members
- Provides opportunities for training and mentorship for all our members through our internal science groupings.



INTEGRATED COMMUNITY

In order to attain our aim of a strongly integrated community the Institute:

- Establishes a formal network of affiliated companies and through this provide opportunities for all our members to interact with them directly
- Provides a diversity of opportunities for Investigators to interact with each other creating cohesion and a sense of belonging, ownership, responsibility, participation and innovation
- Develops and maintains an active MacDiarmid Institute alumni network.

PARTNERING WITH INDUSTRY

In 2014, the MacDiarmid Institute set up an Industry Advisory Group (IAG) to guide them how best to interact with New Zealand's industrial sector. There are six members of the group, including senior managers of some of our most innovative companies. These include Fisher & Paykel Healthcare, which is a leader in the field of sleep disorder and intensive care systems, and Rakon—which specialises in high tech components for communications systems. Other members have considerable expertise in the translation of research into new commercial products and processes that add value to New Zealand's industries.

Thanks to the IAG advice, the Institute is gaining a better understanding about how best to engage with industry so that our basic research directions can be guided by the concerns of New Zealand businesses, as well as getting a better understanding of how the MacDiarmid Institute might be able to help the industrial sector envision where they might move in future.

It also provides valuable advice on the mechanisms the Institute may need to put in place to translate their research into commercial products and processes, and how the Institute can best work with the new structures that have been created to foster technology transfer and drive the application of basic research.

Among the initiatives to come out of the IAG to date is the industry internship scheme, which allows selected PhD students to spend several months out from studies to experience working in industry. (See page 54)

The group consists of six key representatives from New Zealand's industrial sector:

rakon	Michael McIlroy, Managing Director of Rakon
Fisher & Paykel HEALTHCARE	Lewis Gradon, Senior Vice-President Products and Technology, Fisher & Paykel Healthcare
TIN100	Greg Shanahan, Managing Director, TIN100
SCOTT	Barbara Webster, General Manager, Business Development and Innovation, Scott Technology
EVER EDGE IP	Paul Adams, CEO EverEdge IP
arnold.co.nz	Simon Arnold, CEO, Arnold Consulting.

Representing the MacDiarmid Institute on the IAG are: Director Kate McGrath, Principal Investigator Jeff Tallon and Professor David Williams.

See full feature 'What Industry Wants' on page 63.

OPTIMAL LEARNING ENVIRONMENT

Work with partners to target the commercial skills, knowledge and aspirations of our emerging scientists by:

- Providing training/mentoring in IP and commercial assessment, technology transfer and research commercialisation
- Providing our members with direct access to the best equipment, research infrastructure, scientists, innovators and leaders
- Providing appropriate training opportunities that support delivery on our established set of graduate attributes that align with our strategic goals and values
- Working with MESA to develop training opportunities for our students and postdoctoral fellows.

PROVIDING THE ORGANISATIONAL GLUE

The MacDiarmid Emerging Scientists Association (MESA) plays an important role in the Institute in involving PhD, postdoctoral and emerging scientists in the day-to-day activities of the organisation. MESA was set up in 2010 to expand the opportunities for these up-and-coming scientists and establish a strong sense of community in what is a 'virtual' organisation.

Started and run by students and postdoctoral fellows, MESA is represented in the MacDiarmid Institute management structure and plays an important role in providing professional development opportunities, as well as offering a series of social events for its cohort.

Prominent among its professional development activities is an annual intensive research bootcamp on a particular MacDiarmid Institute discipline. In 2014 the topic was photovoltaics, which covered the basics of solar cell physics, manufacturing strategies and practical sessions. The sessions were taken by four

Started and run by students and postdoctoral fellows, MESA is represented in the MacDiarmid Institute management structure and plays an important role in providing professional development opportunities.

MacDiarmid Institute researchers who are world leaders in the field—Dr Justin Hodgkiss, Dr Jonathan Halpert, Professor Keith Gordon and Professor Maan Alkaisi—as well as Dr Attila Mozer of the University of Wollongong, Australia. It was the first time MESA has secured an international speaker for a research bootcamp event.

Dr Justin Hodgkiss says the bootcamp was a highlight of his year.

"It combined many of the things we value in the MacDiarmid Institute: an excellent series of lectures and practical activities on one of our key science programs; getting to know people at all levels from across the Institute; great company, and great fun in a stunning location!"

The bootcamp was held at Cragieburn Educational Centre, 100 km from Christchurch and attracted 19 students and postgraduate fellows from MacDiarmid campuses around the country.

During the year, MESA also organised several short workshops for PhD students and postdoctoral fellows and these covered the thin films and IT-related topics.

Sujay Prabakar

FROM STUDENT TO INVESTIGATOR

After more than a decade in existence, the MacDiarmid Institute is seeing its graduates now moving up the ladder to take more prominent research positions within the organisation.

The latest is Dr Sujay Prabakar—now a research scientist with one of New Zealand's specialist industry-focused research organisations and a MacDiarmid Associate Investigator.

He gained his PhD in Materials Chemistry from Victoria University of Wellington in 2011 under the supervision of Principal Investigator Richard Tilley.

Dr Prabakar is now applying his expertise with the New Zealand Leather and Shoe Research Association (LASRA) in Palmerston North. His research focuses on the synthesis and characterisation of inorganic-based functional nanomaterials for applications such as leather processing and coatings as well as on collagen-based biomaterials that can have applications in the leather, upholstery and footwear manufacturing industries.

DEVELOPING THE FUTURE SCIENCE LEADERS

The Symposium is a critical opportunity for our students and postdoctoral fellows to take responsibility for the design and organisation of a research event.

The MacDiarmid Institute is dedicated to growing and developing scientifically astute, entrepreneurial and socially active leaders at all stages of their scientific career. In 2014, Postdoctoral Fellow Dr Jenny Malmstrom took up the opportunity to develop further leadership skills in taking on a role as head of the organising committee for Get It Out! From Fundamentals to Market, the annual MacDiarmid Institute Student and Postdoc Symposium, held at the University of Auckland in November 2014. (See page 59)

The Symposium is a critical opportunity for our students and postdoctoral fellows to take responsibility for the design and organisation of a research event, under the guidance of a MacDiarmid Principal Investigator mentor—in this case, Dr Geoff Wilmott. It is usual for the organising committee to consist of a mix of PhD students and postdocs, and in 2014, Jenny, who is part of Professor Jadranka Travas-Sedjic's research group in polymer electronics at the University of Auckland, was asked by the existing PhD students on the committee to represent the Institute's postdoctoral fellows.

Jenny was reluctant to take on this additional responsibility at first, as she was concerned that it would take her away from her research and interfere with her home life—she has two young children. "But then I thought, as a feminist, I can't say no!" Ultimately, she is pleased that she made this decision—she ended up developing a critical role in providing leadership within a group of students, being responsible for decision-making and problem-solving during the preparation for and the duration of the symposium itself.

The pressures for early-career researchers, especially those with families, are myriad: Jenny, like many other early-career researchers, had valid concerns that undertaking a role like symposium organisation or similar academic service roles would detract from what seems the most important academic imperative—research and publication.

"In the end though, I could see that the opportunity to have experience in organising an event and the people management that goes alongside this was good for me and my career," says Jenny. Balancing the demands of research and service as a postdoctoral fellow required Jenny to draw upon the example of a number of key role models of leadership—she cites her mother, her PhD supervisor (Associate Professor Duncan Sutherland) and Professor Jadranka Travas-Sedjic, all of whom contributed to her sense of how to approach the task at hand. "It is important to take on responsibility, but to also feel supported in taking it on."

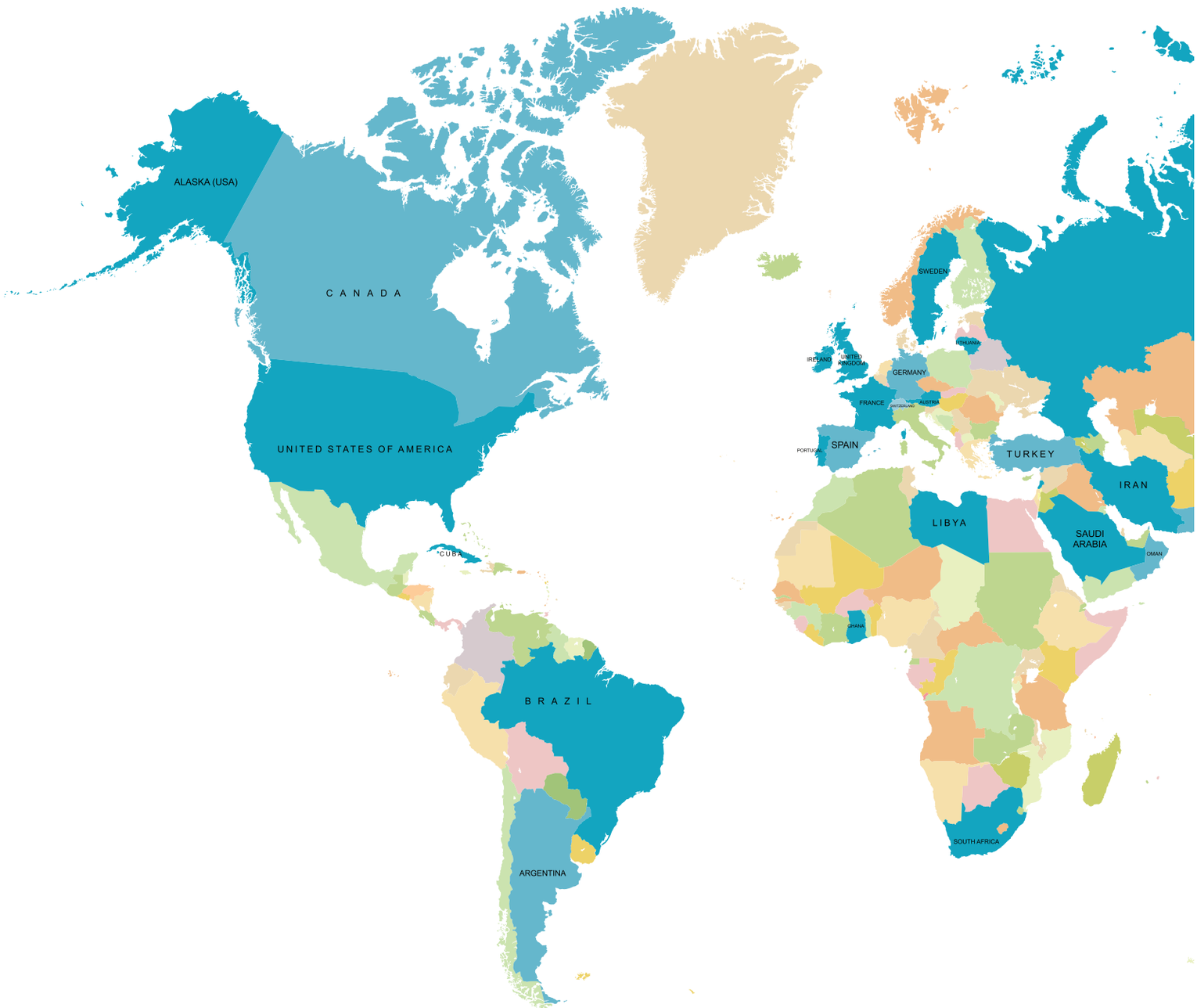
Balancing the demands of research and service as a postdoctoral fellow, required Jenny to draw upon the example of a number of key role models of leadership.

The MacDiarmid Institute's processes, people and structures provided this essential support, with Jenny noting the importance of Sarah Dadley's (Assistant Centre Manager) advice and assistance: "We had really helpful Skype meetings to align our to-do lists." Similarly, the rest of the organising committee—Nihan Aydemir, Cherie Tollemache, Lakshika Perera and Nina Novikova—were instrumental in enabling the success of the symposium. Jenny also credits the wisdom and advice provided by Dr Geoff Wilmott, who acted as mentor to the organising committee. "Geoff's experience in structuring conferences and symposia in the past was hugely helpful as we developed the plan for the days."

Jenny's reluctant undertaking of a leadership role has had a far greater impact than she imagined: "I do feel that knowledge and capability has been passed on to me," she says, reflecting the values of the MacDiarmid Institute, which seeks to support the development of continuity of knowledge and capability in students and postdoctoral fellows, in order to develop future scientific leaders.

GLOBAL IMPACT

MACDIARMID INSTITUTE STUDENTS AND POSTDOCTORAL FELLOWS ARE FROM:



- Argentina
- Australia
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- Brazil
- Canada
- China
- Cuba
- France
- Germany
- Ghana
- Hong Kong
- India
- Indonesia
- Iran
- Ireland
- Japan
- Lebanon
- Libya
- Lithuania
- Malaysia
- Marshall Islands
- New Zealand
- Oman
- Pakistan
- Portugal
- Russia
- Saudi Arabia
- Singapore
- South Africa
- South Korea
- Spain
- Sri Lanka
- Sweden
- Taiwan
- Thailand
- Turkey
- United Kingdom
- United States of America

EXPERIENCE ABROAD

During 2014, some 20 PhD students and postdoctoral fellows had the opportunity to travel to leading international institutions to gain further insights into their particular field of research. The visits took them to the United Kingdom, Germany, France, Spain, Switzerland, Iran, Japan, Taiwan, South Korea, China and Australia.

Eva Anton

THE POSTDOCTORAL EXPERIENCE

MacDiarmid Institute 2014 Postdoctoral Fellow Eva Anton works in an exciting field. She is part of the rare-earth nitrides team that is growing materials that are both semiconducting and ferromagnetic, making them an attractive proposition for a new generation of electronic devices.

Eva first came to the team after meeting Emeritus Professor Joe Trodahl, a founding member of the MacDiarmid Institute, while she was a PhD student in Darmstadt, Germany, arriving at Victoria University of Wellington in 2012. She now works with Professor Trodahl, who co-leads the project with Dr Ben Ruck.

Before arriving in Wellington, Eva's research focused on environmentally friendly lead-free ferroelectric ceramics using Raman Spectroscopy as an analysis tool. It was her experience with that method that led to the invitation to join the MacDiarmid team. She recalls that it was a big change to move to growing thin-film materials.

"The topic is very different. When I came here I had to start from scratch."

"All the literature was new, the materials had hardly any connection—the emphasis from ferroelectrics to ferromagnetism is a big shift," she says. "I needed a lot of support and help."

And that, she says, was what she got. "It was a very nice experience."

Eva has also appreciated what she says is a 'very open' approach to ideas.

"You have your freedom to research the way you want. Obviously there are limits of funding or equipment but no one says: 'You can't do that because we don't want to go in that direction'. No one has ever stopped my creativity."

She says help also came from other parts of the MacDiarmid Institute, especially researchers working on superconductivity at Gracefield—formerly IRL (Industrial Research) but now the Robinson Institute.

As a MacDiarmid Institute Postdoctoral Fellow, Eva receives financial support to take up a variety of opportunities provided by the Institute. For her, one of the greatest experiences was her participation in

We always think about solving our science problems but just to think 'how is it useful?' is completely different.

the 2012 MacDiarmid Symposium. There, she heard about the scoping projects some of the students and postdoctoral fellows had undertaken to sound out the commercial potential of their research.

"It was amazing to me how much output they had from that three weeks of work."

Inspired, Eva got in touch with the commercialisation team and worked closely with Desi Ramoo on the potential commercial applications of her work with thin films. The work she did was to form the basis for one of the patent applications filed by the rare-earth nitrides team in April 2014.

She says the experience means she now views her science in a different way.

"We always think about solving our science problems but just to think 'how is it useful?' is completely different."

"It might mean sometimes not getting it scientifically perfect, but thinking about the need your research might fill, about what it is people might actually need and having it working reliably."

In March 2015, Eva started on a project of her own funded by a Marsden Fast Start grant. Working on the project alongside her continuing research on thin films, she will go back to her PhD specialty—lead-free ceramics. Her aim is to develop materials for use in applications that connect electronic and mechanical functions, micro-electro-mechanical systems. These devices could work in two opposing ways. A current applied to the material could initiate movement—which would be useful in instruments such as microscopes where small, accurate movements are required. The movement of the material could also generate a charge, which would be useful in harvesting energy from even the smallest amount of movement.

As well, the devices would have an advantage over present materials. There would be no toxic lead in the materials to leak into the environment or cause issues when devices come to the end of their life.

PHD STUDENT SUCCESSES

MacDiarmid PhD student David Young was awarded the Royal Australian Chemical Institute (RACI) Inorganic Division's Don Stranks prize for a talk entitled: Examining the Modular Nature of Zinc Metal-Organic Macrocycles at the Royal Australia Chemical Institute National Congress held in Adelaide in December. The prize is awarded to a student member of the RACI and affiliated societies, and recognises outstanding performance in research by a current PhD candidature.

David, who is based at the University of Canterbury, is in his final year of a PhD under the supervision of MacDiarmid Principal Investigator Paul Kruger.

Stephanie Droste, who is studying at Victoria University of Wellington, presented her poster entitled: *Finite-Frequency Full Counting Statistics for Transport Through a Hybrid Superconducting-Normal Structure with a Quantum Dot* at one of the leading conferences on the subject, the 27th International Conference on Low Temperature Physics, held in Buenos Aires, Argentina in August.

Stephanie says the conference was a great opportunity to be updated on the various topics in low-temperature physics by top people in the field.

"Many experts in the field both experimental and theoretical, from across the world attended this conference. It was a great experience for me to exchange information and views, as well as discuss my work with researchers in the field."

LEADERSHIP IN SCIENCE AND SOCIETY

Our excellence in science also rests on showing leadership within the wider community. The Institute does this by:

- Speaking out on topics of misrepresentation of scientific information in the media or society that relate to the evidentiary expertise held within the Institute
- Conducting a national survey of societal perceptions of science, in partnership with relevant organisations
- Holding public forums connecting science with society to address major societal issues of the day, in partnership with relevant organisations
- Supporting our members to present at, and participate in, national and international conferences about science at the interface of society
- Identifying and supporting our best communicators to be science leaders in society.

Grant Williams

QUEEN'S BIRTHDAY HONOUR

MacDiarmid Institute Principal Investigator Dr Grant Williams was made a member of the New Zealand Order of Merit (MNZM) for services to science in the 2014 Queen's Birthday Honours list. The honour is bestowed on those "who, in any field of endeavour, have rendered meritorious service to the Crown and the nation or who have become distinguished by their eminence, talents, contributions or other merits."

Dr Williams, who is Professorial Research Fellow at the School of Chemical and Physical Sciences at Victoria University of Wellington, is currently involved in a number of research programmes that include the study of new materials for magnetic sensors, optical materials and methods for radiation detection, high-temperature superconductivity, topological insulators and linear and nonlinear optics.

Nicola Gaston

Kate McGrath

Michelle Dickinson

Margaret Brimble

MACDIARMID INSTITUTE WOMEN OF INFLUENCE

Four MacDiarmid Institute scientists were finalists in the 2014 Women of Influence in Science and Technology Awards, and one of them, Associate Investigator Distinguished Professor Margaret Brimble was named the winner of the 2014 Westpac Woman of Influence in Science and Innovation.

The Women of Influence Awards, which are sponsored by Westpac, go to “bold, energetic women helping shape New Zealand’s future” in a range of sectors, including science and technology.

Along with Professor Brimble, the other MacDiarmid finalists were Director Professor Kate McGrath, Principal Investigator Dr Nicola Gaston and Associate Investigator Dr Michelle Dickinson—better known to thousands of New Zealand school students as Nanogirl and winner of the 2014 Prime Minister’s Science Media Communication Prize (see page 15).

Dr Gaston is President of the New Zealand Association of Scientists and is frequently cited in the media commenting on issues important to New Zealand science and scientists.

A PLACE TO LIVE

There needs to be a path from basic science through into industry, and industrial problems often throw out really good basic science problems.

The MacDiarmid Institute, in partnership with Victoria University of Wellington, hosted a major national conference in Whanganui in November 2014 entitled: A Place to Live—for the life worth living. It was a follow-up to the highly successful Transit of Venus Forum held in Gisborne in 2012, which explored future directions for New Zealand. The Whanganui forum built on the themes of the Gisborne event with discussion on how to improve the environments and economies of the regions and New Zealand's smaller centres to ensure they are places that offer wonderful lifestyles and also contribute significantly to national wealth. Whanganui was chosen for the 2014 event because it was where Sir Paul Callaghan—who championed the Transit of Venus Forum before his death—grew up.

Among the conference sessions was a public debate by a panel of regional mayors while the invited speakers included Davey Hughes of Levin-based outdoor sports equipment company Swazi, Nelson businessman and arts philanthropist Glenn Schaeffer, green urban designer Gayle Souter-Brown, project manager for Reclaiming Northland David Mules, and furniture designer David Trubridge of Havelock North. The keynote speaker was American writer Richard Louv, who argues the importance of nature and experience of the outdoor environment to the creativity, mental and physical health of children as they are growing up. He also gave a series of seminars for scientists, educators, health professionals and others in Wellington, Nelson, Auckland and Whangarei.

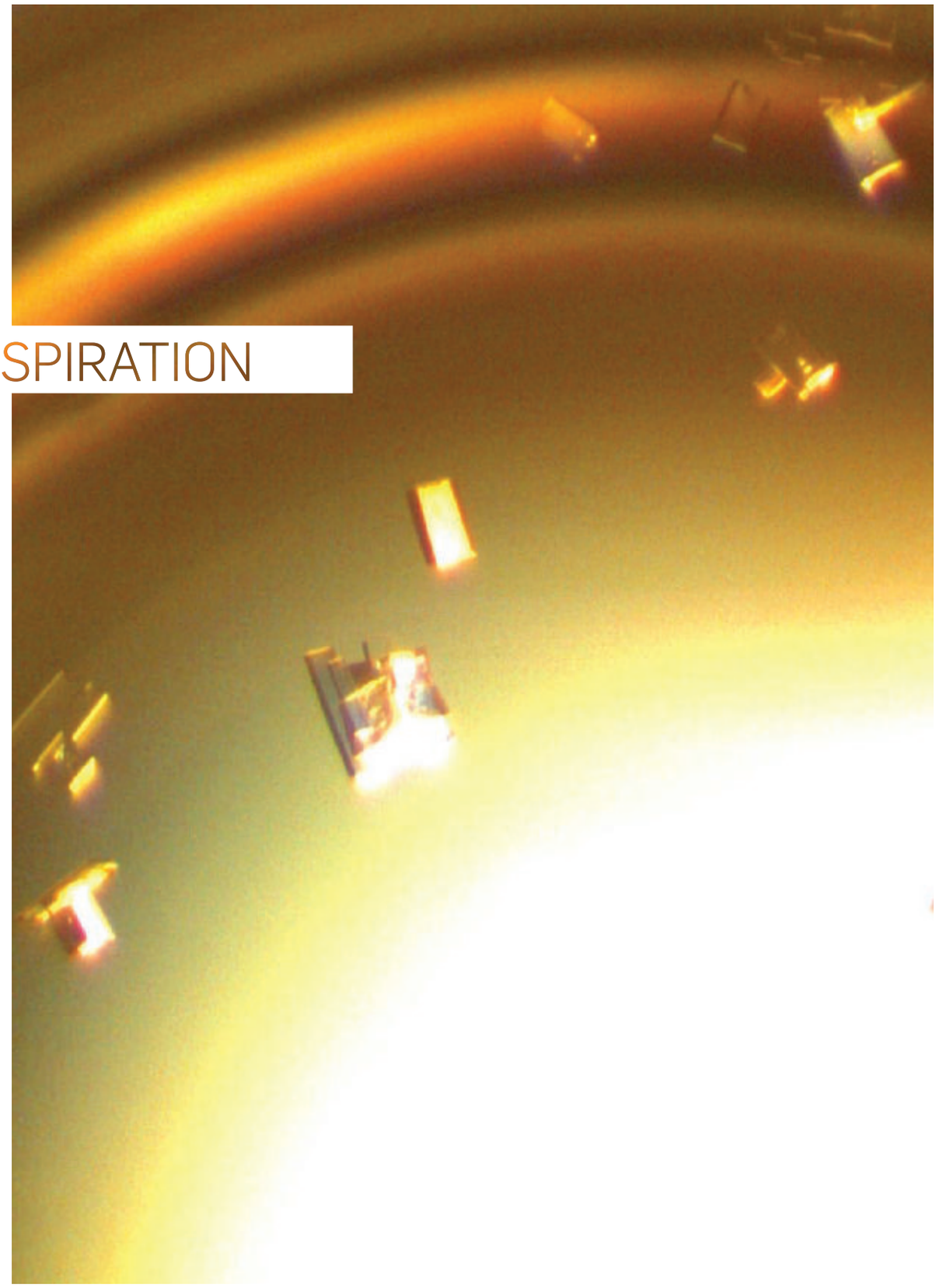
During the conference, the Predator Free New Zealand Trust was launched with the aim of eliminating stoats, rats and possums from New Zealand by 2040.

Delegates also visited Hiruharama (or Jerusalem) on the banks of the Whanganui River and Koriniti Marae and attended a River workshop—Reimaging Water.

Some conference sessions were recorded and broadcast on Radio New Zealand National early in 2015.

The principal sponsor of A Place to Live was Kiwibank, which also gave financial support for the Transit of Venus Forum. Other sponsors included the Department of Conservation, Landcare Research and the Allan Wilson Centre for Molecular Ecology and Evolution.

INSPIRATION



VISION

SCIENTIFIC EXCELLENCE

LEADERSHIP

INSPIRATION

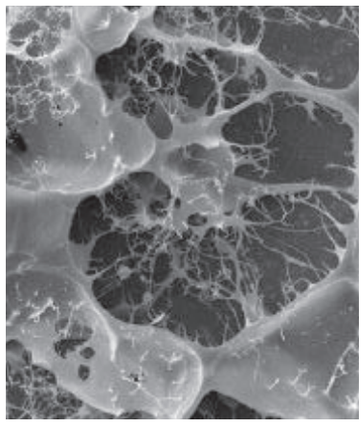
ADVANCEMENT OF NEW ZEALAND

BENEFITS OF SCIENCE & INNOVATION

SHOWCASE

ROLE OF SCIENCE & INNOVATION

MĀORI & PASIFIKA



TO INSPIRE NEW ZEALANDERS

Engendering passion for science and innovation across society

The MacDiarmid Institute works to promote awareness of science and its importance to New Zealand with the ultimate aim of generating a culture change where science and innovation are celebrated as the keys to New Zealand's prosperity. The Institute does this by:

- Stimulating nationwide discussion on the benefits of science and innovation to society
- Engaging directly with the New Zealand public, private sector and Government to share our vision of the role of science and innovation in New Zealand's future
- Showcasing our own, and others', science stories to New Zealanders of all ages
- Engaging directly with Māori and Pasifika communities, generating opportunities and lifting ambitions.

BENEFITS OF SCIENCE AND INNOVATION

To play our role in stimulating nationwide discussions, the Institute:

- Identifies and supports its best communicators to express the benefits of science and innovation to our society
- Develops a media management plan, including media training for staff
- Holds public forums connecting science with society to address major societal issues of the day, in partnership with relevant organisations
- Conducts a national survey of societal perceptions of science, in partnership with relevant organisations.

ENCOURAGING SCIENCE

For the past nine years, the MacDiarmid Institute has supported science classes for journalists, radio producers and people from the publishing and creative industries.

Attendance at the classes is by invitation and in recent years has been held in partnership with the Science Media Centre with facilities provided by the Royal Society of New Zealand and Callaghan Innovation. In 2014, sessions were held in Wellington and, for the first time, in Auckland.

The idea behind the classes is to increase the understanding of science and mathematics among people who play a crucial role in informing the public and the sessions included subjects of current interest to the international science community, such as Ebola, antibiotic resistance, invasive species in Antarctica and drones.

Several overseas speakers were also featured during the year. Well-known television presenter Lord Robert Winston of Imperial College London took a session on frontiers in fertility and Marlene Zuk from the University of Minnesota, in a talk entitled ‘Paleofantasies’, explored the links between evolution, diet and behaviour in challenging some of the myths about human evolution since the Paleolithic age.

MACDIARMID SCIENTISTS IN THE MEDIA

During 2014, MacDiarmid Institute research and researchers were featured in New Zealand media outlets, with several scientists having regular slots.

Principal Investigator Shaun Hendy writes a regular column for Unlimited magazine covering science, politics and industry and is also the physics correspondent for Radio New Zealand National's Nights with Bryan Crump show. Incidentally, he was a finalist for the 2014 Best Columnist in the Business and Trade category of the Magazine Publishers Association Awards.

Associate Investigator Michelle Dickinson is regularly called on by TV3 as a spokesperson on science and in that capacity has appeared on its breakfast news show Firstline, the late evening news programme The Paul Henry Show and on Radio Live.

Principal Investigator Nicola Gaston is also a regular in both the print and electronic media in her position as President of the New Zealand Association of Scientists.

MacDiarmid Institute research has featured regularly on Radio New Zealand's specialist science programme Our Changing World. Over the course of the year our investigators Bernd Rehm, Justin Hodgkiss, Nicola Gaston, Kate McGrath and Shane Telfer, along with students Amy Yewdall and Sarah Thompson, talked about their research.

Several Institute initiatives were also picked up by news media. The Kōrero with Scientists project caught the attention of the education media while the memorandum of understanding with Ngā Hononga Marae Charitable Trust was covered by national media and also appeared in news coverage in Canada and Australia.

Shaun Hendy

Michelle Dickinson

Nicola Gaston

ROLE OF SCIENCE AND INNOVATION

In sharing our vision of the role of science and innovation in New Zealand's future, the Institute and its research personnel engage with the public, the private sector and Government to:

- Publicise the MacDiarmid Institute's contribution to the economy
- Provide a variety of professional development programmes and resources for early childhood and primary school teachers including Kōrero with Scientists and The Best 100 Science Experiments
- Identify key contacts and develop and grow active networks within government, industry, media and schools
- Work with our Industry Advisory Board to identify opportunities to connect science, innovation and society
- Participate in national strategic advisory groups and growing active networks within government to ensure the national science enterprise gives maximum value for investment.

MEDIA SAVVY SCIENTISTS

Each year, MacDiarmid Institute researchers are given the opportunity to hone their media skills at the Media Savvy Science courses administered by the Science Media Centre. Participants learn about all aspects of dealing with the media—from the first phone call to the interview—including coping with nerves and choosing language a general audience will understand. The course also covers new media opportunities through social media and allows participants an opportunity to ask questions of a panel of journalists.

For Principal Investigator Justin Hodgkiss—who took the course in 2014—the opportunity was timely. "The media savvy training gave me excellent preparation for communication through the media, which was fortunate as the TV news called the very next day!"

And for another 2014 participant, Principal Investigator Nicola Gaston, it opened up a great media opportunity.

"It led directly to my appearance with 'the Naked Scientists' show held in Wellington in August and broadcast on Radio New Zealand National's This Way Up programme. I talked about computational nanotechnology in the MacDiarmid Institute and my research on gallium (a trace element found in zinc ores and bauxite)—with the use of an actual gallium 'disappearing' teaspoon."

In May, the MacDiarmid Institute Director, Kate McGrath was one of the guests on a discussion on Radio New Zealand National's Nine to Noon on funding for the Centres of Research Excellence. The other speakers were Professor Hamish Spencer, Director of the Allan Wilson Centre for Molecular Ecology and Evolution; and Tim Fowler, Tertiary Education Commission Chief Executive.

KŌRERO WITH SCIENTISTS

Kōrero with Scientists consists of two-hour workshops where teachers can explore basic scientific concepts.

This initiative was held for the first time in 2014 following an agreement between the MacDiarmid Institute and the New Zealand Educational Institute Te Riu Roa (NZEI) to offer new professional development options for primary and early-childhood teachers.

It gives these teachers to opportunity to talk with, and learn from, scientists—with the goal of giving them a greater understanding and confidence in teaching science.

Kōrero with Scientists consists of two-hour workshops where teachers can explore basic scientific concepts such as magnetism, acids and light, and also hear about areas of specialist research.

“Interacting with scientists is a rare experience for many teachers,” says Eseta Fuli—NZEI coordinator for science-based professional learning and development, “but you see them getting ignited with a child-like excitement at being scientists themselves.”

The series has also struck a chord with MacDiarmid Institute scientists who have taken part. Principal Investigator Dr Natalie Plank of Victoria University of Wellington described it as the coolest thing she did for the Institute during 2014. She demonstrated how electrical forces cause action at a distance by rubbing a perspex rod with a small piece of wool to charge it with electricity and then using the rod to move an overturned soft drink can by simply waving it in the air near the can.

“The teachers knew that the school children would love this. Who doesn’t want to wave a rod and feel like Harry Potter?”

“Being part of an innovative programme like this makes me feel proud to be part of the Institute and pleased that we are able to show the teachers how children can spend time thinking about science and enjoying the process immensely.”

Meanwhile, a meeting held in November to discuss how the country’s CoREs might cooperate was so impressed with the idea that delegates agreed it was an initiative they should work together on to extend its reach.

In another initiative launched with the signing of the NZEI-MacDiarmid Institute agreement, an annual competition invites teachers to submit their favourite simple, fun and fail-safe experiments that use readily available materials. The aim is to gradually build up a portfolio of experiments, named ‘The Best 100’, that can be accessed by teachers to make science learning fun. The submitted experiments are made available on the Learning Hub section of the MacDiarmid Institute website.

SHOWCASE

The Institute showcases its science by:

- Telling its stories through Update, our website, social media, Interface and our Annual Report
- Providing communications training and public-engagement opportunities for our Investigators, students and postdoctoral fellows
- Undertaking targeted and impactive outreach activities
- Tracking high school student outreach alumni such as Nanocamp participants and Discovery Awards winners.

I particularly enjoyed those moments when all the pieces of a lecture fell into place and I began to comprehend a complex concept, which I'd never even heard of before the event began.

FEEDBACK FROM A CAMPER

NANOCAMP 2014

Each year in January, the MacDiarmid Institute holds a week-long science camp for students entering their final year at secondary school. Competition for a place on the camp is always strong, and in 2014 many of the country's top science students applied to be one of the 15 participants. Nanocamp is hosted by a different partner organisation each year and in 2014 it was held at Victoria University of Wellington. Associate Professor Michele Governale of the School of Chemistry and Physical Sciences, who organised the camp with the help of Dr Shen Chong, says the Nanocampers seemed to really enjoy the experience.

"During Nanocamp week the school was buzzing with activity and the contagious enthusiasm of the Nanocampers. Their major complaint was that it was far too short!"

As well as learning more about the basics of nanotechnology, the students were introduced to a range of scientific research and sophisticated research tools at Victoria, including spintronics, magnetic resonance imaging as it applies to material science, Ramon single molecule detection, the use of volatile molecules in pest control and microfabrication.

They also visited GNS Science and Callaghan Innovation to learn more about work going on in superhydrophobics, photonics and superconductivity.

MACDIARMID INSTITUTE SPONSORSHIPS IN 2014

Each year, the MacDiarmid Institute sponsors selected activities, initiatives and events that provide opportunities for young and emerging scientists as well as promote and support excellence in science.

In 2014, the Institute was a major sponsor of a number of significant events. These included: the D4—Devices for Diagnostics and Drug Delivery conference held at the University of Otago in November; the Chemistry Sciences Research Showcase for postgraduate research held in Auckland in July; and the Royal Society of New Zealand 2014 Research Honours Dinner at Te Papa in November, where the winners of New Zealand's top science medals and awards for the year were announced.

In 2014, the Institute was also a major sponsor of the Sir Paul Callaghan EUREKA! Awards programme. The awards are open to tertiary- and senior secondary-school students. The idea behind them is to identify and foster young leaders who, through their knowledge of science, technology, engineering or mathematics, their entrepreneurial vision and their persuasive communication skills, will bring about the New Zealand foreseen by Sir Paul Callaghan of 'the most beautiful, stimulating and exciting place in the world in which to live.'

The MacDiarmid Institute also sponsored travel opportunities for young and emerging scientists.

These included financial support for:

- Students Mahroo Poorsichani and Thomas Nilsson to travel to the 2014 Asia Nanotech Camp in Iran.
- Associate Investigator Michelle Dickinson—who has been recognised for her work in communicating science to young people—to meet Sir Richard Branson on his private estate on Necker Island in the British Virgin Islands in the Caribbean to discuss New Zealand science. She was one of eight people from around the world invited by the billionaire businessman and entrepreneur to visit his retreat to discuss technology and sustainability.
- Students to attend the Association for Women in Science conference in Wellington.

The MacDiarmid Institute sponsorship programme also targets the new generation of scientists coming through the school system and in 2014 that included financial support for the New Zealand team to travel to Hanoi, Vietnam for the Chemistry Olympiad.

The MacDiarmid Institute gives ongoing support to Te Rōpū Āwhina—Victoria University of Wellington's initiative that provides a whānau environment to support Māori and Pasifika students training to be the future scientists, technologists, engineers, architects and designers who will contribute to Māori and Pasifika community development and leadership.

MĀORI AND PASIFIKA

In order to assist Māori and Pasifika communities to grow and prosper through the understanding and adoption of science and technology the Institute:

- Develops, grows and formalises relationships with Māori communities founded on mutual exploration of education and business opportunities supported by a science foundation
- Provides targeted professional development programmes in science for Māori teachers and Pasifika Teachers, such as Kōrero ki te Kaipūtaiao.

MOU SIGNED WITH NGĀ HONONGA MARAE CHARITABLE TRUST

In September, a memorandum was signed in Whanganui between the MacDiarmid Institute and the Ngā Hononga Marae Charitable Trust. Under the Memorandum the MacDiarmid Institute and the Trust will work together to undertake community-based science programmes that will develop learning opportunities for young Māori, engender a passion for science and innovation across the society as well as identify and support science and innovation opportunities for businesses in the Whanganui region.

Since the signing, MacDiarmid Institute alumnus Keoni Mahelona has visited the area and identified an existing green waste composting scheme and a mushroom farming enterprise as two areas where science knowhow could add further economic value. Two University of Auckland science undergraduates also spent a summer internship with the local iwi.

One of MacDiarmid's two Innovation Agents, Desi Ramoo, worked with the Trust to set up the partnership and says it is not just about the Institute helping the community.

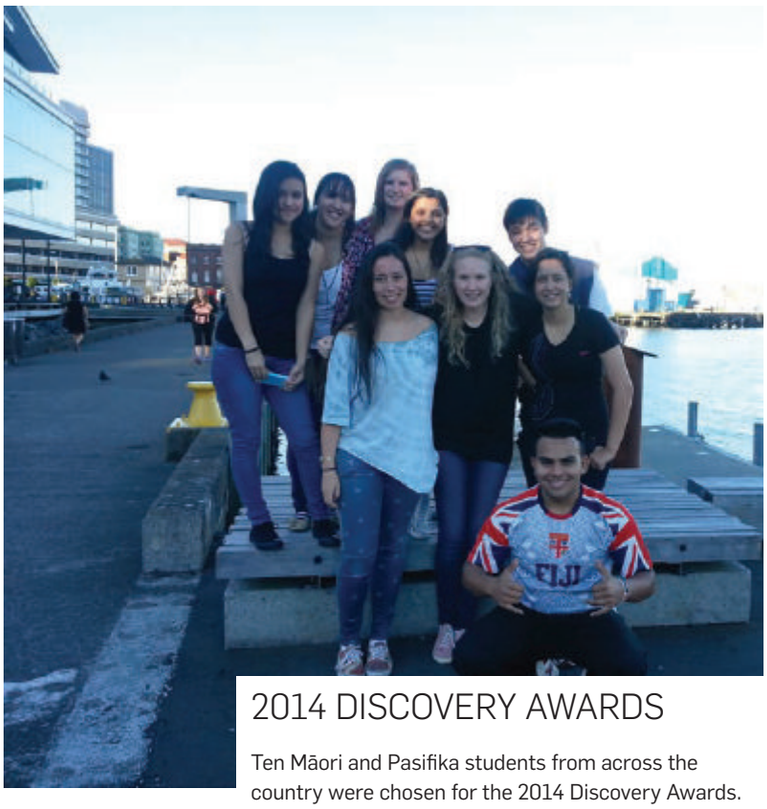
"We're aiming at a culture of community-centred engagement that will create an environment where our scientists can seek Māori participation in the work they do and where scientific opportunities can be initiated by the local community."

Trust Manager Nihi Houia says the agreement has the potential to provide big advantages for young people in the area.

"This partnership gives our children access to see science—to see the world—in another way. If our moko can blend the old people's way—mātauranga Māori—with the modern contemporary way, they will have a distinct advantage."

It is hoped the initiative will see more Māori students opting for, and completing, tertiary study in science, technology, engineering and mathematics qualifications, which Trust Manager Nihi Houia says has the potential to provide big advantages for young people in the area.

Ron and Kate



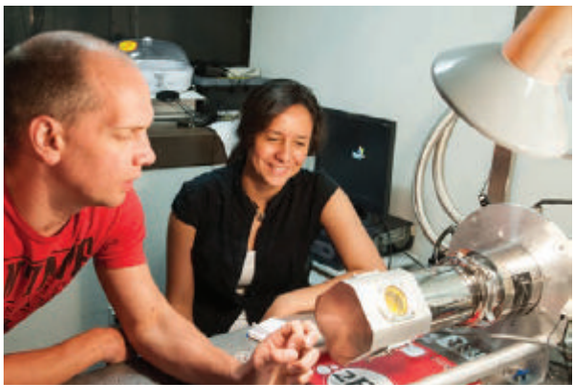
2014 DISCOVERY AWARDS

Ten Māori and Pasifika students from across the country were chosen for the 2014 Discovery Awards. The awards, which were first introduced in 2008 to give Year 12 and 13 Māori and Pasifika students the opportunity to work alongside scientists and their postgraduate students in the research laboratories of one of the Institute's partner organisations.

While academic achievement is an important part of the selection process, the students' goals and personal and financial circumstances are also taken into account.

The 2014 award winners attended a two-day introduction course at Victoria University of Wellington followed by two weeks of laboratory experience.

Under the guidance of supervisors from across the investigator and student cohort: Duncan McGillivray and Bryon Wright (University of Auckland); Ben Ruck and Nicola Gaston (Victoria University of Wellington); Bob Buckley (Callaghan Innovation, now with Robinson Research Institute); Andreas Markwitz (GNS Science); Maan Alkaisi, Roger Reeves and Ian Farrell (University of Canterbury); students were involved in a wide range of experiences, which included hands-on experiments, fabrication of solar cells, presentations, laboratory demonstrations and visits to a variety of research teams.



WHAT THE STUDENTS HAD TO SAY

The experience has been amazing, and has allowed me to realistically see myself in a scientific career. I recommend this to everyone—the experiments and people are amazing and this opportunity will open your eyes to a whole new world that I personally believed only existed in science fiction.

DIONTÉ ROSS

ADVANCEMENT OF NEW ZEALAND

VISION

SCIENTIFIC EXCELLENCE

LEADERSHIP

INSPIRATION

ADVANCEMENT OF NEW ZEALAND

COLLABORATIVE NETWORKS

ALUMNI AS LEADING INNOVATORS

COMMERCIALISE RESEARCH

ENGENDERING ADVANCEMENT

TO ADVANCE A NEW FUTURE FOR NEW ZEALAND

Deliver and support responsible economic development

The MacDiarmid Institute's mission to advance a new future for New Zealand brings together strengths in delivering excellent scientific research and education, fostering and sustaining leadership at all levels among our staff, students and alumni and inspiring New Zealanders about the contribution science can make to their lives. In focusing on the goal to deliver maximum benefit to New Zealand, its people and its economy, the Institute:

- Partners with applied R&D organisations to ensure economic outcomes for our science, and gain an appreciation of the market demands that are important to New Zealand companies, thereby delivering maximum benefit to New Zealand, its people and its economy
- Focuses on producing innovative scientists and engineers who will make leading contributions to New Zealand's prosperity
- Commercialises research, as appropriate, to ensure the greatest possible benefit to the New Zealand economy, society and environment
- Shares and realises a vision for adaptable and sustainable economic growth based on a high-technology export sector.

COLLABORATIVE NETWORKS

In establishing partnerships to ensure economic outcomes for our science the MacDiarmid Institute:

- Works with the Industry Advisory Board to identify opportunities to connect our science, innovation and people to industry
- Establishes and fosters a formal network of affiliated companies
- Fosters and utilises connections with industry, angel and venture capital communities, applied R&D organisations, Callaghan Innovation, affiliated companies, tech-transfer offices, KiwiNet, Return on Science, etc., to facilitate the advancement of science-led economic growth and development of existing and emerging companies and to enable proactive effective two-way engagement
- Works with partner organisations and affiliated companies to advance science-led economic growth and development of existing and emerging companies
- Provides industry IPS (individual placement and support) and industry tour opportunities for its PhD students in partnership with the Industry Advisory Group and affiliated companies.

INDUSTRY INTERNSHIPS

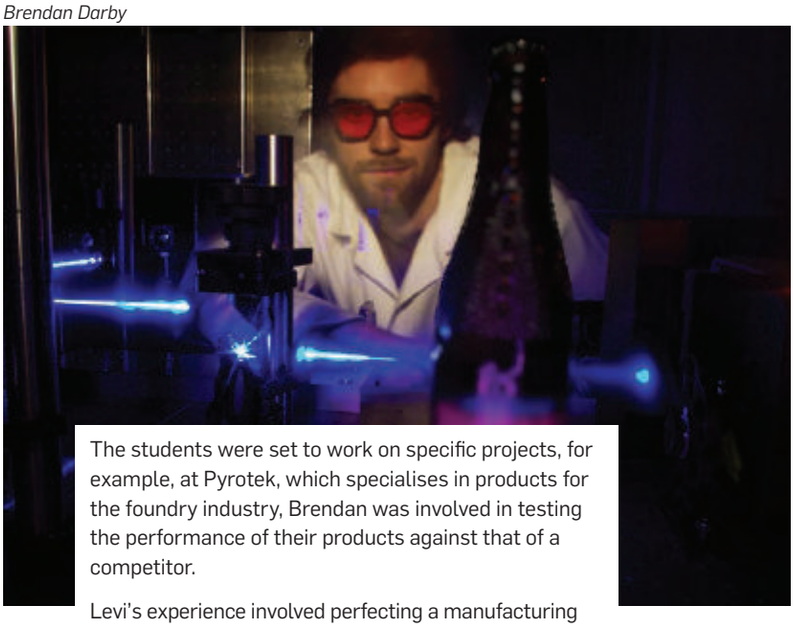
The MacDiarmid Institute industry internships—offered for the first time in 2014—are one initiative to give PhD students the skills they need to apply their capabilities outside the pure research environment.

The internships are administered by MESA and in 2014 four students were matched with specific companies for periods of between three and six months to experience at first hand applying their skills and their scientific knowledge in the commercial world. Levi Bourke was teamed with Rakon Ltd.—a world-leading manufacturer of frequency control components, Cam McNicoll did his internship at Fisher & Paykel Healthcare, Brendan Darby was with Pyrotek and Pablo Hernandez teamed up with Publons.

Levi Bourke

Cam McNicoll

Brendan Darby



The students were set to work on specific projects, for example, at Pyrotek, which specialises in products for the foundry industry, Brendan was involved in testing the performance of their products against that of a competitor.

Levi's experience involved perfecting a manufacturing process that, in the end, did not perform to expectations.

"Although my particular task had a negative result, it was certainly a very beneficial thing for me overall. I met a lot of good people, made several potentially good contacts for the future, developed many useful skills and gained some insight into how the industry works."

Cam McNicoll also values the contacts he made: "I acquired a whole new set of work skills, was introduced to a lot of high-tech companies and most importantly learnt how to interact with engineers. The set of skills and contacts generated from the internship led to me getting a job for a high-tech start-up company in New Zealand."

Pablo Herndandez says he took away a very important lesson from his time at Publons, namely the immense value of communicating with others early on in a research programme.

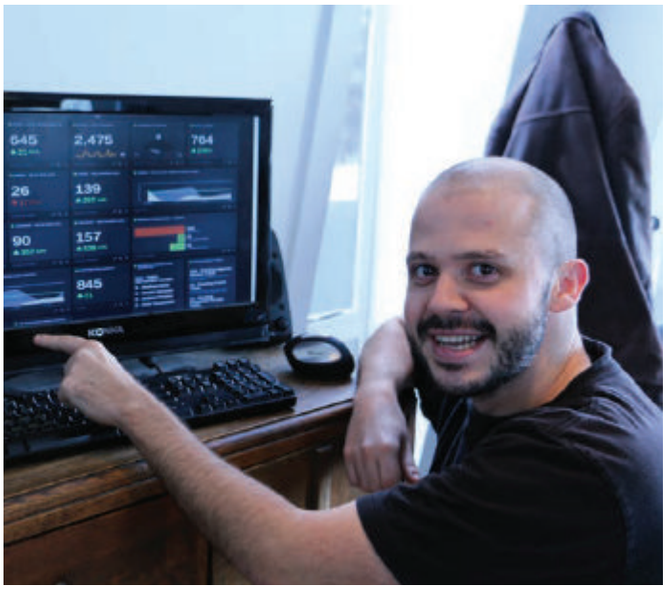
"Early feedback is much better that any other kind of feedback. This is true everywhere, but in a fast-moving environment as a startup, the ability to change and adapt fast is a deal-breaker."

The idea for the industry internships came from the MacDiarmid Institute's Industry Advisory Group, which was formed to strengthen the Institute's relationship with New Zealand's industrial sector. (See page 62)

I acquired a whole new set of work skills, was introduced to a lot of high-tech companies and most importantly learnt how to interact with engineers.

CAM MCNICOLL

Pablo Hernandez



ALUMNI AND LEADING INNOVATORS

In its drive to produce researchers equipped to make leading contributions to New Zealand's prosperity and advancement the MacDiarmid Institute:

- Engages PhD students and postdoctoral fellows in commercialising MacDiarmid Institute research
- Works with MESA, the Innovation Agent and KiwiNet to deliver commercialisation workshops and opportunities that increase awareness and employability
- Maintains connections with the MacDiarmid Institute alumni network
- Encourages students and postdoctoral fellows working with industry, while MESA organises tours of leading innovative businesses.

INDUSTRY TIKI TOURS

MacDiarmid Institute students from Wellington, Auckland and Canterbury participated in the inaugural MESA and MacDiarmid Institute Industry Tiki Tours held in October and November.

The students visited a range of specialist exporting businesses: Optus, Nuenz, Volpara and Publons in Wellington; and, Buckley Systems, Fisher and Paykel Healthcare and Adept in Auckland. The Auckland Tiki Tour also heard a presentation from Rocket Lab—a pioneer company in New Zealand space-rocket technology.

The Tiki Tours provide students with an opportunity to see how industry funds and incorporates scientific research into its business. Fisher & Paykel Healthcare alone employs around 400 R&D staff in New Zealand, and more than 90 percent of its sales are in exports.

As one of the students who took the tour, PhD student Chun Yee Cheah remarked: "Overall, this Tiki Tour gave us a great insight to the inner workings of actual companies; a valuable exposure especially for the emerging scientists of the MacDiarmid Institute."

Andrew Preston

ENTREPRENEURIAL ALUMNI

Besides taking up positions in research institutions in New Zealand and overseas, former MacDiarmid Institute students are also employed in industry and, in some cases, have set up and are running their own companies.

Andrew Preston graduated with a PhD from Victoria University of Wellington in 2009 having been part of the MacDiarmid Institute rare-earth nitrides team. He then did postdoctoral work in x-ray spectroscopy at Boston University. He returned to Wellington in 2011 with a business idea—a web-based company aimed at speeding up science publishing by streamlining the citation process.

The business he has cofounded with Daniel Johnston is called Publons—https://publons.com—and Andrew says it was his experience at Boston that started him thinking about the service.

"I loved doing scientific research, but the one thing that frustrated me is you work incredibly hard and then eventually publish a paper that expands the sphere of human knowledge, a bit, but not by much," he says. "I knew that I wanted to figure out ways of building tools that make everybody more productive, expanding the sphere of human knowledge faster—hence our mission, which is to speed up science."

Publons combines the two types of peer review—pre-publication, which happens before an article is published to ensure it is factually correct and significant enough to warrant publication, and post-publication, where discussion is added after publication.

"What we're doing combines pre- and post-publication peer review on a single platform, turning these peer reviews into publications in their own right, by assigning Digital Object Identifiers (DOIs)."

Among the reasons Andrew Preston opted to set up Publons physical base in Wellington was the contacts he had made while at the MacDiarmid Institute.

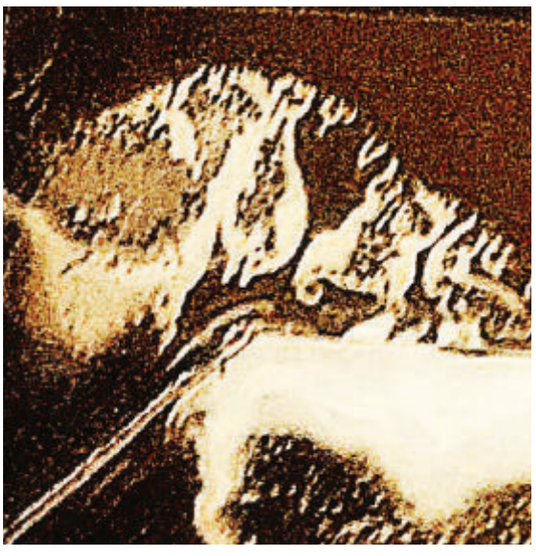
"Doing a PhD, especially at a place like the MacDiarmid Institute, where you are exposed to a range of people doing super interesting things, you have a huge opportunity to go out there into the world and essentially create your own thing."

He says that starting Publons has been the best year of his life. "I think it's important to have the biggest effect on the world that you possibly can."

COMMERCIALISE RESEARCH

The MacDiarmid Institute works to ensure the leading-edge science produced in its laboratories is commercialised to the benefit of New Zealand companies and the country as a whole by:

- Working with its community partners, including Callaghan Innovation, to exploit its intellectual property and generate new businesses
- Fostering cross-theme, cross-disciplinary and/or cross-CoRE activities that have direct economic outcomes
- Supporting its PhD students and postdoctoral fellows to initiate their own science-based businesses.



COMMERCIALISATION PROGRAMME

The MacDiarmid Institute is committed to commercial exploitation of intellectual property, including the knowledge and human capital contained within the Institute, in the most general possible way.

The MacDiarmid Institute's commercialisation plan focuses on a scheme that marries provision of resources for realising the commercial potential of institute research and provision of new opportunities for emerging researchers (principally PhD students) to participate in commercialisation projects and gain experience in the commercial arena. In addition, it has provided longer-term and more in-depth support for various projects. There has been a focus on energising emerging scientists to consider commercialisation of research—this was the focus for the MacDiarmid Student and Postdoc Symposium in 2014.

Highlights have been the success of the PhD Industry Internship scheme, the success of our education programmes to increase awareness and experience of students and postdoctoral fellows around commercialisation of research and our involvement with Ngā Hononga Marae Trust (NHMT) in Whanganui. Education in research commercialisation is now a major effort in New Zealand, with involvement from the university business schools, KiwiNet, University TTOs (technology transfer offices) and others. The Institute's role has evolved into one in which it makes sure that its investigators can participate and benefit fully from all the opportunities available, filling in gaps where appropriate through its own symposia and workshops.

In 2014 MacDiarmid Institute commercialisation projects were run by its Innovation Agent, Desi Ramoo. Two types of project were available:

- Scoping: typically ~10 days over a month, to provide initial assessments of commercial potential
- In-depth: typically three month projects, full time.

SUMMARY OF COMMERCIALISATION ACHIEVEMENTS

- Two scoping projects (summer studentships) and expert consultancy in support on Ngā Hononga Marae Trust in Whanganui
- Three in-depth evaluations of Institute research, complete with experimental work to strengthen or extend patent coverage
- Three research commercialisation workshops completed (Auckland, Wellington and Christchurch)
- Two student-supervisor industry tours (Auckland and Wellington)
- Four student internships in industry completed
- Two successful Ministry of Business, Innovation and Employment Pre-Seed Accelerator Fund applications
- Research conducted for the following New Zealand companies: Veritide Ltd. (NZ), Raztec Sensors, Gallagher, Tait Communications, Stafford Engineering Ltd., Kline Pharmaceuticals, BENEX Ltd., Izon Science, Fonterra, Canterbury Scientific Limited.

COMMERCIALISATION FOCUS FOR SYMPOSIUM

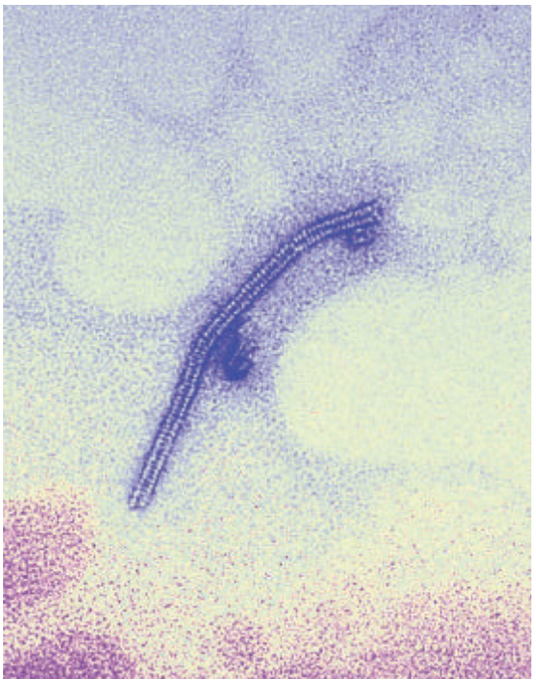
The MacDiarmid Institute 10th Annual Student and Postdoc Symposium in 2014 was devoted to exploring how academic research fits into the commercial world. Entitled 'Get it out—from fundamentals to market', the two-day symposium held at the University of Auckland discussed the early stages of the research commercialisation process in a series of lectures, workshops and a poster competition. Speakers shared their commercialisation stories and gave the audience of 76 an insight into how to protect intellectual property, when to publish and when to patent their idea. One session was also devoted to social entrepreneurship.

The students and postdoctoral fellows who attended also had an opportunity to quiz a panel of representatives from Fonterra, Winstone Wallboards, Revolution Fibres and innovation network KiwiNet about how best to approach possible industry partners as part of getting their research adopted by industry. As well, the poster competition allowed participants to practice how to communicate their research to industry.

ENGENDERING ADVANCEMENT

The Institute shares its vision of an innovative New Zealand based on the application of science and technology by:

- Telling its stories and ensuring that its vision forms an integral component of the national science/business/innovation agenda
- Working with its partners and affiliated companies to communicate the benefits of commercially-led and scientifically-enabled business development.



A YEAR OF PATENTS

This was a productive year for MacDiarmid scientists in filing patents related to their research. In all, 13 patent applications have been filed in 2014. They include one for a new skin test for tuberculosis (TB) in animals that promises to be more effective than current testing methods. TB is a major issue in New Zealand's dairy industry and a more accurate test would reduce costs for the farmer and help manage the disease in the nation's dairy herds more effectively.

The technology is being commercialised by a New Zealand company, PolyBatics, based in Palmerston North. The company focuses on producing 'biobeads'—particles of natural polymers covered with proteins that are designed to perform specific functions—in the case of this technology, the presence of TB. The company was set up in 2009 and its Chief Scientific Officer is MacDiarmid Principal Investigator Bernd Rehm—who developed the original biobead technology.

PolyBatics is currently field testing the TB test in partnership with TBfree New Zealand. The technology has also attracted interest from agricultural authorities in the United States and United Kingdom.

Another patent was filed by Principal Investigator Jeff Tallon and Associate Investigator Shen Chong and is for a novel hybrid material—MoCuO4-(phenanthroline)0.5. The researchers subjected it to heat and found the material went through several transition phases as a result. Two of those were of magnetic origin, while the third appears to have superconductivity properties.

RARE-EARTH NITRIDES BREAKTHROUGH

Two patents filed during 2014, relate to the leading work being done by MacDiarmid Institute researchers led by Principal Investigator Dr Ben Ruck in the field of rare-earth nitrides—or RENs. These materials defy conventional scientific wisdom that magnetic fields and superconductivity cannot exist together in the same material—that superconductivity shuns magnetic fields. In conjunction with researchers at Valbonne in France, the team at the Institute has developed a detailed understanding of the electrical conduction and magnetism of the materials. Their most recent work is in controlling the electrical conductivity by 'contaminating' the REN material by adding small concentrations of other atoms, in particular magnesium, meaning that they could be used as semiconductors in electronic devices.

The other patent the rare-earth nitride group at Victoria University of Wellington has applied for relates to potential applications using the magnetic properties of thin films of RENs. This application would allow the replacement of the current random-access memory or RAM system in computers with what is called non-volatile memory. Because it is stored electrically, current RAM technology means information is not retained when the power source is switched off. Using the magnetic properties of RENs would mean the information remained, leading to a device that would perform faster, be more versatile and use less energy. In particular, this would be an advantage for cloud data storage, where the information spans multiple servers.

The ability to switch between magnetic and non-magnetic is also a significant breakthrough for developing and constructing spintronics—an emerging technology where the spin of an electron is controlled to manipulate its electronic charge.

The work at Victoria University has attracted strong international interest and papers have been submitted to leading physics journals, with at least one considering publication.

THE FUTURE OF SCREENS

The new generation of lighter, thinner and smaller tablet computers is largely thanks to developments in screen technology. Indium gallium zinc oxide—known as IGZO—is a semiconducting material used in the new generation of flat screens and it has several advantages over the traditional silicon screens. IGZO can be fashioned into much smaller transistors meaning more pixels and higher quality resolution. It is also transparent so needs less power to illuminate the screen—meaning longer battery life for mobile users. However, the IZGO transistors are not always stable and manufacturers need to add in other components to compensate for that.

The patented technology has the potential to operate flat-panel displays at higher speeds with lower power consumption.

MacDiarmid Institute research at the University of Canterbury, working with researchers in the United States and Japan, are on the way to overcoming those issues. They and their collaborators have produced IGZO of the required quality at room temperature and used it to make prototype transparent transistors of thin film that show improved stability in operation.

The patented technology has the potential to operate flat-panel displays at higher speeds with lower power consumption. It could also improve the sensitivity and brightness of touch-screen display. Furthermore, the production process could easily be integrated into existing manufacturing lines.

The technology has been licensed for commercialisation by KiwiNet—the body set up by a consortium of universities, Crown Research Institutes and other organisations to increase the scale and impact of New Zealand's science and technology.

A research engineer has also been brought in to develop proof-of-concept prototypes as a step towards licensing the technology to electronic display manufacturers.

NEW HIGH-TECH PRODUCTS FROM WASTE

A programme led by Professor Juliet Gerrard, Principal Investigator based at the University of Auckland (formerly of the University of Canterbury) and Callaghan Innovation, is researching how waste products from New Zealand's primary industries might be put to better use and add value to the sector. The research is focusing on creating amyloid fibrils from some of the waste from abattoirs and results look promising for a new sustainable industry.

Amyloid fibrils are an aggregate of normally soluble proteins or peptides that form, under certain conditions, into an insoluble form. When they form in the body they can be the cause of diseases, including Alzheimer's, Type 2 Diabetes and Parkinson's Disease. They can also be formed in the laboratory using purified proteins, and this has been an important area of research given their role in human health. Creating the amyloid fibrils from pure proteins, however, comes with a high price tag since the pure proteins needed as starting material are very expensive. The MacDiarmid Institute programme has been exploring whether proteins found in biological waste from the primary production industry can be used instead. The work is showing promise and the team believe the amyloid fibrils produced may be useful, in particular, for biosensing applications.

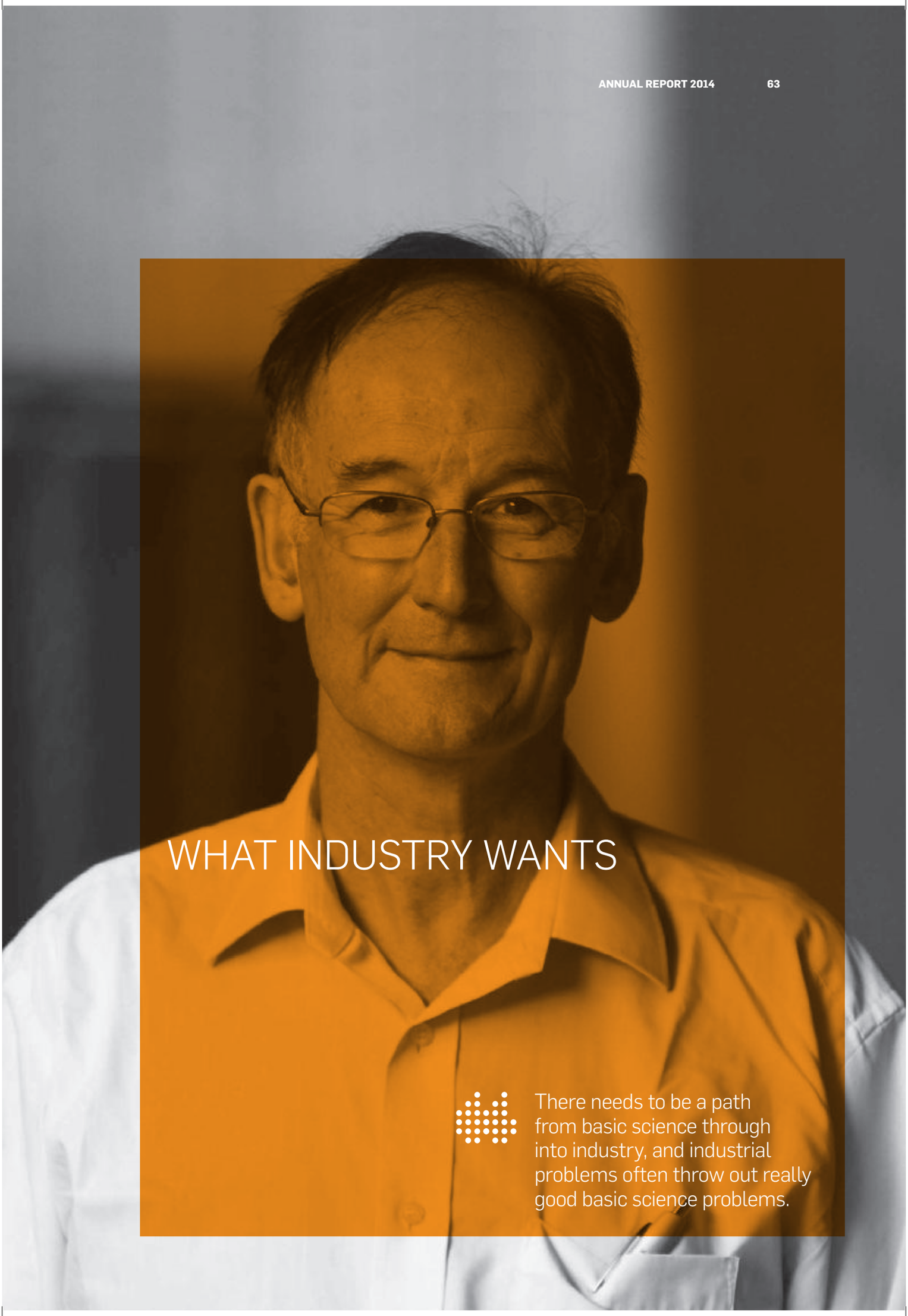
RESEARCH AIDING INDUSTRY

Thanks to MacDiarmid Principal Investigators Andreas Markowitz and John Kennedy of GNS Science, New Zealand companies now have access to a state-of-the-art technology that in the past has been beyond their financial means.

The researchers worked in partnership with Tauranga company Page Macrae Engineering to develop an argon ion beam capable of cleaning metal surfaces that is also affordable for New Zealand's small industries. The system has now been installed at Page Macrae's Coating division.

Ion beam technology involves charged atoms being implanted into the metal forming a coating only a few atoms thick, and can be used to produce an ultra-smooth surface, improved electrical conductivity, greater corrosion resistance or super hardness.

In the case of the argon ion beam, shallow nitride layers are laid down and the research team believes it might also be used to deposit diamond-like carbon (DLC) materials to protect the equipment that is used to coat industrial products using a process known as physical vapour deposition or PVD.



WHAT INDUSTRY WANTS

There needs to be a path from basic science through into industry, and industrial problems often throw out really good basic science problems.

We don't have assumptions or baggage that comes with particular labels. We're offering very positive things.

At certain times of year, usually when a grant round has been announced, academics will pick up the phone and ring people in industry to drum up support for their applications. "Industrial people get really fed up. They just get bombarded with stuff," says David Williams, Deputy Director, Commercialisation and Industry Engagement at the MacDiarmid Institute.

So to increase contact, awareness and attitudes towards industry, and to create a proper relationship, the MacDiarmid Institute established the Industry Advisory Group (IAG) in 2014. The group consists of six key industrialists, Michael McIlroy, Managing Director of Rakon; Lewis Gradon, Senior Vice-President Products and Technology, Fisher & Paykel Healthcare; Greg Shanahan, Managing Director, TIN100; Barbara Webster, General Manager, Business Development and Innovation, Scott Technology; Paul Adams, CEO, EverEdge IP; and Simon Arnold, CEO, Arnold Consulting; plus MacDiarmid Institute Director Kate McGrath; Jeff Tallon, Principal Investigator, MacDiarmid Institute and Williams.

"To actually be able to get a couple of hours time with these people is enormously valuable," says Williams. "The idea too is to keep the group reasonably small, but working with the TIN100 is one way to generalise the discussion."

In the past year the IAG has had two meetings in Auckland. "They've been really useful," says Williams. "There needs to be a path from basic science through into industry, and industrial problems often throw out really good basic science problems."

Some of the questions asked at the meetings have been about initiating and growing functioning relationships between industry and research, and what the MacDiarmid Institute can best offer industry. Williams says that as a national Centre of Research Excellence, the MacDiarmid Institute can have a different type of discussion in this context. "We're not pushing a particular barrow," he says. "We don't have assumptions or baggage that comes with particular labels. We're offering very positive things."

From these discussions, specific initiatives have already resulted. For example, a programme of industry internships has been established for PhD students to take three to six months out from their studies and work in industry. "For the students, it's almost like a three month extended job interview, and they've loved it. The ones who have done it have found it enormously valuable," says Williams. "Indeed, one student got offered two jobs!" Since the vast majority of PhD students don't go into academia, the internships allow students to realise that they have a whole set of skills that are enormously valuable to industry.

Industry Advisory Group (IAG)

rakon	Michael McIlroy, Managing Director of Rakon
Fisher & Paykel HEALTHCARE	Lewis Gradon, Senior Vice-President Products and Technology, Fisher & Paykel Healthcare
TIN100	Greg Shanahan, Managing Director, TIN100
SCOTT	Barbara Webster, General Manager, Business Development and Innovation, Scott Technology
EVER EDGE IP	Paul Adams, CEO EverEdge IP
arnold.co.nz	Simon Arnold, CEO, Arnold Consulting.

Last year, five students did internships, but the next challenge will be to find more students who are amenable to the idea, because most are not. "They sort of worry about getting their PhD finished," says Williams. Another challenge is that some institutions have regulations framed in such a way that it makes it difficult to work around things like visas and tax, although other universities are seeing the initiative as a way to trail blaze similar programmes currently being set up.

Another initiative for students is tiki tours of industry sites like Fisher & Paykel, Rakon, Adept Scientific and Aeroqual. "One of the things you notice in New Zealand, is that there's an awful lot of really interesting industry that students don't know about," says Williams. The tiki tours are a way to demonstrate to students that: "industry is doing stuff and it is a significant contributor to the economy. It can grow and you can be a part of it," says Williams.

Discussions are not just centred on students though. Another idea is to develop an industry sabbatical for academics. Other jurisdictions like the United Kingdom have Royal Society Industry Research Fellowships and Williams himself received one to spend half his time in a company for three years. "They take people from industry and put them in academia, they take people from academia and put them in industry and everybody agrees that they're enormously valuable," says Williams. These sabbaticals give people a new perspective, access to different types of problems, as well as building relationships, which allows for technology transfer from academia into applied research.

The IAG is also discussing intellectual property, particularly the cost and how to ensure adequate protection for ideas at an early stage. "It's difficult in New Zealand, you're a long way from major jurisdictions and patenting is actually very expensive," says Williams. And while universities do patent, there is a lot more research that isn't IP (intellectual property) protected. "How does industry know about all this stuff that's bubbling around?," says Williams. This is another thing the IAG is looking at.

An agenda for the next IAG meeting has yet to be set, but questions will be framed around what is being done right or wrong and what can be improved. "We'll continue exploring ideas that we've already started off, which will take quite a bit of work to bring to fruition," says Williams. The group will also work on building relationships with industry. "As opposed to people just ringing out of the blue when MBIE announce a grant round," he says.

THREE ELITE SCIENCE TEAMS TAKING ON THE WORLD

Nanotechnology research is hard. But not as hard as getting scientists to work together. Disconnection, between disciplines, sectors and organisations is internationally recognised as one of the greatest inhibitors to innovation. New Zealand may not have the resources of other countries, but our size and culture of openness gives us a unique advantage to address this problem. The MacDiarmid Institute has dedicated the last 12 years to mastering the art of collaborative research. In recognition of their progress they have been entrusted with just over $40 million over the next six years to tackle some of the world's greatest science challenges.

"It's an exciting time," says Professor Kate McGrath who led the Institute through the refunding process. "It has taken a lot of time to learn how to overcome the barriers of distance, to trust each other and work together intimately. But we're there now!"

This marks a turning point in the MacDiarmid story. The Institute's 80 researchers have transformed into three elite science research teams. They have put aside their individual interests and chosen audacious science programmes uniquely suited to their combination of disciplines, skills, resources, knowledge and experience. The focus now will be delivering real economic, cultural and environmental value to New Zealanders.

SCIENCE AREA 1

FUNCTIONAL NANOSTRUCTURES

Imagine what you could create by combining the natural genius of biology with the latest advances in technology? Think of nanobots seeking out and destroying disease, bone implants that grow themselves, a plethora of new biodegradable reusable materials. This is the realm that the first science team will be playing in.

Creation of these new functional nanostructured materials, with their enhanced capabilities will be informed by the development of innovative nano-tools. These tools will allow more straightforward and direct understanding, manipulation and control of materials including cells and their behaviour and function on the nanoscale, with relevance for example from stem cell therapies to cancer.

SCIENCE AREA 2

MATERIALS FOR ENERGY CAPTURE AND UTILISATION

The sun provides more than enough energy to meet the world's energy needs, but current solar technologies are either too inefficient or too expensive to capture enough. This team's unique combination of expertise places them in a world-leading position to develop a new generation of cheap, efficient photovoltaics using abundant nontoxic materials. Their discoveries could revolutionise the energy sector.

This team is also working on 'crystalline sponge' materials, which absorb greenhouse gas emissions and could lead to the development of methane-fuelled vehicles.

SCIENCE AREA 3

MATERIALS FOR HIGH-VALUE TECHNOLOGIES

MacDiarmid Institute founding director, Sir Paul Callaghan, inspired the country with his vision of a flourishing high-value manufacturing sector. This programme aims to establish a foundation of new ideas, smart materials, and human capital for industry to grow from. Their incredible optical, electronic, magnetic and superconducting materials also have the potential to revolutionise the way we control and use energy. Imagine buildings made of energy-harvesting glass, diagnostic devices that detect single molecules of disease and invisible self-powered sensors for detecting gases or chemicals.

The ultimate goal is to inspire and connect every New Zealander with the potential of science and to ensure science discoveries are translated into tangible outcomes for New Zealand.

Each team is well placed to lead the world in science discovery. The MacDiarmid commitment to collaboration embraces more than just science. The ultimate goal is to inspire and connect every New Zealander with the potential of science and to ensure science discoveries are translated into tangible outcomes for New Zealand.

As Professor McGrath points out, scientists will need to learn to communicate and engage with all sorts of people to make this vision a reality.

"These days our audience could be an eight-year old child, an industry with a vague question, a government ministry needing expert advice or an iwi group with a business opportunity. We've got to learn how to make our skills and people readily accessible."

As more and more virtual institutes are set up in New Zealand with the National Science Challenges, Centres of Research Excellence and ICT Graduate Schools, the MacDiarmid Institute provides an invaluable source of knowledge and experience. McGrath cautions us not to underestimate the human nature of the challenge.

"You can't just stick people in a room and expect them to collaborate. It's even more difficult when they're spread across the country. Face-to-face time is crucial and that takes constant effort, time and resources."

McGrath would like to see an evolution of the virtual institute model including more dynamic and flexible support, advisory and monitoring systems to replace standard governance boards and funding systems that are less dependent on the government.

The MacDiarmid Institute will continue to build on their commitment to grassroots community engagement, outreach programmes and mentoring students.

"As scientists we're extraordinarily privileged," says McGrath. "That comes with responsibility to do something really valuable. We're all dedicated to doing that. I think we're really well placed to define the state of play internationally and to drive a new culture that looks to a broader context and serves society."

GOVERNANCE & FINANCE

GOVERNANCE

REPRESENTATIVE BOARD

Dr Steve Thompson, *Chair of the Board*
Science and Innovation Promoter
British High Commission

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

Dr Wayne Ngata
Ministry of Education
University of Auckland

Dr Bob Buckley
Director
Robinson Research Institute

Professor Don Cleland
Head of School and Professor of Process Engineering
Massey University

Professor Charles Daugherty
Associate Vice Chancellor Research
Victoria University of Wellington

Professor Jan Evans-Freeman
Pro Vice Chancellor of Engineering
University of Canterbury

Dr Ian Graham
General Manager, Research
GNS Science, Lower Hutt

Professor Jane Harding
Deputy Vice Chancellor (Research)
University of Auckland

Roger Ridley

Professor Vernon Squire
Deputy Vice-Chancellor, Academic & International
University of Otago

Mr Geoff Todd
Managing Director, VicLink Limited

Mr Fred Samandari
Director, Wireless Research Centre
University of Canterbury

EX-OFFICIO

Professor Kathryn McGrath
Director of the MacDiarmid Institute
Victoria University of Wellington

Professor Alison Downard
Deputy Director Stakeholder Engagement
University of Canterbury

Professor David Williams
Deputy Director, Commercialisation and Industry Engagement
University of Auckland

INDUSTRY ADVISORY GROUP

Michael McIlroy

Managing Director
Rakon

Lewis Gradon

Senior Vice-President Products and Technology
Fisher & Paykel Healthcare

Greg Shanahan

Managing Director
TIN100

Barbara Webster

General Manager, Business Development and Innovation
Scott Technology

Paul Adams

CEO
EverEdge IP

Simon Arnold

CEO
Arnold Consulting

INTERNATIONAL SCIENCE ADVISORY BOARD

Professor Jeff Tallon, *Chair*

Principal Investigator, The MacDiarmid Institute
Principal Scientist at Robinson Research Institute
Victoria University of Wellington, New Zealand

Professor Haroon Ahmed

Microelectronics Research Centre, Cavendish Laboratory, University of Cambridge, UK Advisor on Higher Education to the Pakistan Government
Nanoengineered devices

Professor Neil Ashcroft*

Horace White Professor of Physics,Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, USA
Materials Science

Dr Don Eigler

The Wetnose Institute for Advanced Pelagic Studies, Auckland, New Zealand & California, USA
Nanoscience

Professor Sir Richard Friend

Cavendish Professor of Physics University Of Cambridge, Great Britain

Professor Lynn Gladden OBE, FRS

Department of Chemical Engineering,
University of Cambridge, UK
Chemical engineering and porous media

Professor Michael Kelly, FRS*

Prince Philip Professor of Technology,
University of Cambridge, UK
Electro-optic materials and devices

Professor Sir Harry Kroto, Nobel Laureate

Department of Chemistry and Biochemistry
Florida State University, USA
Spectroscopy, radioastronomy, nanoscience

Professor Hiroshi Mizuta

School of Electronics and Computer Science University of Southampton, UK
Nanoengineered electronic devices

Professor Daniel Nocera

Patterson Rockwood Professor of Energy
Harvard, USA
Renewable energy

Professor Michelle Simmons

Director, Australian Research Council Centre of Excellence for Quantum Computation and Communication Technology
Federation Fellow and Professor of Physics
University of New South Wales, Australia

Professor Henry Smith

Keithley Professor of Electrical Engineering and Head of NanoStructures Laboratory, MIT, USA
Nanofabrication

Professor Mark Warner*

Theory of Condensed Matter Group, Cavendish Laboratory Cambridge University, UK
Soft Materials

Dr David Williams

Chief Research Scientist and Laboratory Manager, Hitachi Cambridge Laboratory, Cambridge, UK
Nanoengineered electronic devices

** indicates New Zealander*

SCIENCE EXECUTIVE

Professor Kathryn McGrath

Director
Victoria University of Wellington

Professor Alison Downard

Deputy Director, Stakeholder Engagement
University of Canterbury

Professor David Williams

Deputy Director, Commercialisation and Industry Engagement
University of Auckland

Dr Natalie Plank

Theme Leader: Nanofabrication and Devices From July 2014
Victoria University of Wellington

Professor Shaun Hendy

Theme Leader: Nanofabrication and Devices Until June 2014
Victoria University of Wellington

Associate Professor Eric Le Ru

Theme Leader: Electronic and Optical Materials
Victoria University of Wellington

Associate Professor Shane Telfer

Theme Leader: Molecular Materials
Massey University

Dr Geoff Willmott

Theme Leader: The Intersection of Nanoscience and Biology
Industrial Research Limited

Professor Juliet Gerrard

Cross-theme Representative
University of Canterbury

Brendan Darby

MESA Chairperson
Victoria University of Wellington

MACDIARMID EMERGING SCIENTIST ASSOCIATION (MESA) 2014

Brendan Darby: Chairperson
PhD Student
Victoria University of Wellington

Leah Graham: Treasurer
PhD Student
Victoria University of Wellington

Brad Mansel
PhD Student
Massey University

Dr Luigi Sasso
Postdoctoral Fellow
University of Canterbury

Pablo Hernandez
PhD Student
Massey University

Chris Larsen
PhD Student
University of Otago

Lakshika Perera
PhD Student
University of Auckland

Harry Warring
PhD Student
Victoria University Wellington

Jonathan Tailby
PhD Student
Callaghan Innovation

Moritz Banholzer
PhD Student
Victoria University Wellington

Pauline Calloch
PhD Student
Callaghan Innovation

Cherie Tollemache
PhD Student
University of Auckland

Jan Dormanns
PhD Student
University of Canterbury

FINANCE

THE MACDIARMID INSTITUTE
SPECIAL PURPOSE – STATEMENT OF FINANCIAL PERFORMANCE

for the period ended 31 December 2014

All Quoted Excl of GST	Note	Victoria University Wellington	University of Canterbury	Massey University	University of Otago	University of Auckland	IRL	GNS	Consolidated
		$ 000	**$ 000**	**$ 000**	**$ 000**	**$ 000**	**$ 000**	**$ 000**	**$ 000**
Revenue									
Operational Receipts		4,403	2,038	891	509	1,200	(244)	106	8,903
Interest Income	**1**	52	-	-	-	-	-	-	52
Other Income	**2**	-	129	63	-	-	17	-	209
Total Revenue		4,455	2,167	954	509	1,200	(227)	106	9,164
Expenditure									
People Costs		708	440	368	74	394	5	41	2,030
Overheads		630	307	222	47	227	(289)	25	1,169
Direct Project Costs		1,238	234	119	151	93	37	28	1,900
Travel		219	113	57	36	50	20	12	507
Postgraduate Students		1,340	867	138	192	436	-	-	2,973
Depreciation on CoRE Eqpt	**3**	320	206	50	9	-	-	-	585
Subcontractors		-							-
Extraordinary Items		-							-
Total Expenditure		4,455	2,167	954	509	1,200	(227)	106	9,164
Surplus for the year		-	-	-	-	-	-	-	-

STATEMENT OF MOVEMENTS IN EQUITY

for the period ended 31 December 2014

	Note	$ 000	$ 000	$ 000	$ 000	$ 000	$ 000	$ 000	$ 000
Surplus for the year		-	-	-	-	-	-	-	-
Capital Funds received from Government		-	-	-	-	-	-	-	-
Total changes in Equity		-	-	-	-	-	-	-	-
Opening Equity		10,320	7,087	1,652	564	-	-	-	19,623
Closing Equity		10,320	7,087	1,652	564	-	-	-	19,623

THE MACDIARMID INSTITUTE
SPECIAL PURPOSE – STATEMENT OF FINANCIAL POSITION

as at 31 December 2014

	Victoria University Wellington	University of Canterbury	Massey University	University of Otago	University of Auckland	IRL	GNS	Consolidated
	$ 000	**$ 000**	**$ 000**	**$ 000**	**$ 000**	**$ 000**	**$ 000**	**$ 000**
Current Assets								
Cash at Bank/Short Term Investments	3,962	2,065	718	159	-	37	-	6,867
Accounts Receivable & Prepayments	-		-	-				-
Total Current Assets	3,962	2,065	718	159	-	(37)	-	6,867
Non-Current Assets								
Plant & Equipment	7,594	5,031	946	419	-	-	-	13,990
Construction in Progress	-		-	-				-
Total Non-Current Assets	7,594	5,031	946	419	-	-	-	13,990
Total Assets	**11,556**	**7,096**	**1,664**	**578**	**-**	**(37)**	**-**	**20,857**
Current Liabilities								
Accounts Payable and Accruals	-	-	-	-	-	-	-	-
Research Grants Unexpended	1,236	9	12	14	-	37	-	1,234
Total Current Liabilities	1,236	9	12	14	-	(37)	-	1,234
Total Net Assets	**10,320**	**7,087**	**1,652**	**564**	**-**	**-**	**-**	**19,623**
Represented By:								
Community Equity	**10,320**	**7,087**	**1,652**	**564**	**-**	**-**	**-**	**19,623**

THE MACDIARMID INSTITUTE
SPECIAL PURPOSE – STATEMENT OF CASH FLOWS

for the period ended 31 December 2014

	Victoria University Wellington	University of Canterbury	Massey University	University of Otago	University of Auckland	IRL	GNS	Consolidated
	Actual $ 000	**Actual $ 000**	**Actual $ 000**	**Actual $ 000**	**Actual $ 000**	**Actual $ 000**	**Actual $ 000**	**Actual $ 000**
Operating Activities								
Cash was provided from:								
Royal Society New Zealand	2,364	1,757	741	329	1,066	-	106	6,363
Interest income on funds held	52	-						52
Other sources	-	129	63		-	17		209
	2,416	1,886	804	329	1,066	17	106	6,624
Cash was applied to:								
Employees and Suppliers	(4,135)	(1,961)	(904)	(500)	(1,200)	227	(106)	(8,579)
	(4,135)	(1,961)	(904)	(500)	(1,200)	227	(106)	(8,579)
Net Cash Flows from Operating	**(1,719)**	**(75)**	**(100)**	**(171)**	**(134)**	**244**	**-**	**(1,955)**
Investing Activities								
Cash was provided from:								
	-	-	-	43	-	-	-	43
Cash was applied to:								
Property, Plant & Equipment	-				-	-	-	-
Net Cash Flows from Investing	**-**	**-**	**-**	**43**	**-**	**-**	**-**	**43**
Financing Activities								
Cash was provided from:								
Funds from TEC	-	-	-	-	-	-	-	-
Net Cash Flows from Financing	-	-	-	-	-	-	-	-
Net Cash Flows for the year	(1,719)	(75)	(100)	(128)	(134)	244	-	(1,912)
Add Cash at start of year	5,681	2,140	818	287	134	281	-	8,779
Cash at end of the year	**3,962**	**2,065**	**718**	**159**	**-**	**(37)**	**-**	**6,867**
Cash at end of the year comprises:								
Cash at Bank/Short Term Investments	3,962	2,065	718	159	-	(37)	-	6,867
Cash at end of the year	**3,962**	**2,065**	**718**	**159**	**-**	**(37)**	**-**	**6,867**

THE MACDIARMID INSTITUTE
NOTES TO THE SPECIAL PURPOSE FINANCIAL STATEMENTS

for the period ended 31 December 2014

NOTE 1 ***Interest Income***

Revenue generated from investment of CoRE funds by Victoria University Wellington

NOTE 2 ***Other Income***

Revenue generated from donations, commercial income and sponsorship

NOTE 3 ***Depreciation***

The Fixed Asset Registers of all partners will show a depreciation balance higher than that reported here. The partner universities have been required to subsidise CoRE activities by meeting the depreciation shortfall.

NOTE 4 ***Payments from the Tertiary Education Commission***

During 2014, the MacDiarmid Institute received CoRE funding from the TEC. The funding received from the TEC was $6,301,602 (2013: $6,385,553)

THE MACDIARMID INSTITUTE STATEMENT OF ACCOUNTING POLICIES

for the period ended 31 December 2014

THE REPORTING ENTITY

The MacDiarmid Institute is a collaboration between Victoria University Wellington, University of Canterbury, The University of Auckland, Massey University, University of Otago GNS Science and Callaghan Innovation to undertake research on a project funded by the Ministry of Education (MoE) via the Tertiary Education Commission (TEC). The terms of this collaboration is set out in the Memorandum of Understanding agreed by the partners in July 2008, and was initially established in 2002.

MEASUREMENT BASE

The accounting principles recognised as appropriate for the measurement and reporting of financial performance and financial position are on a historical cost basis.

SPECIFIC ACCOUNTING POLICIES

Consolidated Special Purpose Financial Statements

These comprise the returns from each university. The consolidation excludes inter-entity entries.

Revenue Recognition

Funds received from TEC were held in a Research Grants Unexpended account. Once costs were incurred, an amount sufficient to cover the expenditure was recognised as revenue.

Financial Instruments

These are recognised in the Statement of Financial Position. These financial instruments include bank accounts, accounts receivable, short-term deposits and accounts payable. Revenue and costs in relation to all financial instruments are recognised in the Statement of Financial Performance.

Goods and Services (GST)

The Special Purpose Financial Statements are prepared on a GST exclusive basis.

Plant & Equipment

All items of plant and equipment are initially recorded at cost, including costs directly attributable to bringing the asset to its working condition. Depreciation has been charged to this project following application of the TEC guidelines of 3% (45% of a 6.67%) Straight Line annual asset charge, excluding the super-computer. This project is charged for this particular asset at 11.25% (45% of a 25%) Straight Line basis. All are in compliance with the CoRE Budget approved by the TEC. TAMU guidance, received 5th September 2003 via TEC, enables the partners to retain project funds to cover depreciation of CoRE assets when TEC funding has ended. This is included in the Research Grants Unexpended value.

Cash Flow Policy

The following are the definitions of the terms used in the Special Purpose Statement of Cash Flows: (a) Operating activities include all transactions and other events that are not investing or financing activities, (b) Investing activities are those activities relating to the acquisition, holding and disposal of property, plant and equipment and of investments. Investments can include securities not falling within the definition of cash, (c) Financing activities are those activities that result in changes in the size and composition of the capital structure. This includes both equity and debt not falling within the definition of cash. Dividends paid in relation to the capital structure are included in financing activities and (d) Cash is considered to be cash on hand and current accounts in banks, net of bank overdrafts.

Changes in Accounting Policy

There have been no changes to the accounting policies outlined above.

DIRECTORY

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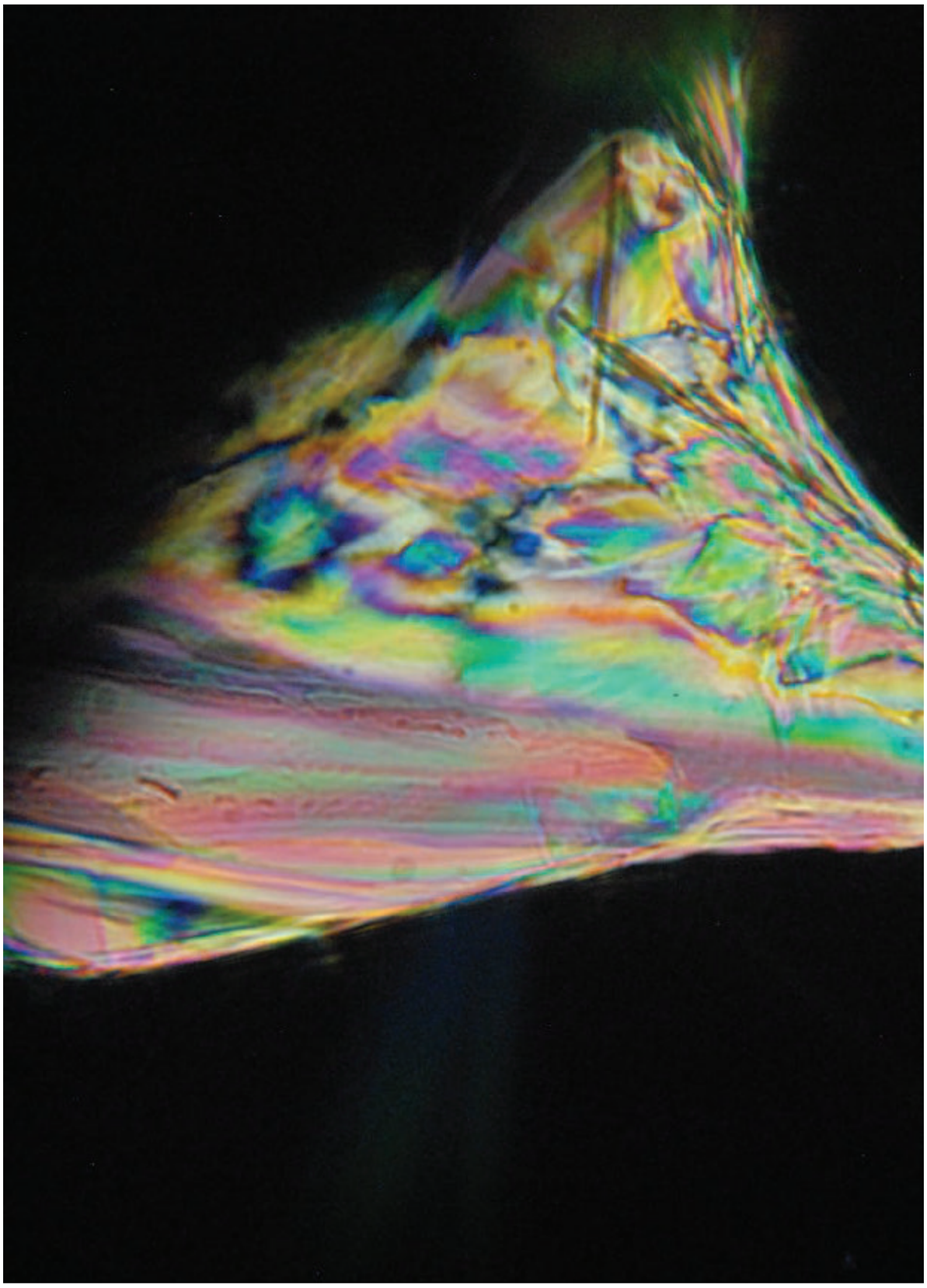
For current contact information for all our investigators and support staff, please refer to www.macdiarmid.ac.nz



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