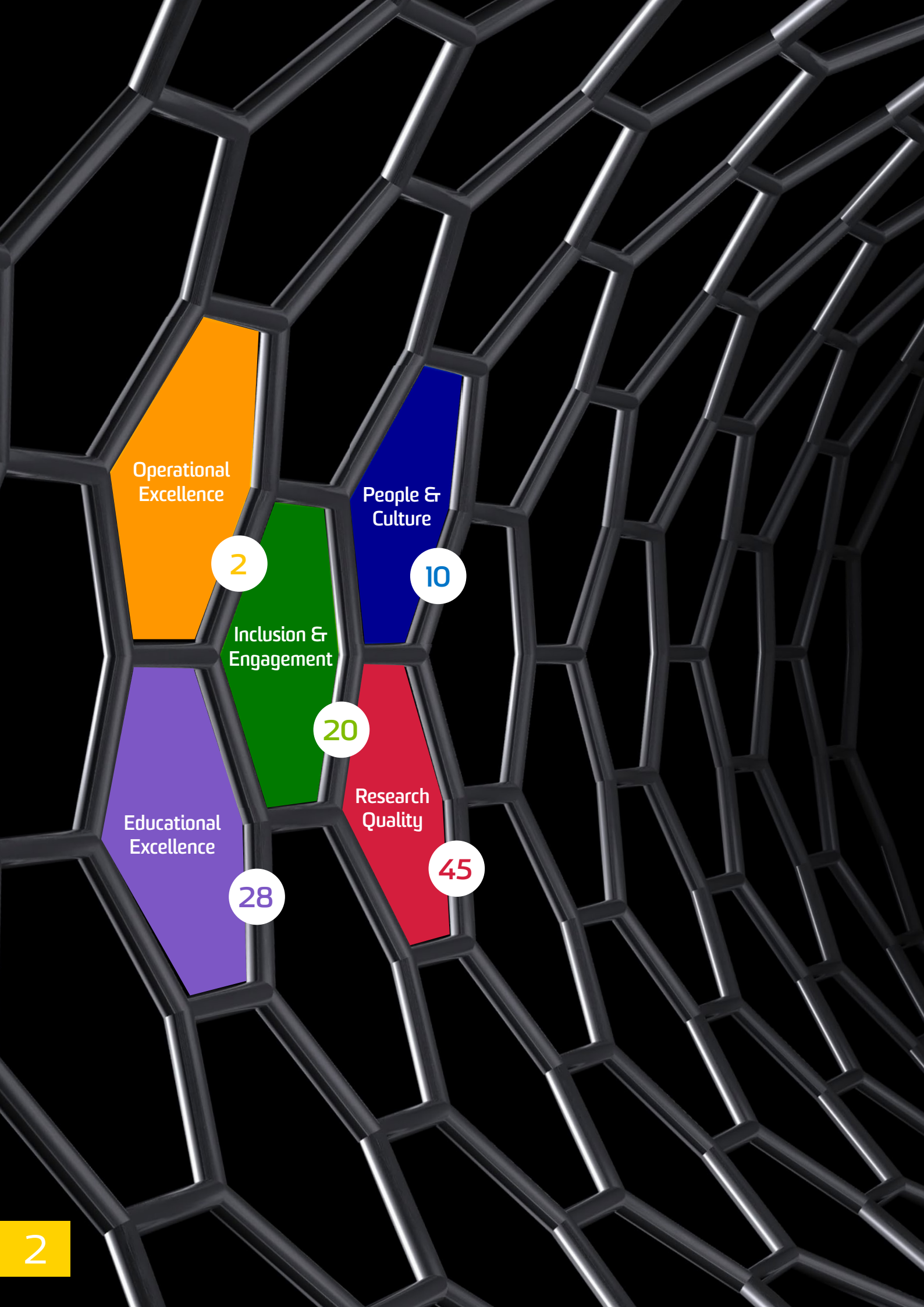
UNSW SYDNEY | Australia's Global University

School of Materials Science and Engineering

Annual Report 2018


Operational Excellence
2
People & Culture
10
Inclusion & Engagement
20
Research Quality
45
Educational Excellence
28

Who we are

The development of new materials drives innovation in a wide range of fields including transportation, information technology, health science and solutions for energy security. The School of Materials Science and Engineering at UNSW Sydney is one of the world's leading schools in the development of novel functional materials and in devising innovative solutions for their application. Beyond this, an emerging paradigm in materials development is sustainability, such that materials can be manufactured through energetically efficient processes and then readily recycled at the end of component lifetimes.

Our research covers a wide range of areas including:

- Functional materials for next generation electronic devices
- Sustainable recycling of e-waste
- Advanced ceramic coatings for pollution control
- Conducting polymers for tissue regeneration
- Lightweight energy efficient materials for aerospace applications
- Graphene-based membranes for water purification
- Computational modelling of advanced functional materials for improving solid state cooling
- Advanced polymers for the development of stem cell therapies
- Lead-free environmentally-friendly brasses for clean water
- Hybrid and mixed-dimensional materials for optoelectronic and energy conversation technologies

The School is located in a new purpose-built $143M building containing a suite of state-of-the-art laboratories with cutting edge facilities for processing, analysis and testing of materials. A number of new labs came online this year including a nanoionics laboratory, e-waste micro-factory, thin film lab and optoelectronics device lab. The School is located adjacent to the Mark Wainwright Analytical Centre which features an extensive range of instruments for materials characterization.

Our goal is to provide first class teaching and research training in an intellectually stimulating and creative environment, equipping our graduates with technical and generic skills at a level that will lead them into attractive and productive employment. We continue to work in close partnership with local and international industry to develop innovative advancements in materials and solve real-world problems.

Welcome

Head of School **Professor Michael Ferry**

It is a pleasure to introduce the 2018 Annual Report and my first as Head of School. The School continues to perform strongly across the domains of academic excellence in teaching & research, social engagement and global impact, which are the cornerstones of UNSW's 2025 Strategic Vision. This report catalogues the School's outstanding achievements across all domains.

I would like to thank my predecessor, Professor Paul Munroe, for leading the ongoing transformation of the School over the past six years into a national and international leader in materials science and engineering and for steering the School through the myriad of changes associated with the University's strategic vision. Paul stepped down as Head of School in December to concentrate on his role as Deputy Dean (Research) in the Faculty of Science. He will continue to be a much-valued member of staff through the supervision of research students and the provision of undergraduate teaching.

Enrolments across our various coursework and research degree programs continue to be strong, with particularly rapid growth in our Master by Coursework program, which has been very attractive to international students wishing to enhance their expertise in materials science and engineering. At all levels, students receive excellent and innovative teaching from our staff, as demonstrated by the continual receipt of some the most outstanding student evaluations in the university.

As a further boost to the School's commitment to excellence in teaching and learning, we welcomed Dr Caitlin Healy to our team of education-focused academics, who have been central in transforming coursework programs in readiness for the UNSW3+ academic calendar in 2019.

Our dedicated and hard-working staff and students make the School a wonderful place to work and study, and their various achievements are duly acknowledged. The School congratulates Drs Samane Maroufi, Sally Chen, Daniel Sando and Jianliang Yang for their promotions to Level B (Lecturer), Drs Rakesh Joshi and Damia Mawad for their promotions to Level C (Senior Lecturer) and Dr Sophie Primig for securing a prestigious UNSW Scientia Fellowship. Congratulations also to Professor Paul Munroe and Ms Laura McNally for winning two prestigious awards associated with organising the 19th International Microscopy Congress, and to Mr Bill Joe for his UNSW Science Staff Award for Excellence in Research Support.

The School maintains its excellent standing in research, evidenced by the 2018 QS World Rankings in Materials Science where it was once again ranked in the world's top fifty, and first in Australia. Staff also received five extremely competitive ARC Discovery grants and an ARC Linkage grant, with Professor Tom Wu and Drs Damia Mawad and Sophie Primig securing their first Discovery grants! It is worth noting that our modest-sized School received more ARC grants than the total awarded in several Australian universities.

Research excellence from our staff and students is further demonstrated through their published works in world leading multidisciplinary journals, Nature, Nature-Materials, -Nanotechnology, -Communications and Science Advances, in addition to numerous publications in the highest-calibre disciplinary journals in their respective fields.

A major School achievement in 2018 was the substantial funding received by Professor Sean Li and his interdisciplinary research team to establish the UNSW Materials and Manufacturing Futures Institute. The Institute is one of four launched by the University focusing on transforming the future of materials and manufacturing research in energy, transport, health-care and information technology.

The School continues to lead a broad range of innovative, high-impact research programs and scientific initiatives for addressing important social and global issues. Dr Kevin Laws developed a new type of lead-free brass for circumventing lead contamination in our drinking water and Scientia Professor Veena Sahajwalla's leading research into sustainable materials and processes was key to securing NSW State Government funding to establish and lead the NSW Circular Economy Innovation Network.

The School's successes extend well beyond its excellent teaching and research and is constantly active in promoting its discipline to the wider community. In particular, our two student societies, MATSOC and PGSOC, were exceptionally busy engaging students and organised many exciting events throughout the year.

In summary, the School is in a strong position and is delivering excellent outcomes on all fronts. I hope you enjoy reading about our journey through 2018.

Numbers at a Glance

27
Academic Staff

168
Higher Degree Students

84
Masters by Coursework

24
Research Staff

4
Future Fellows

$3.12m
New grant funding (2019)

268
Refereed research publications (2017)

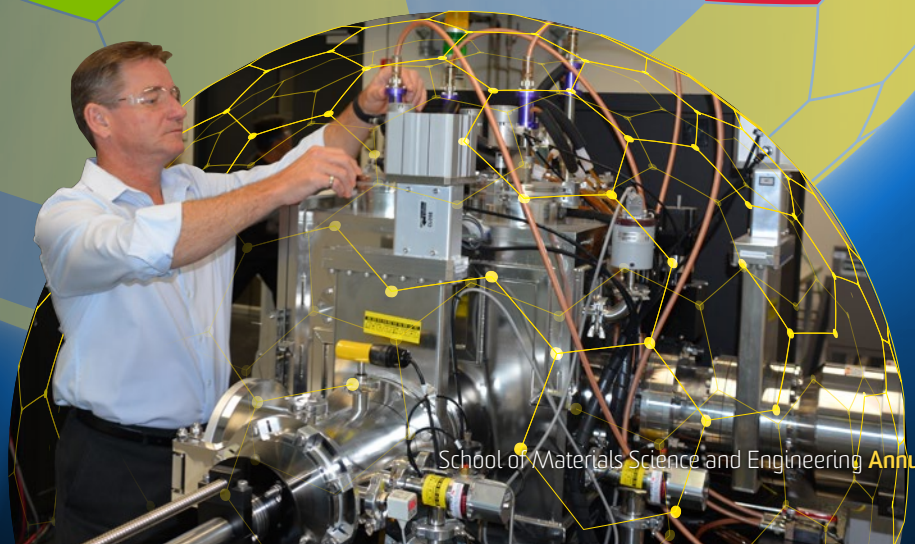
340
Undergraduate

$2.2 m
Strategic UNSW Income (2018)

$11.5 m
Research funding (2018)

20
Professional & Technical Staff

1
ARC Laureate Fellow



Financial Report 2018

For the 2018 financial year, budget allocations were largely based on existing budget methodology, and are aligned with UNSW's financial management principles, as reflected in the UNSW Financial Management Framework. Of note, financial plans for 2018–2020 reflect the principle that funds mobilised through Strategy 2025 activities have been "ring-fenced" within Faculty operating budgets. Previous practice of holding central quarantines against expenditure budgets has been discontinued.

Resultantly, the School's 2018 budget was adjusted to reflect the impact of the Operational Excellence program led by the University, especially in the people cost reduction as we received a 3.6% overall cut. Our student numbers have continued to grow, with a larger than ever postgraduate coursework student cohort. Research wise, we had another successful year gaining seven ARC grants and attracted millions of dollars of overseas industry funds. Strategic Hire Professor Tom Wu and Future Fellow Claudio Cazorla both published in the esteemed "Nature" scientific journal, showcasing their high-calibre research.

Income

The School receives its income from three primary sources:

Operating income is allocations from the University, via the Faculty, to fund the day to day running of the School. For the 2018 financial year, budget allocations were made using existing budget allocation principles based on the School's local and international undergraduate, postgraduate coursework and higher degree research student load.

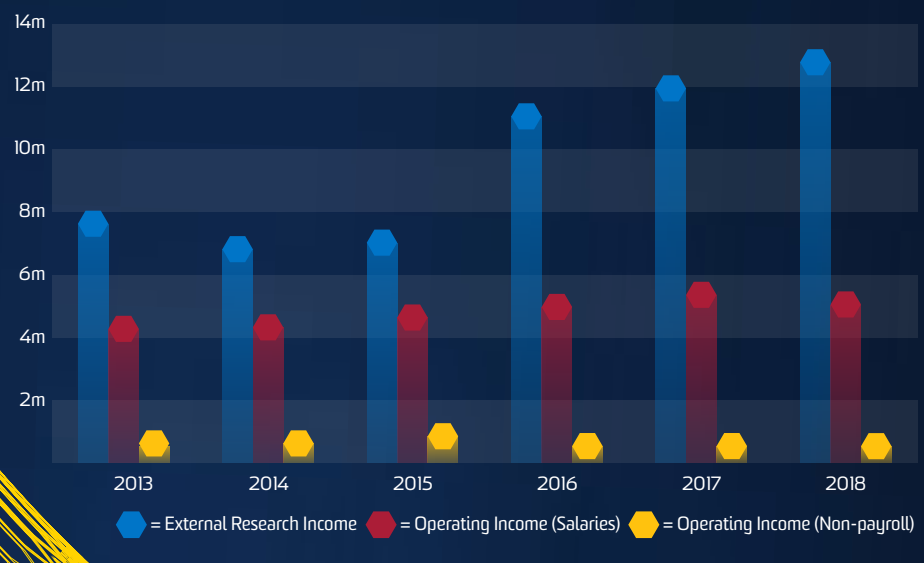
Research income is from research grants obtained from bodies outside the university. Past and current research performance, and future research potential, are incentivised and supported by the University through *Strategic Funds*. The graph below shows trends in the School's operating and research and restricted funds.

Operating Income

Operating income budgets were derived from teaching revenue, research revenue from Commonwealth Government, indirect cost recoveries on contract research and other revenues projected from historical levels, adjusted for price and volume.

Our allocated operating budget primarily is used for salaries for teaching and research academics, technical and professional staff. Although a number of the School's academic staff hold externally-funded research fellowships, the School covers the invariable shortfall in these fellowships from its operating budget allocation, deriving a specific, though capped, allocation from the University for this purpose.

This budget was also used to pay for casual teaching staff.



Income		
University:		
Teaching	$11,826,532	
Other	$53,000	$11,869,532
Allocation to School:		
Teaching and Research	$6,391,282	
Fellowship salary shortfalls	$122,355	
Capital equipment funding	$120,000	$6,633,637
Expenditure		
Salaries	$5,545,084	
Non-salary	$1,024,849	
Capital expenses	$235,867	$6,805,800
Variance		($172,163)

Equipment	Lead Applicants	Allocation ($)
Biolin Scientic Programmable Dip Coater	Charles Sorrell, P Koshy, WF Chen, J Daniels, J Hart, O Standard	11,000
CHI 604E Electrochemical Workstation	Dewei Chu, T Wu, S Chan	8,000
Struers Tegramin-20 Automatic Polishing Grinding Unit	George Yang, C Sorrell, A Crosky, JQ Zhang, K Laws	19,000
3D Optical Microscopy-3D Accessories for Olympus BX53M	George Yang, A Crosky, O Standard, J Hart, S Chan	11,000
Nuaire Class II Biological Safety Cabinet	Kristopher Kilian, C Sorrell, J Gooding, I Roohaniesfahani, P Thordarson, P Spicer, K Gaus	6,368
Laser Unit Replacement	Nagarajan Valanoor, J Seidel	15,000
Probe Station 40A-GS-350-DP	Tom Wu	10,000

Other major expenditure items are support of teaching laboratories, daily operational expenses, marketing and undergraduate recruitment, undergraduate scholarships, allocations to teaching staff based upon research supervision and various research outputs including publications and provided start-up funds for new academic staff.

The table left shows the School's operating income breakdown.

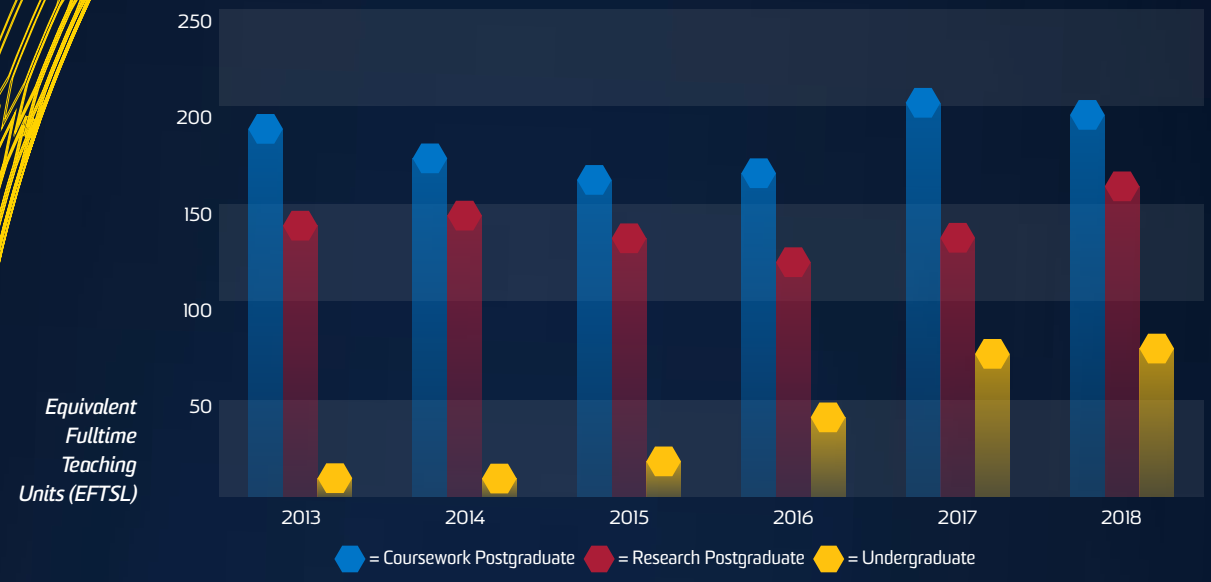
Due to increased costs, mainly in capital equipment, the variance was absorbed by the Faculty.

From the capital equipment budget, the School's Advisory Committee assessed applications for small equipment grants based on end-user engagement and research impact, but also on the impact they will make in support of the School's research, grant income and teaching outputs.

The table to the left shows the successful bids.

Teaching Load

The primary driver for operating income at the School level is undergraduate and postgraduate teaching load. The graph below shows the strong growth the School has achieved in recent years, with notable growth in Postgraduate Coursework and Research student cohorts.



UNSW Strategic Funding

UNSW aspires to be Australia's global university, improving and transforming lives through excellence in research, outstanding education and a commitment to advancing a just society. The University is currently in the implementation phase of Strategy 2025. As projects are approved, they are enabled financially through strategic allocation and the School received a marked increase compared with previous years.

In 2018, these included:

Project Name	Project Manager	Amount ($)
SHARP hire	Tom Wu	2,517,088
SHARP: Lance Li	Sean Li	5,483
Scientia Fellow	Krisopher Kilian	111,889
Research Support	Mark Hoffman	65,814
Research Support	Sean Li	400,000
Safety Net Support	Chunguang Tang	64,261
Fellowship Transition	Dewei Chu	37,470
Urban Mining Support	Veena Sahajwalla	46,779
Green Manufacturing	Veena Sahajwalla	33,887
Laureate Postdoc Support	Veena Sahajwalla	75,000
Intelligent E-Waste	Veena Sahajwalla	60,000
High Temp E-Waste Investigations	Veena Sahajwalla	456,417
SPF02 Materials	Various	215,505
SPF04 Materials	Various	176860.59
Total:		4,266,454

Lead Chief Investigator	Project Title	Grant ($)
Damia Mawad	Dynamic Mechanical Testing	199,300
Kevin Laws	Thermal Treatment Facility	159,697
Rakesh Joshi	Chemical Vapor Deposition	95,000
Michael Ferry	Technical Support Engineer	95,525

Research Infrastructure Scheme

The University receives a Research Infrastructure Block Grant. Through a competitive internal grant process, UNSW provides a world-class research environment to attract and retain a critical mass of research excellence. The table to the left outlines the School's successful major items, in 2018.

Item	Amount ($)
Student Research Allocations	100,000
Undergraduate scholarships	70,000
Publications allocation	100,000
Teaching laboratories	66,425
Safety	10,512
School Office	35,000
Staff Start Up	197,500
Marketing	30,000
Repair, Maintenance & building utilities	25,000
International recruitment	15,000
Undergraduates association support	5,000
Postgraduates association support	7,000

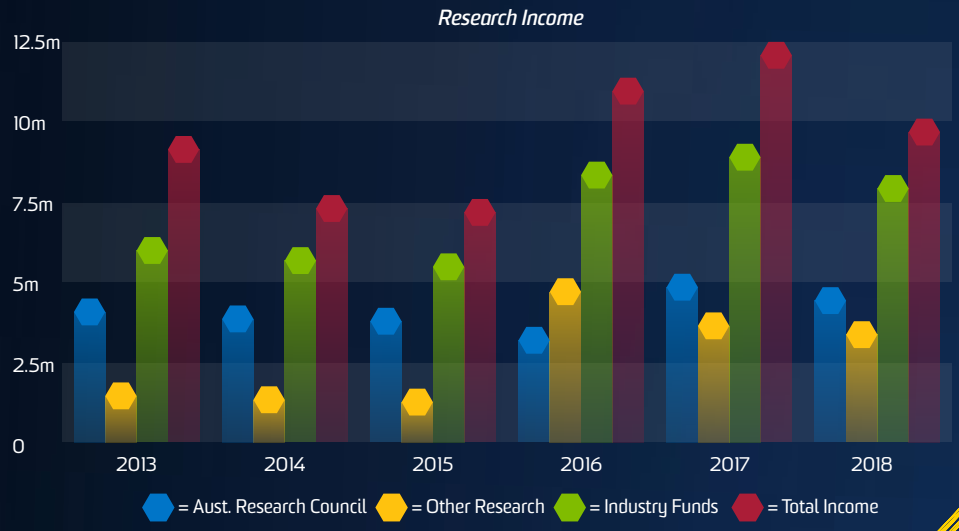
Expenditure

The main component of School expenditure is staff salaries which comprised over 80% of total non-capital operating expenditure.

This is in line with the majority of schools across the campus. The table to the left shows the School's main expenditure items in 2018.

Research Income

The School's research income comprises the largest fraction of the overall income of the School. Though we experienced a slight overall drop, possibly due to the stalling global economic climate, we had a fantastic outcome winning 5 new ARC Discovery Grants (31% success rate) and a Linkage Grant (100% success rate!).



Academic Staff

ARC Future Fellow & Senior Lecturer **Dr Claudio Cazorla**

Claudio's research expertise is built on the study of bulk and low-dimensional condensed matter systems using advanced quantum simulation methods. The topics he investigates are relevant to a broad range of fundamentally and technologically important fields such as Nanotechnology, Materials Chemistry, Earth and Planetary Sciences and Atomic Physics. Claudio is particularly interested in the fundamental study of and technological applications involving multi-ferroic and fast-ion conductor materials.

Associate Professor Sammy Chan

Sammy's research interests are in the areas of energy materials, hydrogen storage and metal matrix composites (MMCs).

ARC Future Fellow **Associate Professor Dewei Chu**

Dewei's research interests include ionic conductive oxide-based nanomaterials and their applications in nanodevices, including resistive random access memory, transparent thin film transistors, supercapacitors, electric double layer transistors, and artificial synapses, etc. He is also interested in functional ceramics for energy harvesting applications.

Professor Alan Crosky

Alan's research focuses on the effect of structure (both micro and macro) on mechanical behavior. Specific areas of research include directed fibre placement in fibre reinforced plastic composites, failure of composites, natural fibre composites, wood plastic composites and engineering failure analysis.

Associate Professor John Daniels

John's research focuses on the understanding of the structural origin of physical properties of materials. This research has, to date, been primarily directed in the field of electro-mechanical materials where a wide range of underlying structural processes at different length scales leads to the coupling of mechanical load and electrical charge.

Acting Head of School **Professor Michael Ferry**

Michael's research interests are concerned mainly with the mechanisms of microstructure and texture evolution during solidification, solid-state phase transformation and deformation & annealing with recent emphasis on the mechanical and physical properties of crystalline and amorphous light metals.

Senior Lecturer **Dr Judy Hart**

Judy's research interests are in developing new semiconducting materials, particularly solid solutions and doped materials, for use in renewable energy applications such as photocatalysis and solar cells. The focus of this work is understanding relationships between composition and properties and finding effective ways of using computational and experimental techniques in parallel.

Lecturer **Dr Caitlin Healy**

Caitlin's research interests are the design, development and characterisation of new metallic alloys. With a focus on single phase high entropy alloys and using the compositionally complex designs to enhance binary intermetallics.

Dean of Engineering **Professor Mark Hoffman**

Mark's research expertise is in the area of structural integrity of materials, specifically the design of materials for high reliability in complex environments through a combination of computational modelling and investigation using an extensive mechanical property research laboratory at UNSW. His research covers fracture mechanics, fatigue and wear and tribology from macro- to nano-scale.

Senior Lecturer **Dr Rakesh Joshi**

Rakesh is currently focusing on developing methods to prepare high value carbon materials such as graphene and fullerene from waste materials. He has developed experimental methods to prepare graphene and carbon nanotubes for various applications. His areas of interest include sustainable materials, 2D Materials- graphene and metal chalcogenides, nanomaterials and thin films. Dr Joshi is leading many industrial projects on the application of graphene and graphene supercomposites.

ARC Future Fellow & Scientia Fellow
Senior Lecturer **Dr Kris Kilian**

Kris's research group explores how natural and synthetic materials influence the signalling that controls cell fate and function. Combining both 'soft' and 'hard' materials chemistry with nano- and micro-fabrication techniques, they specialise in designing and developing synthetic tissue models to more accurately explore cell signalling and tissue assembly across numerous physiological and pathological conditions including development and cancer.

Senior Lecturer **Dr Kevin Laws**

Kevin's research interests are concerned with the design, development and fundamentals of new or advanced metal alloys; specifically amorphous alloys (bulk metallic glasses) and single-phase high entropy alloys. This is closely tied with the design and development of new alloy production technologies and applications for these materials.

Professor Sean Li

Sean's research interests mainly focus on advanced multifunctional materials including 2D electron gases of complex hetero-structured oxides, energy materials and other electrical and optical oxide based materials.

Senior Lecturer **Dr Damia Mawad**

Damia's research interests are in tissue engineering/regenerative medicine. Her contributions in the field focus on development of advanced functional biomaterials with tailored properties. These include flexible bioelectronics with enhanced electronic stability, conjugated nanoparticles for photo-thermal therapy and on-demand drug delivery, and 3D printing of bioactive scaffolds.

Academic Staff

Deputy Dean - Research **Professor Paul Munroe**

Paul's research is focused on the characterization of materials using electron microscopy and related methods. This includes publication of a significant body of work focused on ion beam technology. He is also active in a range of areas in characterization of materials such as functional thin films, intermetallic alloys and biochars.

Emeritus Professor Oleg Ostrovski

Oleg's major contributions are in the field of pyrometallurgical technologies for minerals processing, iron-, steel- and ferroalloy-making. Areas of research include thermodynamics, kinetics and mechanisms of metallurgical reactions, properties of molten metals and slags, reduction, smelting and refining processes, and environmental issues in pyrometallurgy.

ARC DECRA Fellow & Scientia Fellow
Senior Lecturer **Dr Sophie Primig**

Sophie's research interests are in advanced property-structure relationships in structural metallic materials such as advanced steels, nickel-based alloys and refractory metals. She combines state-of-the-art experimental techniques such as electron microscopy, atom probe tomography and thermal analysis with mechanical testing and contemporary modeling approaches. Her research philosophy is to achieve a balance between fundamental discovery and industrial application.

Director - SMaRT Centre, ARC Laureate Fellow
Scientia Professor Veena Sahajwalla

Veena's research interests include sustainability of materials and processes with emphasis on environmental benefits. She has a deep knowledge of industrial processes. Veena invented an environmentally friendly process for recycling plastics and rubber into electric arc furnace steelmaking. As Director of SMaRT she provides leadership in research programs on sustainable materials.

Professor Jan Seidel

Jan's research interests are in the area of advanced electronic, photonic and spintronic materials, including scanning probe microscopy, nanotechnology enhanced photovoltaics, electrochromism, nanoscale phase separation, nano-optics, spectroscopy, plasmonics, x-ray based synchrotron techniques and high-resolution transmission electron microscopy.

Professor Chris Sorrell

The main focus of Chris' research has been the processing of ceramics, including fabricaiton, forming and densification of bulk materials, thick films and thin films. Main research areas include phase equilibria, crystal growth, high-temperature superconductivity, bioceramics, microwave heating of ceramics, gas sensors and fuel cells and photocatalytic titania.

Deputy Head of School, Senior Lecturer **Dr Owen Standard**

Owen's research is in the processing/microstructure/ property relationship of advanced ceramics for functional applications including colloidal processing of electroceramics, compositional and microstructural modification of bioactive and bionert ceramics, sol-gel deposition of functional ceramic coatings, development of sol-gel coatings on textile fibres and ceramic coatings on biomedical alloys.

Professor Nagarajan Valanoor

Nagy's most significant contribution is in the field of thin film epitaxy functional property relationships for ferroelectrics, dielectrics and multiferroic nano-materials. Research includes thin-film oxide epitaxy, scanned probe microscopy of functional materials and Landau-Ginzberg modelling of phase transitions.

Senior Lecturer **Dr Danyang Wang**

Danyang's most significant contribution is in the field of growth and characterization of functional oxide thin films for ferroelectric, piezoelectric, electro-optic and dielectric applications. Areas of research include thin film technology and physics, functional materials and devices, micro/ nanofabrication techniques, structural analysis and x-ray physics.

Professor Tom Wu

Tom's research focuses on the vapor- and solution-based synthesis of transition-metal oxides and hybrid halide perovskites, in the forms of thin films, nanomaterials and mixed-dimensional nanocomposites. His team is interested in exploring composition-structure-property correlations in emerging materials, targeting at diverse disruptive electronic, data storage and energy conversion technologies.

Associate Professor Runyu Yang

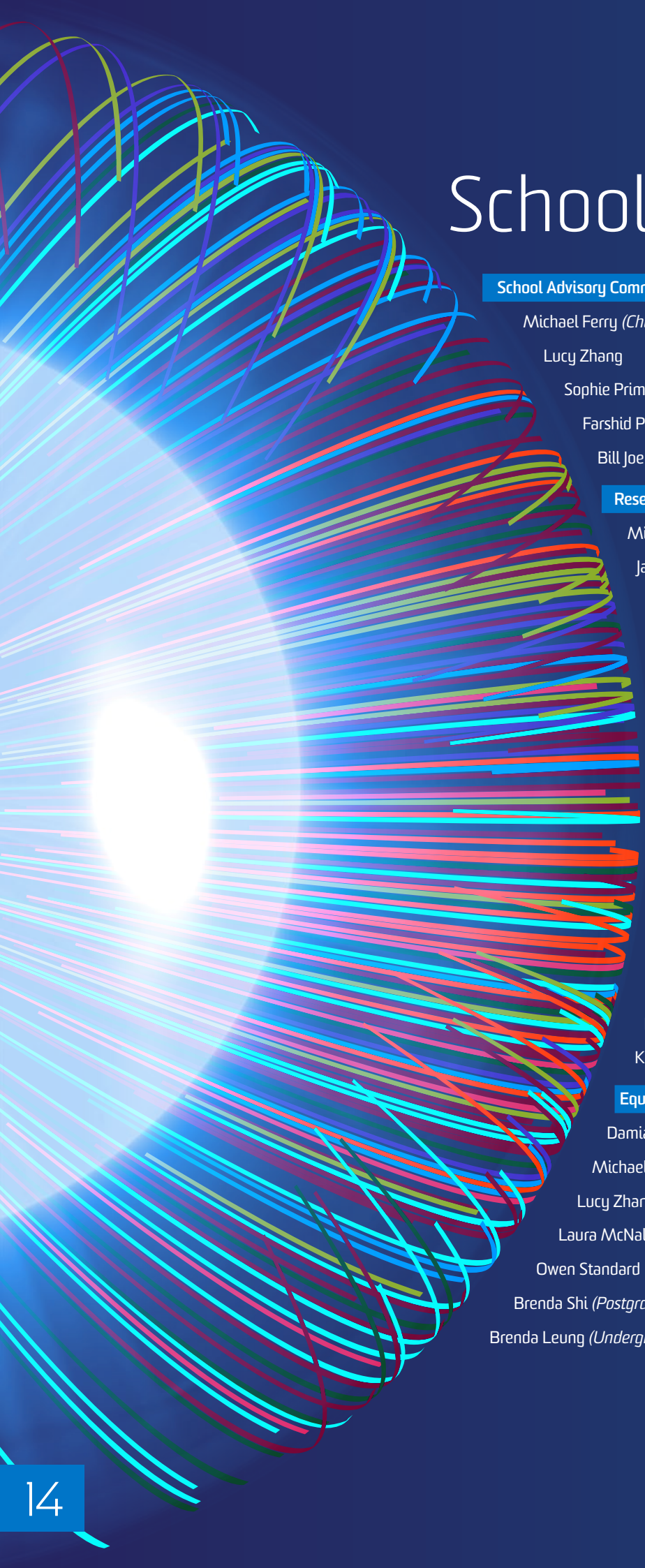
Runyu is focussed in the field of particle/powder science and technology. His primary research interests lie in particle technology, aiming to understand the behavior of particles through rigorous modelling and simulation at microscopic and macroscopic levels. This knowledge is then applied to solving problems in various industrial applications.

Emeritus Professor David Young

David's most significant contributions are in the field of high temperature alloy-gas interactions. Particular emphasis is placed on the diffusion and phase transformation processes which support these reactions. Current work includes fundamental studies of corrosion by CO_2, metal dusting reactions and water vapour effects on oxidation.

Associate Professor Jianqiang Zhang

Jianqiang's research is focused in the field of gas-solid reactions at high temperature, including high temperature corrosion and processing metallurgy. Research emphasis is on reaction thermodynamics and kinetics, phase transformation and characterisation, reaction mechanism understanding, sustainable materials processing and new materials development.



School Committees

School Advisory Committee

Michael Ferry *(Chair)*

Lucy Zhang

Sophie Primig

Farshid Pahlevani

Bill Joe

Research Committee

Michael Ferry *(Chair)*

Jan Seidal

Veena Sahajwalla

Sean Li

Learning and Teaching Committee

Sammy Lap Ip Chan *(Chair)*

Owen Standard

Danyang Wang

Judy Hart

WHS Committee

Jianqiang Zhang *(Chair)*

Anthony Zhang

Michael Ferry

Rakesh Joshi

Rahmat Kartono

Khushalini Ulman *(Postgraduate Student Rep.)*

Equity, Diversity & Inclusion Committee

Damia Mawad *(Chair)*

Michael Ferry

Lucy Zhang

Laura McNally

Owen Standard

Brenda Shi *(Postgraduate Student Rep.)*

Brenda Leung *(Undergraduate Student Rep.)*

School Scholarship Committee

Michael Ferry (Chair)

Owen Standard

Lucy Zhang

School Co-op Scholarship Representative

Owen Standard

Postgraduate Coordinators

Nagarajan Valanoor

Danyang Wang

Undergraduate Program Coordinator

Owen Standard

Honours Projects Coordinator

Kevin Laws

Master by Coursework Coordinator

Runyu Yang

Misconduct and Grievance Officer

Owen Standard

Faculty Undergraduate Assessment

Owen Standard

Sammy Lap Ip Chan

Overseas Degree Programs/Asia Engagement

Sammy Lap Ip Chan

Women in Materials

Judy Hart

Faculty Enterprise Committee

Dewei Chu

Seminar Coordinators

John Daniels

Claudio Cazorla

School Staff

Research Staff

Postdoctoral Fellow	Joseph Arsecularatne
Research Associate	Wen Fan Chen
Postdoctoral Fellow	Sagar Cholake
Research Associate	Rifat Farzana
New Generation Network Scholar, Postdoctoral Fellow	Vaibhav Gaikwad
Senior Research Fellow	Pramod Koshy
Research Associate	Nitish Kumar
Postdoctoral Fellow	Hamid Lashgari
Research Associate	Samane Maroufi
Senior Research Fellow	Farshid Pahlevani
Research Associate	Bo Qu
Postdoctoral Fellow	Daniel Sando
Research Associate	Pankaj Sharma
Postdoctoral Fellow	Sagar Shirsath
Postdoctoral Fellow	Xing Xing
Postdoctoral Fellow	Jian Yang
Research Associate	Jianliang Yang
Postdoctoral Fellow	Adnan Younis
Postdoctoral Fellow	Le Zhang
Postdoctoral Fellow/Technical Officer	Qi (Peggy) Zhang

Technical Staff

Technical Officer	Soo Woon Chong
ITC Support Officer	Jane Gao
Research Support Engineer	William (Bill) Joe
Technical Officer	Rahmat Kartono
ITC Support Officer	Danny Kim
Technical Officer	Xi Lin
Laboratory Manager	Irshad Mansuri
Technical Officer	David Miskovic
Research Assistant	John Sharp
Senior Research Scientist	Thiam Teck (TT) Tan
Technical Officer	George Yang
Safety Officer	Anthony Zhang

School Administration

Head of School	Michael Ferry
Deputy Head of School	Owen Standard
School Manager	Lucy Zhang
Projects Coordinator/Executive Assistant to HoS	Laura McNally
Administrative Officer	Alan Chow
Student Advisor	Michael Lai
Community & Current Student Engagement Officer	Michelle Freney
Executive Assistant to Prof Sean Li	Kim Foster
Manager, Operations & Business Strategy, SMaRT	Uttra Benton
Research Support Officer, SMaRT	Qing Xia
Research & Administration Assistant, SMaRT	Nahid Sultana

Industry Advisory Board

Dr Adam Berkovich	*Rio Tinto Aluminium*
Professor Lyndon Edwards	*ANSTO*
Dr Catherine Foley	*CSIRO*
Mr Michiel Freislich	*HATCH*
Mr Michael Gow	*PGH Bricks & Pavers*
Dr Edward Humphries	*Weir Minerals*
Mrs Cathy Inglis	*Brickworks*
Mr Steve Kennedy	*Cochlear Limited*
Dr George Melhem	*Perfect Engineering Pty Ltd*
Dr Jason Hodges	*Bluescope Research*
Mr Andrew Petersen	*Business Council for Sustainable Development Australia*
Professor Emma Johnston	*UNSW Sydney*
Professor Paul Munroe	*UNSW Sydney*
Dr Owen Standard	*UNSW Sydney*
Ms Lucy Zhang	*UNSW Sydney*

Staff Awards & Achievements

ARC Research Grant Awards Success

The School was awarded the following Australian Research Council grants in the 2018 round:

Discovery Grants

Tom Wu – *Light-Responsive Spin Transport and Spintronics with Stable Perovskites*

Damia Mawad – *Bioelectronics: addressing the biointerface challenge*

Sean Li – *Thin Combinatorial Films for Heat Management in Microelectronics*

Michael Ferry and Sophie Primig – *Unlocking the diverse property profile of ultra-lightweight Mg alloys*

David Young and Jianqiang Zhang – *Reducing gas and ash corrosion in advanced power generation*

Linkage Projects with Industry

Sophie Primig – *Advancing the Australian specialty alloy processing capability*

UNSW Futures

The School was awarded funding for a 'Materials and Manufacturing Futures Institute', led by **Sean Li**, aimed at transforming the future of materials and manufacturing research in energy, transport, information technology, and health care. UNSW Futures provides a framework for facilitating cross-faculty and interdisciplinary work, driving innovative approaches to research, and addressing scientific and social challenges.

ARC Postgrad Event

The School cleaned up at the annual Postgraduate Supervisor Awards with many academics receiving supervision awards. **John Daniels** and **Rakesh Joshi** won Outstanding Supervisor Awards, and **Claudio Cazorla**, **Vaibhav Gaikwad** and **Sophie Primig** won 'Supervisor Awards.

UNSW Science Staff Excellence Award for Excellence in Research Support

Bill Joe received this award in recognition of his excellent work across a range of different labs and techniques and assisting a large number of students and other researchers.

Nature Paper Hat Trick

Blazing a trail in 'Nature' and 'Science' papers, **Claudio Cazorla** published a whopping 3 *Nature Communications* articles! This is a great achievement for him and his group.

New Alloy to Solve Lead Problem in Drinking Water

Kevin Laws and his collaborators have created a lead-free brass alloy for use in plumbing that makes drinking water safer. The breakthrough alloy, which the group has named 'bright brass', has been designed to retain all the advantages that lead provides to brass for its manufacturing but without the toxicity.

Welcome Additions

The School welcomed a new Community and Current Students Engagement Officer, **Michelle Freney**, to principally look after undergraduate and postgraduate students through peer mentoring and other initiatives to create a unique student experience that develops empowered, socially-engaged, global citizens.

Kim Foster has also been a warm addition to the team, as Executive Assistant to Professor Sean Li.

Equity, Diversity & Inclusion

The School aims to provide a safe, supportive and inclusive environment for all students regardless of their race, sex, age, religion, disability, sexual orientation or gender identification – a place where our staff and students are best supported to reach their full potential. In keeping with this philosophy, the School's Equity Diversity and Inclusion (EDI) Committee leads and inspires this diversity agenda through planning events such as "R U OK? Day" and supporting EDI events organised by our student societies.

In August, the committee supported PGSOC in organising a panel discussion event, Women's Equity in STEM, with the aim to highlight and raise public awareness of the current underrepresentation of women in STEM disciplines.

In October, staff and students in the School came together to celebrate "World Mental Health Day", raising awareness of indiscriminate mental health issues, which can be a reality for people around us and to break the stigma surrounding mental illness, encouraging those struggling to seek help when needed.

The School hosted an ambassador from Beyond Blue who shared their lived experience with mental illness and delivered a message of hope. Attendees learned that implementing stress management strategies, seeking help and relying on support mechanisms made all the difference.

The EDI team encouraged staff to create 'affirmation boxes' to be filled with with positive messages, wellbeing quotes and affirmations from colleagues. The boxes could then sit on staff desks and be added to and revisited throughout the year at times when an extra boost was needed.

WHS Work Health & Safety

A/Prof. Jianqiang Zhang
WHS Chairperson

Dr Owen Standard
Former WHS Chairperson

The School of Materials Science and Engineering is committed to providing a safe work environment for all staff, students, and visitors in compliance with *Work Health and Safety Act 2011* and as implemented through the *UNSW Work Health and Safety Policy*. The members of the School WHS Committee in 2018 were

Owen Standard
(chairperson and academic representative)

Anthony Zhang
(school safety officer)

Rahmat Kartono
(technical and administrative staff representative)

Paul Munroe
(management representative)

Scott Gleason
(postgraduate student representative)

Scott left the committee in the latter part of 2018 and the School gratefully acknowledges his contribution to the Committee. Scott was replaced by Khushalini Ulman. In August 2018, A/Prof Jianqiang Zhang replaced Owen Standard on the Committee as chairperson and academic representative. The Committee met quarterly to discuss, monitor, and implement WHS policy and procedures, to investigate hazards and incidents, and to consult with staff and students. WHS activities in the School during 2018 included:

All staff and students in the School are thanked for their ongoing cooperation and compliance with WHS requirements and procedures.

Building

- Commissioning of 5 new laboratories and associated health and safety systems

Compliance

- Implementation of new GHS labelling and classification system for chemical containers
- Introduction of KPTs for WHS in all staff performance reviews
- Review of Hilmer building Emergency Control Organisation
- Completion of the University WHS self-audit tool for which the School received a compliance rating of 94%

Inspections

- Quarterly laboratory safety inspections and completion of corrective actions
- Annual electrical tagging & testing of all single-phase lab. equipment

Training

- WHS Awareness and Ergonomics online completed by all staff
- University "Supervisor Training" course completed by all academic and research staff
- Mandatory School WHS info sessions (~6 per year) for all new staff, postgrad and honours students
- Annual emergency evacuation training and practice drills for the entire building
- External laser usage training (BSMS)
- External gas usage training (Supagas)
- Forklift training completed by selected laboratory staff
- Contractor engagement training completed by laboratory staff
- Mental Health First Aid to be completed by selected staff

Record Systems

- JAGGER – UNSW online system for purchasing and recording chemicals introduced
- New UNSW Contractor Management System introduced

Women in Materials

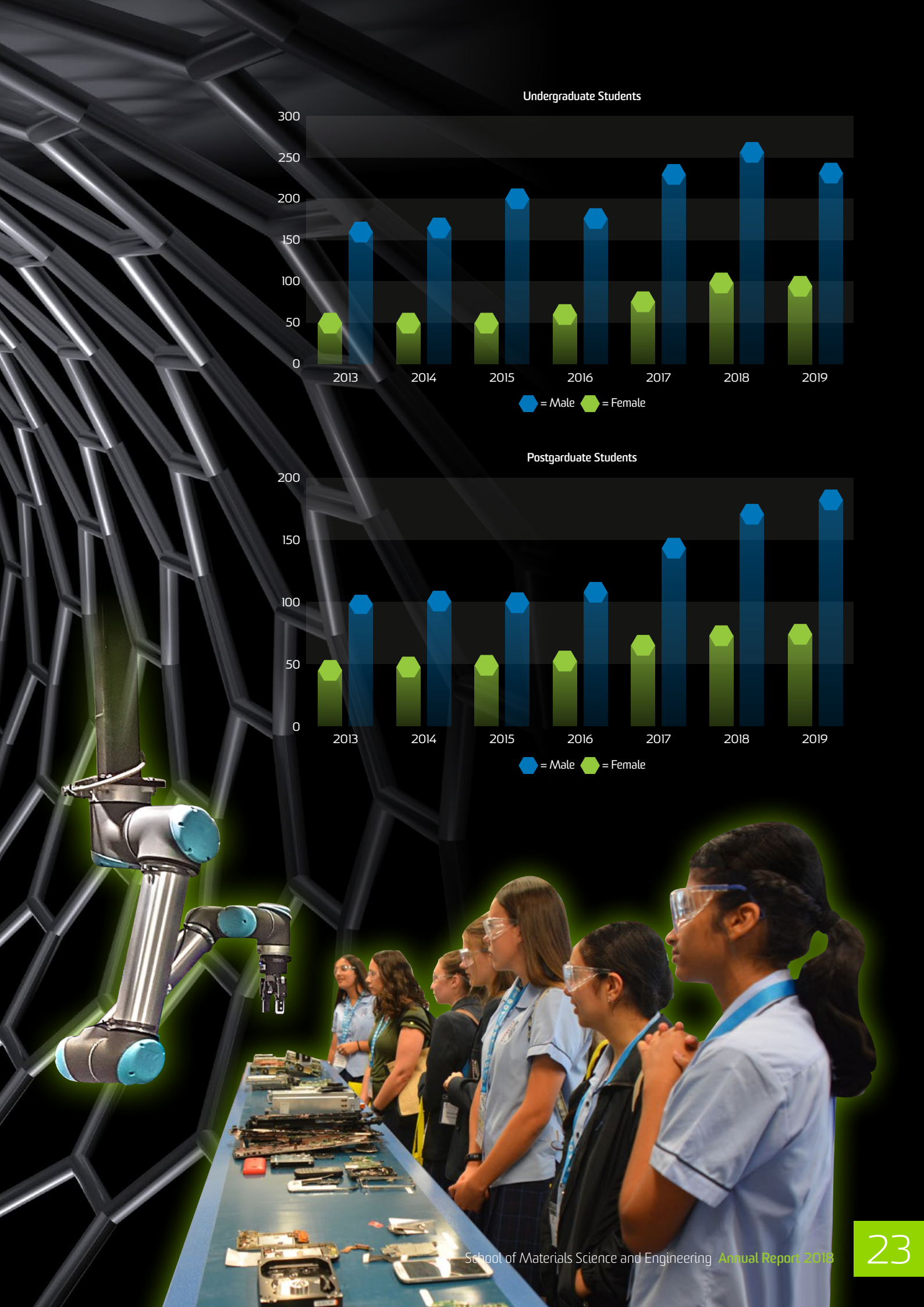
The School's Postgraduate Student Society (PGSOC), with support from academic staff, organised a panel discussion in August on gender equity in the STEM professions. It was a very well-attended event with a lively discussion of the issues women face in STEM careers.

The panel comprised of Professor Julie Cairney (University of Sydney, School alumna), Dr Maryam Parviz (SDIP Innovations), Dr Amanda Wang (Pallion, School alumna) and our own Dr Judy Hart (See image below).

The School co-hosted the L'Oreal-UNESCO Girls in Science Day in which groups of 20–30 senior high-school students attended information sessions about Materials Science as a potential career path. These were followed by a tour of SMaRT's new e-waste micro-factory (See image opposing page).

Students engaged in discussions about waste materials, its global impact and how it can be transformed into 'green' materials. The event was a great success with students demonstrating genuine interest, asking insightful questions throughout and providing positive feedback afterwards.

Whilst the total proportion of female students across the School's programs has consistently achieved ~30%, it now proudly boasts a contingent of 45% female students in both the combined degree in Materials Science and Engineering and Biomedical Engineering, and the new combined Materials Science and Engineering and Chemical Engineering program.


Undergraduate Students
300
250
200
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
= Male
= Female
Postgarduate Students
200
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
= Male
= Female

Marketing Outreach Report

A super-cooled, superconducting Mobius-track featuring 1500 neodymium magnets, fixed into the shape of a Mobius strip, so that a small superconducting 'puck', when cooled in liquid nitrogen, will whizz around the track, spending half of each orbit hanging suspended by its 'pinned' internal magnetic fields.

The School implemented a multi-faceted marketing and current student engagement approach in 2018. We encouraged more females to take up study and careers in STEM and ran successful events with school age females, promoting awareness of equity both in education and in the work force.

We also increased our profile in regional areas, encouraging student cohort diversity by attending outreach events and hosting visits from local and international schools.

Being aware of the high levels of stress that often accompany university study, we continued to support our students in the important area of mental health by reinforcing access pathways to services available to them on campus and in the broader community.

We also concentrated on building community within the School from Year 1, with our undergraduate student society teaming up with our First Year Peer Mentors to create an inclusive environment of shared learning, fun and support.

Below are some of this year's highlights.

Open Day

Once again, the Materials Science and Engineering Tent was the most vibrant, exciting and engaging! With a record number of staff and student volunteers, a dozen exciting interactive demonstrations and (of course) liquid nitrogen ice cream, the School tent attracted hundreds of prospective students with a high percentage of those registering being female and an increase of students from schools outside the Sydney metropolitan area.

L'Oréal Girls in Science Event

As part of this event, which is designed to promote Science as fun, creative and a promising career field for women, the School hosted 60 female students from 6 Sydney High Schools providing them with an Introduction to the School and a tour of the SMaRT Centre E-Waste Micro-Factory.

PGSOC Women's Equity in STEM Panel

Together with the School's Equity, Diversity and Inclusion (EDI) committee, PGSOC held a panel discussion event: 'Women's Equity in STEM', to raise awareness of the current underrepresentation of women in STEM disciplines.

The panel comprised 4 female representatives with PhD experience in STEM and who are currently working in related industries or academia. Panel members shared experiences from their PhDs, careers and also provided sound advice about skill development and the benefits of a good mentor.

ASPIRE Jump into Uni! Dubbo 2018

Year 7 students from regional ASPIRE partner schools are invited to attend this program which is aimed at increasing awareness of what higher education has to offer and gives students confidence to see university as a place for them. One of our Postdoctoral Fellows, Wen-Fan (Sally) Chen, was chosen to represent the School at the ASPIRE Jump into Uni event in Dubbo, during which she developed a fun, hands-on Catapult Design activity for the students. Being part of these outreach events is an important opportunity to build the profile of Materials Science and Engineering with the university students of the future.

Visit from Republic Polytechnic, Singapore

The School hosted a visit from 24 Diploma of Materials Science students and 2 teachers from Republic Polytechnic (RP). The students had a great time touring our building, watching demonstrations on Tensile and Charpy Impact Testing, MagLev trains and chatting to current Student Ambassadors about what it's like to study Materials Science and Engineering at UNSW. An articulation agreement with RP means that students who complete the Diploma with a GPA of 3 or above are eligible to apply for up to 10 courses of advanced standing towards UNSW MSE degree program.

World Mental Health Day & RU OK? Events

By hosting these events, the School contributed to opening lines of communication and breaking down stigmas surrounding mental health. These events included a guest speaker from Beyond Blue and we provided information from UNSW counselling and the RU OK? organisation to give students the tools to recognise when their peers might be struggling and how to support them or to direct them for professional help where necessary.

Peer Mentoring Program

A record number of engaged, enthusiastic and excited students signed up for the Peer Mentoring program, ready to welcome a new intake of students next year. The Peer Mentors work in collaboration with MATSOC to create an events schedule that speaks to the first year experience and helps to orient the first years to UNSW and to the School, thereby building community, encouraging student engagement, satisfaction and retention.

Alumni Evening

The School welcomed around 70 alumni to reconnect, meet industry partners and hear about some of our current exciting research in sustainable materials using the world's first e-waste micro-factory.

There was an excellent vibe in the room all night and many attendees expressed feelings of inspiration and fondness as they articulated the tangible impact the School has had on them both personally and professionally.

IMC19

19th International Microscopy Congress (IMC19)

The Australian microscopy community welcomed the world to Sydney for the 19th International Microscopy Congress (IMC19) in September. Over 2,100 delegates attended the meeting from 48 countries. Of these, around 600 were from Australia and over 1,500 from overseas, with large contingents from Japan, Korea and Europe. The meeting attracted over 2,000 presentations including ~150 invited talks and ~450 oral presentations. Outstanding plenary lectures by Nobel Laureate Dan Shechtman and Jennifer Dionne, Zhiwen Shan and Misty Jenkins were just some of the meeting's highlights. For the conference's closing session on the Friday, Nobel Laureate Joachim Frank reflected quite brilliantly on his award as part of the IFSM symposium.

In this meeting we introduced, with some trepidation, digital posters (almost 800 presented in different forms), where attendees could view presentations electronically on any screen, as well as share, download and 'like' posters of interest. Presentations in this form proved to be highly popular and will undoubtedly play a key role in microscopy meetings in the future.

2,100 delegates

48 countries represented

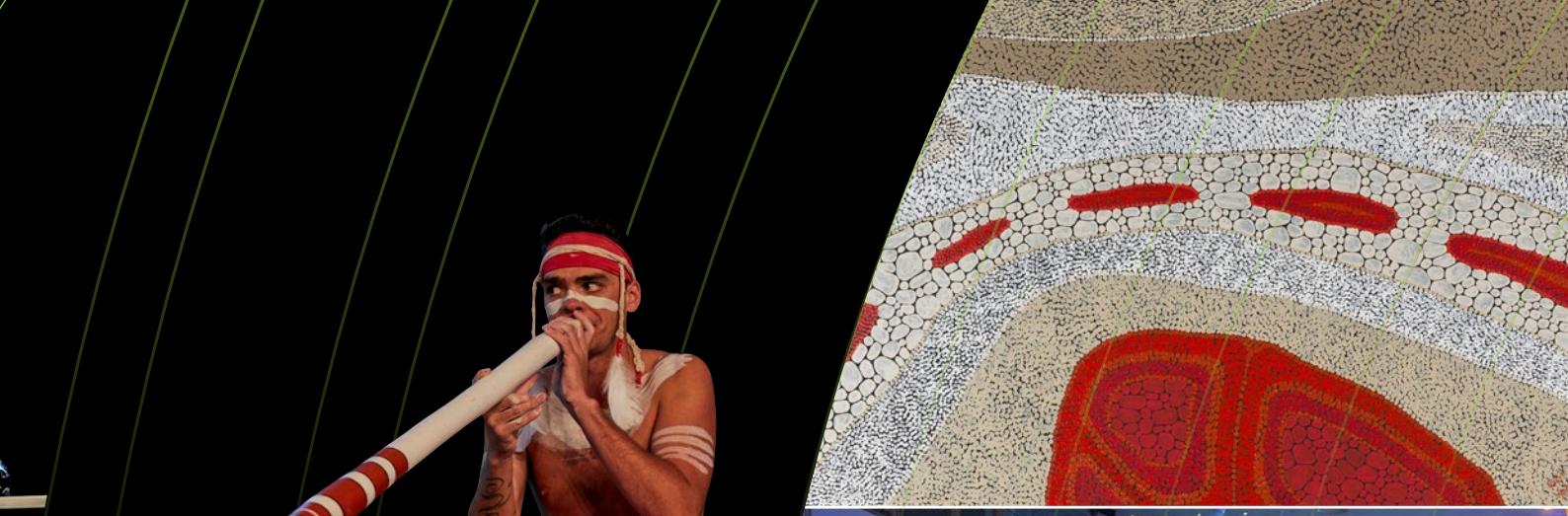
2,000 presentations

450 oral presentations

150 invited talks

The trade exhibition was sold out with 70 companies represented. With morning and afternoon tea and lunches served in the exhibition hall, as well as this acting as the venue for mini-oral presentations, the trade show was a constant hive of activity... helped not insignificantly by the excellent standard of food and barista quality coffee!

Prior to the meeting we hosted a series of workshops at several venues from Sydney to Wollongong providing training on a range of microscopy modalities. We also hosted the IFSM "Young Scientist's Assembly" over the preceding weekend, which allowed 50 early career researchers to meet, network and



listen to advice from leading academics, including both our Nobel Laureates.

During the meeting we ran a 'School Outreach' program that brought the world of microscopy to 570 school students, as well as a remarkable series of works that brought together microscopy and indigenous art.

Great thanks are due to many – notably, Conference Chair Professor Simon Ringer (University of Sydney) and co-Chair Professor Paul Munroe (UNSW Sydney), Local Organising Committee: Associate Professor Martin Saunders, Ms Ellie Kable, Ms Laura McNally and Professor Richard Tilley; Scientific Program Committee: Professor Julie Cairney, Professor Joanne Etheridge and Associate Professor Filip Braet. These groups have worked tirelessly in planning this meeting for the past several years. Thanks also to Jenny Whiting for championing the 'School Outreach' program and the 'Stories and Structures – New Connections' exhibition. Thanks are also due to the small army of workshop convenors and volunteers who selflessly gave up their time to support the meeting in many different ways. Finally, we thank our PCO, Arinex, especially project manager, Melissa Murphy. The meeting would not have been a success without her hard work and dedication!

Following the conference, IMC19 received two major awards; "Association Event of the Year" from Meetings and Events Australia (MEA) and "2018 IAPCO Collaboration Award" from the International Association of Professional Conference Organisers (IAPCO). The latter is a globally recognised industry award, reflecting credit on our PCO colleagues (Arinex) and the super-hardworking IMC19 local organising committee.

Busan in Korea were selected as hosts for IMC20 in 2020. We wish the organising committee all the best with the organisation for that meeting.

Undergraduate Studies

Dr Owen Standard *Undergraduate Coordinator*

Undergraduate Programs Offered

The main undergraduate degree program offered by the School is a Bachelor of Engineering Honours (BEHons) in Materials Science and Engineering. The program consists of four years of full-time study and requires students to complete at least 60 days of approved industrial training (in materials engineering or a related field) and is fully accredited with Engineers Australia. In addition, the BEHons program is offered as formal structured combination with the following programs: Bachelor of Engineering Science in Chemical Engineering (BEHons/BSc); Bachelor of Commerce (BEHons/BCom); and a Master of Biomedical Engineering (BEHons/MBiomedE).

In the BE program students complete a common engineering first year, a common second year of fundamental materials engineering courses and mathematics courses, followed by more discipline-specific materials courses in Years 3 and 4, as well as an Honours research project in Year 4. Students major in either Materials Engineering, Ceramic Engineering, Physical Metallurgy or Process Metallurgy by selection of appropriate professional electives in Years 3 and 4 and an appropriate Honours research project in Year 4.

The School also offers a major in Materials Science in the Bachelor of Science (BSc) coordinated by the Faculty of Science. The BSc (Materials) consists of three years of full time study and Honours can be obtained by a further year of full-time study. The BSc can also be combined with degree programs in other Faculties, including Bachelor of Engineering, Bachelor of Arts, Bachelor of Law, etc. The major in Materials Science is also offered in the 4-year Bachelor of Advanced Science Honours (BAdvScHons) coordinated by the Faculty of Science.

The primary aim of the School's undergraduate programs is to deliver graduates possessing the fundamental knowledge, skills, and capabilities needed to succeed in the discipline of Materials Science and Engineering, as well as having the generic graduate attributes expected in a university graduate and, in the case of the BEHons program, having the Stage 1 graduate engineering competencies prescribed by Engineers Australia. The School's undergraduate programs are designed to have strong relevancy to today's material's industry and research whilst being adaptable to future trends and growth in the discipline.

Revision of Undergraduate Programs

As part of its UNSW 2025 Strategic Plan, the University has introduced a trimester academic structure effective from 2019. This structure consists of three academic teaching terms, each being 10 weeks duration, with students undertaking a maximum of three standard courses per term.

The School's BEHons and related programs (and their courses) were restructured in 2017–2018 into the trimester format and this provided opportunity for the School to revise the content and delivery of its programs and courses. The trimester structure offers three formal options for the structure of each program: standard structure in which students complete 8 courses per year; structure involving 9 courses per year with the third trimester in Year 3 available for students to undertake industrial training; structure for first year students to enter into the third trimester of each calendar year.

New Enrolments

Admission to the School's BE programs is through the Universities Admissions Centre (UAC) for local students. International students with appropriate qualifications apply through UAC International or directly through UNSW Apply Online.

Enrolments into the School's BE programs have been healthy over the past ~5 years and are summarised in Table 1. Similar to previous years, the quality of the new local students was high as indicated by ATAR entry scores of >90 for the School's undergraduate programs.

International students comprised approximately one third of the 2017 student intake with approximately being female. The School continues to have the largest undergraduate program in the discipline nationwide by a considerable margin.

Table 1: **First Year Intake**

Program	2014	2015	2016	2017	2018
3131 BE(Materials Sci. & Eng.)	44 (15)	63 (26)	43 (10)	97 (41)	95 (38)
3132 BE(Materials Sci. & Eng.)/BEngSci.	7 (0)	9 (2)	5 (0)	3 (0)	6 (2)
3133 BE(Materials Sci. & Eng.)/MBiomedE	16 (0)	16 (5)	19 (2)	7 (0)	33 (2)
3134 BE(Materials Sci. & Eng.)/BCom	7 (0)	9 (3)	3 (0)	5 (1)	1 (1)
Total:	74 (15)	97 (36)	70 (12)	112 (42)	135 (43)

Retention and Graduation

The numbers of students in each program and year of the all the School's BE and BE-combined programs for 2014 – 2018 are listed in Table 2. The number in each year of study is dependent on the number of students who entered that cohort initially (i.e., in Year 1) as well as the number of students who transferred into or out of the cohort in subsequent years. Furthermore, the number of students in a particular year of study includes students who are deemed by the University's enrolment system to have not yet completed that year of study (owing to failed courses and/or courses not yet undertaken). In addition to the data below for the School's own undergraduate cohort, a significant number of undergraduate students from other schools enrol in the School's courses, the majority being Engineering students who enrol in a first-year introductory materials course. Also, there are approximately 20 – 30 students undertaking the Materials Science major of the BSc program, but reliable data is difficult to obtain because many students do not declare their major until late in their program.

Table 2: **Program Enrolment**

Cohort	2014	2015	2016	2017	2018
Stage 1	69	97	106	132	135
Stage 2	45	47	82	90	–
Stage 3	53	49	72	–	–
Stage 4	70	61	–	–	–
Total:	2017	2018	2019	2020	2021

Graduating Class

The BE degree is awarded at Honours First Class (H1); Second Class Division 1 (H2/1), Second Class Division 2 (H2/2), or Pass classifications as determined by a weighted average mark calculated based on the year of study and the relative weighting of each course in the curriculum for that year. In addition, an exceptionally high level of attainment for H1 may be recognised by the awarding of the University medal. A total of 37 students graduated in 2018 (nb. programs are those prior to revision) with classifications as listed in Table 3.

Table 3: **2018 Graduating Class**

Program	H1 + Medal	H1	H2/1	H2/2	Pass	Total
3135 BE(Materials Sci & Eng)	1	2	1	3	7	14
3136 BE(Materials Sci & Eng)/BCom	0	2	0	0	0	2
3137 BE(Materials Sci & Eng)/BE(ChemEng)	1	7	2	1	0	11
3138 BE(Materials Sci & Eng)/MBiomedE	0	5	2	2	1	10
3972 BAdvSci(Materials Sci)	0	0	0	0	0	0
Total:	2	16	5	6	8	37

Co-Op Scholarship Program

Owen Standard *Academic Coordinator* • Co-op Program in Materials Science & Engineering www.coop.unsw.edu.au

The Co-op Scholarship Program provides industry-funded scholarships to UNSW undergraduate students in various Faculties and degree programs. These scholarships provide students with a significant stipend (~$20,000 per annum for 4 years) and substantial opportunity for industrial training with the sponsoring companies. For the School of Materials Science and Engineering, Co-op scholarships are an effective means to attract high-quality students into our discipline and to provide them with beneficial industrial training in the engineering sector.

Since the introduction of Co-op scholarships in Materials Science and Engineering in 1989 there have been a total of 129 scholarships from 30 different industrial sponsors. Co-op scholars are selected not only on the basis of their academic ability (successful students have ATARs typically 99+), but also on their communication skills, commitment and motivation, perseverance and resilience, teamwork skills, and leadership potential as well as passion and understanding for the materials science and engineering discipline.

In 2018, a total of 3 scholarships (Table 1) were provided by two industrial sponsors – Pacific Aluminium (Rio Tinto) and Weir Minerals with both companies commencing two new scholarships for students commencing in 2018.

In addition to the industrial training placements, the Co-op Program provides students with an ongoing professional development program to help them develop strong graduate attributes and to make a smooth transition to the workplace.

The Co-op Program provides scholars with access to a range of support networks and academic mentor is assigned to each program cohort to offer specific program advice and guidance.

Workshops and training activities are offered throughout the duration of the scholarship and these provide an interactive environment for scholars to learn about professional expectations and ethics, reflect on their own work experiences individually and with peer support, and gain advice from industry representatives.

Table 1: **Co-op Program Scholars in Materials Science and Engineering**

Intake Year	2014	2015	2016	2017	2018	Total
Current Year of Degree	4	3 (IT)	3	2	1	
Number of Scholars						
Ceramic Eng.	–	–	–	–	–	0
Materials Eng.	–	1	–	–	2	3
Physical Met.	–	–	–	–	–	0
Process Met.	–	–	–	–	–	0
Total	–	1	–	–	2	3

Co-op Scholars who commenced prior to 2018 complete 68 weeks of structured and highly relevant industrial training with the sponsor companies – 10 weeks at the end of year 1, 10 weeks at the end of year 1, and two 24-week placements at the end of Year 3. As part of the University's implementation of the trimester academic structure for 2019, the placement schedule changed to 4 weeks at the end of year 1 (optional), 20 weeks during Term 2 of year 2, and two 24-week placements commencing in Term 3 of Year 3. Students are paid for the first 4 years of their Co-op program with an Honours scholarship possible for those students who elect to undertake their Honours research project with a sponsor company.

Students take 5 years to complete their degree, but this is offset by the scholarship and, more significantly, by the immensely valuable graduate skills, networking, and workplace experience obtained from the industrial training placements. Each IT placement is reviewed by the Academic Coordinator in the form of an interview with the scholar and sponsor representative(s) and by written appraisals of the placement by the scholar and sponsor. Industry sponsors quantify the quality and value of work completed by the scholars during their placements to give the students meaningful feedback on the value (and importance) of their work to the business.

The industrial sponsors are provided with highly motivated, capable students to complete important and valuable industrial work. It also provides sponsors the opportunity to have direct involvement in the education and development of our School's students and from whom they can potentially recruit their future managers and leaders.

Co-op graduates are highly sought by industry and many of those who have entered the materials industry have risen to senior leadership and management positions. The School takes this opportunity to again thanks its Co-op sponsors for the efforts they put into organising the placements as well as their training, guidance, and support of scholars during the placements, and for their continued generous support of the Co-op Program.

Postgraduate Degree Programs

The School of Materials Science and Engineering has one of the largest and most active programs in postgraduate research in Australia. The School's staff normally lead UNSW in research grant success, journal publication rates, and postgraduate supervision/graduation rates.

Master of Materials Technology (Coursework)

The Master of Materials Technology program consists of 2 years of full-time or equivalent study comprising coursework in materials processing, materials design, materials technology and materials industry management.

It is designed for graduates wishing to acquire expertise in the design, selection, use and performance of modern materials. It also includes a component of experimental and/or design project work, and an original research project is also undertaken in a chosen area.

Materials Science and Engineering – Master of Science (Research) / Master of Engineering (Research)

A Master by Research degree requires completion of an original piece of research, more limited in scope and nature than that required for a PhD. Candidates develop mastery of appropriate methodology and they present their findings in the wider context of their discipline.

There is the opportunity for graduates of either the Master of Science or Master of Engineering program to progress to PhD study.

Materials Science and Engineering – Master of Philosophy (Research)

The M.Phil degree involves minimum of 1.5 years full time study during which students undertake supervised research leading to the production of a thesis. The program is designed to provide an alternative to the honours program for students who have previously completed a BSc and wish to proceed to a research degree.

There is the opportunity for graduates of the Master of Philosophy program to progress to PhD study.

Materials Science and Engineering – PhD

A PhD degree requires completion of a piece of research that demands a significant and original contribution to knowledge in the field of study. Candidates acquire advanced specialist research training and produce a thesis that summarises the research and provides evidence of independent thought and critical analysis, effective communication and expert knowledge of the discipline in the international context.

Program	Mode	UNSW Program Code	Length of Study	Min. Units of Credit
Materials Technology Masters Degree (Coursework)	Campus, Directed Research, Independent Research	8717	2 years full-time	96
Materials Science Engineering Master of Science (Research)	Directed Research, Independent Research	2055	2 years full-time	96
Materials Science Engineering Master of Engineering (Research)	Directed Research, Independent Research	2175	2 years full-time	96
Materials Science Engineering Master of Philosophy (Research)	Directed Research, Independent Research	2475	1.5 years full-time	72
Materials Science and Engineering PhD	Directed Research, Independent Research	1045	3 years full-time	144

Student Awards & Achievements

University Medals

Mia Maric and **Jonathan Hopkins** have been awarded University Medals for substantial academic achievements throughout their degrees. The University Medal is the most distinguished award that UNSW bestows on an undergraduate student.

1-Minute Thesis Winner

Wilson Handoko won the 'People's Choice Award' at the Faculty of Science Postgraduate Showcase. This competition requires entrants to transmit complex, and often critical, information in a very succinct, clear and relatable manner.

CAMS2018 – Advancing Materials and Manufacturing Conference

Kochurani Johnson won first prize for her 1-minute thesis competition-style poster presentation.

Materials Australia Undergraduate Student Presentation

Mia Maric and **Martin Pacak** were awarded 1st prize and 3rd prizes, respectively, for their presentations '*The effect of cold-rolling and welding on the molten salt corrosion resistance of 316L stainless steel*' and '*Development of Au-based bulk metallic glasses for aesthetic applications*'.

Michelle Yeoh and **Hafsah Indrianita Pratiwi** were awarded 1st prize and 2nd prizes, respectively, for their posters '*Novel K-alkali activated geopolymers*' and '*Advanced thermos-mechanical processing of modern HSLA steels*'.

Xi Shi selected for President's Council of Students Advisors (PCSA)

Xi Shi has been selected to become a delegate for the President's Council of Students Advisors (PCSA), the student leadership committee within The American Ceramic Society (ACerS).

Philanthropic Alumni Strikes Again!

Continuing their philanthropic spree, School Alumni **Pietro Bergamaschi** and his wife **Georgia** have generously donated tuition fee sponsorship for a second postgraduate research student in the School.

Demonstrator Awards

Carina Ledermueller and **Sajjad Mofarah** received demonstrator awards for being most effective in the delivery of lab and tutorial classes to our undergraduates.

Graduating Class of 2018

In our Graduating Class of 2018, the following prizes were awarded:

The prestigious Hugh Muir Prize for the student, who, in the opinion of the Head of School, has contributed most to the corporate life of the School of Materials Science and Engineering was dually awarded to **Mia Maric** and **Richard Chen**.

Mia's stellar year continued, receiving a University Medal for substantial academic achievements throughout her degree and the Perfect Engineering award for the best final year project in Process Metallurgy.

Jonathan Hopkins also had a tremendous year, receiving a University Medal, being the most distinguished award that UNSW bestows on an undergraduate student, and the Perfect Engineering Prize for the best final year project in Materials Engineering.

Richard also received the Wallarah Minerals prize for the best Honours thesis in Advanced Ceramics.

Alan Cen also had a terrific year, winning both the Max Hatherly prize for the best performance in MATS4001 Secondary Processing of Metals and the Australasian Corrosion Association Prize for the best performance in MATS4007 Engineered Surfaces to Resist Corrosion and Wear.

Martin Pacak took home both the Sir Rupert Myers prize for the best performance in MATS3001 Micromechanisms of Mechanical Behaviour of Metals and the Perfect Engineering award for the best final year project in Physical Metallurgy.

Xihua Chen received the Perfect Engineering award for the best final year project in Ceramics.

The Cochlear Prize for the highest overall WAM at the end of Year 3 was awarded to **Keenan Burrough**.

And finally, the Pacific Aluminium Prize for the best performance in MATS3007 Materials Industry Management was awarded to **Vicki Zhong**.

Congratulations to these students and to the entire graduating class of 2018. We wish them great success in the future.

Industrial Training: Poster Competition Winners

In March, the School held its annual Industrial Training Poster Competition.

Each of our bachelor degree programs contain a requirement for students to complete a minimum of 60 days industrial training, aimed at preparing them for future employment in their chosen engineering discipline. Industrial training enhances the academic materials studies and allows students to practice what they have learned, while developing key professional attributes.

35 students who had recently completed their IT placements at universities and companies both within Australia and internationally presented posters and a brief oral summary to showcase their experiences. The quality of the presentations was extremely high and clearly many students found their IT placements to be a very valuable learning experience.

We were very pleased to welcome Cameron Chai from AXT, Benjamin Fishburn & Taka Numata from Brickworks, Alireza Hedayati from LMATS, Asa Jamting from National Measurement Institue, Kevin Nguyen from Perfect Engineering and Bao Le, Jenny Tran & Katherine Vakas from Pallion as our judges for the evening.

This year's winners:

1st Prize: Ishita Puri

Preparation and Analysis of Titania Samples

2nd Prize: Silvia Wong

Quality Assurance and Product Innovation of Large Scale Brick Manufacturing

3rd Prize: Andrew Chun

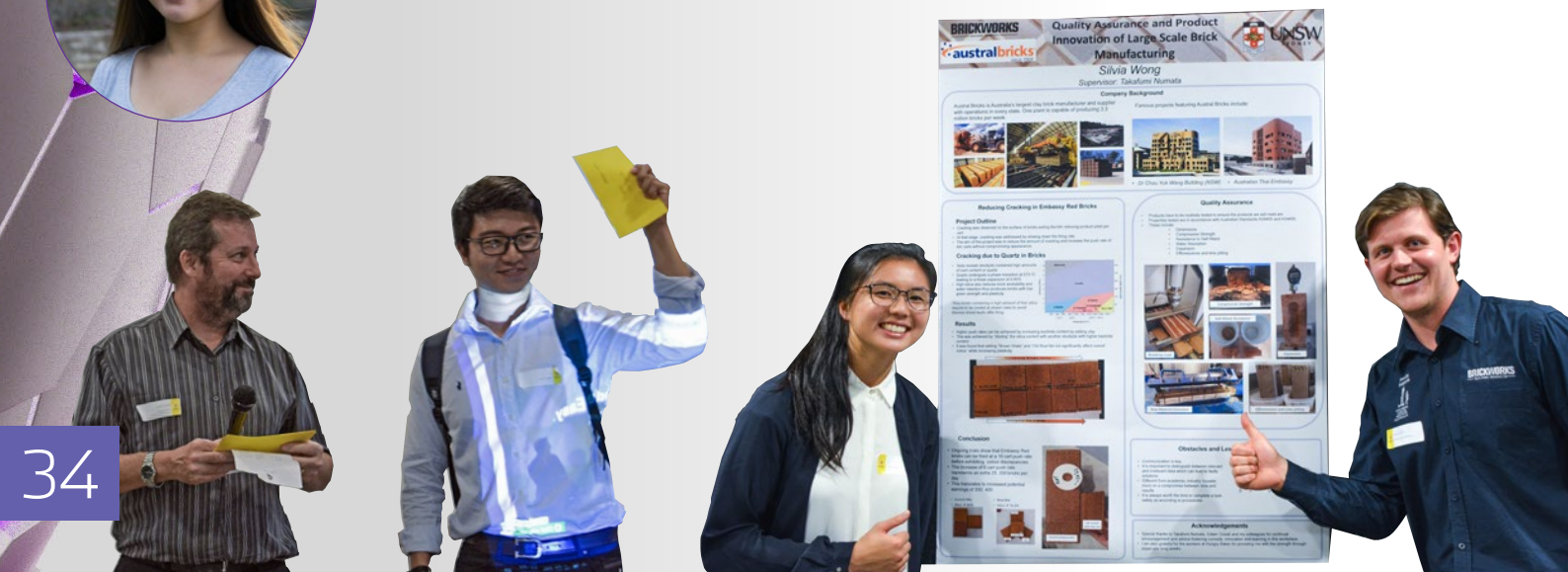
Industrial Training at Austral Brickworks

People's Choice (Poster): Chantelle Malacco

Engineering Health in the Developing World

People's Choice (Presentation): Jacqualine Huynh

Synthesis of PEDOT:PSS for Next-Generation Biosensors in Contact Lenses



Industrial Training: Ishita's Experience

As a Materials Science and Engineering student, I wanted to gain some laboratory experience prior to commencing my Honors Thesis. I was fortunate to be selected to intern at the National Measurement Institute (NMI) in Lindfield, Australia over the 2017/2018 summer.

Through a formal interview process, the members of each department at NMI discussed with candidates their interests and skills to allocate them projects. I was accompanied by four engineering students, across various disciplines and universities. I formed new friendships and learnt about reproducing images pixel by pixel, electrical circuit boards and determining calibrants for different machines from the other interns.

I was allocated the Nanometrology project, which involved preparing and analysing titanium dioxide powdered samples. Titanium dioxide is found in toothpaste and paints – so it is commonly ingested or inhaled. My research was done in collaboration with FSANZ and ANSTO to determine whether titanium dioxide suspended in solution is harmful to rats, and by extension, humans.

I referred to previous protocols and conducted research to develop a method to prepare the titania solutions. I was trained on various characterisation instruments and learnt how to efficiently analyse the results. After conducting trials with numerous methods, I was able to refine my experimental method. Doing so, I accurately prepared and analysed my samples. The results were sent to Western Australia to be further analysed.

From accurately pipetting solutions to dispersing nanoparticles by ultrasonic disruption, NMI allowed me to master basic laboratory skills. Additionally, I had to manually calibrate the instruments, allowing me to gain a deeper understanding behind the mechanism of the process, which is vital for research. These techniques greatly assisted me with my Thesis experiment as I was able to draw on my past experience when preparing solutions and operating instruments.

Under the supervision of Dr. Asa Jamting and Dr. Victoria Coleman, I was exposed to a professional but friendly environment where I was able to learn iteratively and independently repeat the experiments to produce reliable and valid results.

The week before our Christmas break, the staff at NMI organised a wonderful Christmas lunch and picnic at Lane Cove National Park. It was a great opportunity to get to know my colleagues more personally and network with NMI staff across different departments. I would love to be part of another project offered by NMI as there is a vast array of research topics, a friendly environment and opportunity to further my skills.

My experience at NMI was challenging but extremely rewarding. As I was new to the instruments, equipment and research, I found it daunting to implement my own method and execute it. At times, I had to think on my feet, especially when altering my method after unsuccessful trails. Even though it was difficult to conduct an experiment without being able to predict the outcome or be certain about the accuracy of the results, the experience was unforgettable. I am proud of my achievements as I was able to produce results to be sent to ANSTO and FSANZ for analysis.

MATSOC

Richard Chen *2018 MATSOC President*

In 2018, the MATSOC executive committee successfully organised and executed a range of events for undergraduate Materials Science and Engineering students. Our role over these past few years has revolved around organising social and professional events, collaborating with our School and the Materials Postgraduate Society, PGSOC.

This year we were able to expand the scope of our activities with greater engagement with industry, more school-based community events and establishing contact with materials students at other universities.

The executive team set a mission statement of ***'creating an enriching student experience and vibrant community for all our students ... that will develop well-rounded engineers and individuals'***. This would be achieved through the core objectives of creating more cohesive year groups that are consistently engaged in the school community, expanding the engagement with industry contacts and a focus on personal and professional development of the executive team itself.

As a result, MATSOC held a total of 20 events across the year, including 3 professional events, 5 interschool collaborations and 6 collaborative events with other engineering societies.

Event highlights included:

- 50 MSE students attending First Year Camp
- Introduction of an additional School sports day in Semester 2 and the Industrial Training Poster Presentations
- Hosting 105 student and academics at the Annual Materials Trivia Night
- Engaging with representatives from 17 different materials industries for the Speed Networking Event

In recognition of our achievements over previous years, the partnership between Cochlear and MATSOC continued in 2018. This year also saw the start of a new collaboration with Pallion as MATSOC's sponsor. The support from Cochlear and Pallion enabled us to develop these industry engagement events into more professional events.

MATSOC's contribution to expanding the traditional Industrial Training Poster Presentations saw 10 industry guests attend the event and deliver presentations about the current Materials industry in Australia. Our annual Industry Careers Evening saw more than 80 students engage with 6 different representatives from a range of industries including biomedical, metals processing and production, aerospace and engineering consultancy.

Finally, our Speed Networking Evening offered students the opportunity to practise networking with 8 industry guests in preparation for their applications to internships.

We also ran highly-contended School-wide competitions including Sports Days and Trivia Nights. Both the Soccer Sports Day and Basketball Sports Day were big hits! While postgraduates continued their winning sporting streak, undergraduates made a comeback winning Trivia Night and we're looking forward to taking them on again next year!

Through these events, we have fostered the sense of community and pride as a Materials Engineer in the younger students, ensuring an active and cohesive community will continue for years to come. In developing this positive legacy, members of our executive team have also had to opportunity to learn new skills and grow their leadership capacity.

2018 has been MATSOC's best year to date and would not have been as successful without the unconditional support from the School, generous sponsorship from Cochlear and Pallion and enthusiasm and engagement from the Materials Science and Engineering students. In 2019, we will continue to nurture the School community and relationships with industry that have been developed.

This year we were able to expand the scope of our activities with greater engagement with industry, more school-based community events and establishing contact with materials students at other universities.

PGSOC

Friday Socials

The School's postgraduate society started the year with a special Chinese New Year-themed celebration where attendees competed in a Chinese culture trivia game. Throughout the year, Friday Socials continued to bring students and staff together with themed nights, board games, snacks and mini-events for special occasions like St Patrick's Day. Students welcomed the break from their studies after a busy, productive week.

The year kicked off with a special Chinese New Year-themed celebration where attendees competed in a Chinese culture trivia game.

Peer Mentoring

Tea Gatherings were held throughout the year to welcome new students, provide an opportunity for peer bonding and enhance the community spirit.

BBQs were held at Centennial Park at the start of each semester, allowing students to catch a breath of fresh air and get to know their peers through ice-breaking games.

Collaborative Events

The School's student societies collaborated on many events throughout the year, including two sports days, BBQs and a trivia night. Early in the year, undergrads, postgrads and School staff tussled it out in a mini soccer tournament followed by a half-court Basketball competition later in the year.

The annual Trivia Night didn't disappoint with over 100 School students and staff, from fresh faced first years and seasoned postgraduates to wise academics, battling it out in the pop culture quiz. The night was finally decided in an exciting dual in which every team reproduced the Sydney Harbour Bridge with play dough.

World Culture Day

An array of cultures are represented by students and staff in the School, who showcased their culinary talents in an international taste party where authentic, traditional homemade dishes were shared to promote diversity awareness on World Culture Day.

Women's Equity in STEM Panel Discussion

Together with the School's Equity, Diversity and Inclusion (EDI) committee, PGSOC held a panel discussion event: 'Women's Equity in STEM' on August 30, with an aim to raise awareness of the current underrepresentation of women in STEM disciplines. The panel comprised 4 female representatives with PhD experience in STEM and who are currently working in related industries or academia. Panel members shared experiences from their PhDs, careers and also provided sound advice about skill development and the benefits of a good mentor.

Practicum Exchange

Tralia Yang

I was lucky enough to embark on a 3-month research exchange working in the Research and Development department at Inventec Solar Energy Corporation (ISEC) in Taoyuan County, Taiwan. This area was 1.5 hours away from the capital city, Taipei, and 30 minutes away from the nearest train station. The company specialises in the research and manufacturing of multicrystalline silicon solar cells, with a large portion of their cells going to China.

A typical work day started with a morning meeting with the other engineers, managers, and department heads. In this meeting, the engineers would present the progress they made in the plant the day before and bring up any problems which may have affected their work. The section managers would then delegate further tasks to each engineer and these results would be submitted to the manager at the end of the day.

As an intern with minimal background in photovoltaics, my first task was to become familiar with the company's main products and manufacturing processes. My supervisor provided me with all the resources needed to gain a solid understanding of how a solar cell works and how it is manufactured. This understanding was supplemented by regular visits to the production plant where I could see the machines in operation and observe the whole process from bare wafer to the final product. Each process and industrial machine was explained and later used when I assisted the engineers with experiments during my placement.

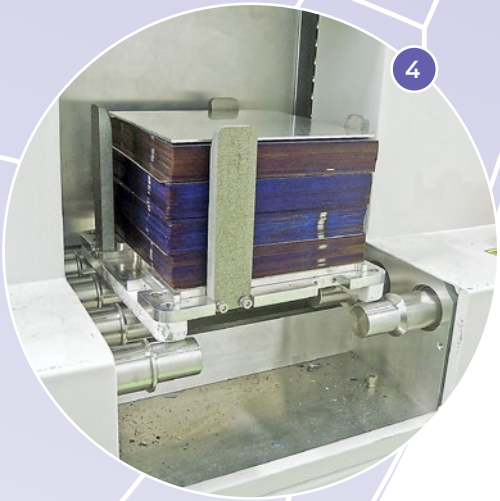
My time at the company allowed me to gain practical experience and it really solidified my understanding of how a product is designed and manufactured. Each week I was working on a different experimental, analytical, or processing method, depending on which engineer I was assigned to. I was also able to learn how to operate the analytical instruments in the plant including Scanning Electron Microscope, Energy Dispersive X-ray Spectroscopy, Laser Scanning Microscope, and Tensiometer.

We visited some beautiful areas in Taiwan on our days off work. On these trips we were able to meet local students, share information about our universities, and answer any questions they had.

We also toured 2 large factories near Taipei – one dedicated to producing Nylon 66, a niche polymer fibre used in the textile industry, and another dedicated to recycling plastic bottles from the ocean which are cleaned and reprocessed into polymer pellets ready to be formed into new product packaging.

In my free time, I went to different gym classes including Zumba, Salsa, and other styles of dancing. The elderly Taiwanese ladies sure love to dance!

By the end of this trip, I felt like I had a very good understanding of what life as an engineer is like in Asia. This experience helped me gain a better understanding of myself and what my future career could hold. Aside from the technical skills, it also allowed me to build my independence and critical thinking skills through the many situations I faced along the way.



Main Pic: View of Taipei from Elephant Mountain. 2. Dome of Light in Kaohsiung. 3. Solar cell ready to be packed and shipped. 4. Stack of wafers ready for Hydrogenation. 5. Students at Sun Moon Lake. 6. Associate Professor Sammy Chan and his students promoting UNSW Science in Taipei. Food Images L-R: Fried chicken and braised intestines mee sua, Traditional fish ball soup, Taiwanese beef noodle soup, Milk tea with pearls (also known as boba).

Alumni Profile

Holstein Wong

One of the School's high-achieving alumni, Holstein Wong, was selected to represent Australia at the 2018 Asia-Pacific Economic Co-operation (APEC) youth forum in Papua New Guinea. This was held as a satellite meeting to the concurrently held APEC leaders meeting.

It was a pleasure to attend this year's APEC CEO Summit and Voices of the Future youth summit in Port Moresby, representing Australia as Educator for our youth delegation. It was a bit surreal at times, especially the day that we were on full security lock down on a cruise ship with some of the world's most powerful political and business leaders!

The Australian delegation were all alumni of the Duke of Edinburgh Award scheme, including one current UNSW co-op scholar. Our group was selected on the basis of our leadership experience, interest in international cooperation, and potential to share benefits back to the Australian community.

The 93 youth representatives from 14 of the member economies engaged in week-long group discussions on a variety of topics such as inclusion, diversity, geopolitics, digital disruption, and what this all means for the future of work, trade and joint prosperity for our common region. It was especially interesting to hear from the PNG delegates on challenges facing their country, being a developing nation rich in natural resources, yet still lacking in basic infrastructure like electricity in some of the rural provinces, or roads connecting major cities (many places are only accessible by air transport, which is unaffordable for most). We also visited the PNG LNG plant, and attended a cultural night with representatives from 10 of PNG's 22 provinces.

At the end of the summit we produced a Youth Declaration which was presented to all of our economic leaders and demonstrated that youth in the region are taking an active role in the social and economic development of our countries. The students really appreciated the opportunity to attend live speeches by world leaders such as President Xi of the PRC, VP Pence of the USA, PM Medvedev of Russia and President Pinera of Chile (Chile will host APEC 2019).

I also got the chance to visit some villages in Central Province, which were a stark contrast to the city despite only being an hour away. It's humbling to see the resilience and passion of healthcare workers and teachers who work in tough conditions, usually with no electricity or running water in their facilities. It reminded me how fortunate we are to have reliable transport infrastructure and telecommunications networks so that both urban and rural areas have access to education and services.

Overall, it was an extremely rewarding week and I encourage all UNSW students with an interest in Asia-Pacific cooperation to apply for this unique experience.

Holstein graduated in from the School in 2013 with 1st Class Honours in BEng with the University Medal in Ceramic Engineering and is currently a market analyst for BHP. Earlier this year she received an award for Queensland's Exceptional Young Women in Resources and was a finalist for the Women in Resources National Awards for her Volunteer work related to gender diversity and equality in the mining industry.

Shaping A Cure for Cancer

Dr Kris Kilian

Dr Kris Kilian is leading a team of researchers building geometrically patterned tumours, using techniques adapted from the microelectronics industry, to better understand patient-specific disease, and to aid drug discovery and development.

The research, published in the journal Nature Materials, involves a "soft lithography" technique, where silicon manufacturing enables creation of a silicone rubber stamp, that can be inked with materials that promote cancer cell growth for geometrically defining hundreds of microtumours, using patient-derived cells, across a single 1 cm2 chip. The resulting microtumour array can then be used to study cancer progression, develop new drugs, or as a method to screen drugs on a patient's own cells to determine what drugs work best.

"The current best-practice for developing anti-cancer drugs involve adding the compound to cells cultured on plastic, followed by a test to see if the drug kills the cells. However, flat plastic dishes do not reflect the complexity of tumour tissue", says Kilian, corresponding author on the study. "This could inadvertently lead to viable drugs being rejected. What we have done is develop new cell culture materials through materials engineering that better reflect the environment of real tumours."

Kilian's work has led to novel insights into the role of a tumour's geometry and its aggressiveness, where certain shapes at the tumour border appear to mediate the major causes of suffering in cancer: metastasis, drug resistance and tumour recurrence. Using this approach, the deadly features responsible can be spatially engineered, thereby allowing new drugs to be tested across hundreds of microtumours. The small footprint of the chip opens up avenues for screening many drugs and their combinations in a short amount of time.

"Since our technique can be used with cells from a patient's biopsy, there is enormous potential for individualised-therapy," says Kilian.

"Our vision is to use our chips to both understand a patient's disease, and to assign the right therapy to the right person quickly and accurately. It is tremendously important to understand how cells interact with materials if we want to effectively model disease states. We believe these advances show great promise for easing the suffering of people struggling with cancer."

This work was initiated by Dr Kilian at the University of Illinois at Urbana-Champaign before his move to UNSW Sydney in 2017. Full details of the study: J Lee, AA Abdeen, KL Wycislo, TM Fan, KA Kilian (2016) Interfacial geometry dictates cancer cell tumorigenicity, Nature Materials 15 (8), 856

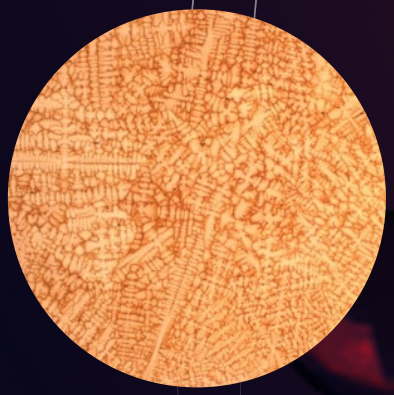
"Our vision is to use our chips to both understand a patient's disease, and to assign the right therapy to the right person quickly and accurately..."

Ionic Crystals that are Fast & Cool

Dr. Claudio Cazorla

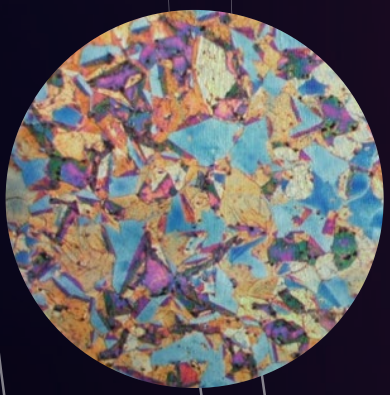
Fast-ion conductor (FIC), or superionic, materials are solids in which ions are highly mobile. They are usually employed as electrolytes in solid-state batteries. Above a certain critical temperature, the ionic mobility in FIC becomes comparable to that of a molten salt. This superionic transition can be thought of as a sublattice melting that, in analogy to homogeneous melting, has associated a large increase in entropy. Now, Dr. Claudio Cazorla in collaboration with PhD student Arun K. Sagotra and A/Prof. Dewei Chu have found that fast-ion conductors can be used for cooling purposes via the application of small pressures.

Conventional refrigeration technologies are based on compression cycles of greenhouse gases. One kilogram of a typical refrigerant gas has the same greenhouse impact as two tonnes of carbon dioxide, which is the equivalent of running a car continuously for six months. In addition, current cooling technologies cannot be scaled down to microchip dimensions, which hinders the development of faster and more compact computers and portable electronic devices. Finding environmentally friendly and highly scalable cooling solutions, therefore, is pressingly needed for improving a number of critical technologies as well as world's sustainability.

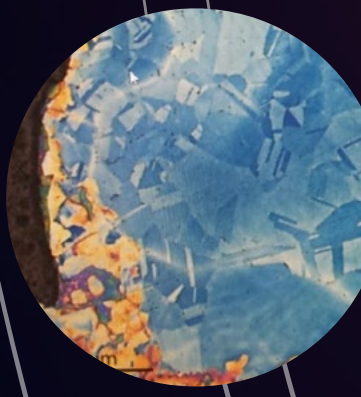


Solid-state cooling is an environmentally friendly, highly energy-efficient, and highly scalable technology that can solve most of the problems of current refrigeration methods.

Solid-state cooling is an environmentally friendly, highly energy-efficient, and highly scalable technology that can solve most of the problems of current refrigeration methods. Solid-state cooling relies on applying external fields (magnetic, electric, or mechanic) on caloric materials. Caloric materials undergo temperature variations as a result of field-induced phase transformations that involve large changes in entropy. Examples of caloric materials include shape-memory alloys, ferroelectric materials and polymers. Nevertheless, most caloric materials known to date only present modest refrigeration performances and/or operate at conditions far from room temperature.



The results reported by Cazorla and colleagues[1] brings new and exciting prospects to the field of solid-state cooling; the researchers have revealed very large entropy changes associated with pressure-induced variations in the ionic conductivity of Li_3N at room temperature, which can be used for refrigeration purposes. Unlike other caloric materials, the cooling effects revealed in Li_3N are not driven by field-induced structural phase transitions but instead by stress-driven changes in the ionic conductivity. As a result, large and highly reversible caloric effects can be achieved at room temperature. Cazorla and colleagues' findings should stimulate the development of room-temperature cooling devices based on fast-ion conductors, whose energy efficiency and refrigerant performance can be superior to those of other caloric materials.



1. A. K. Sagotra, D. Chu, and C. Cazorla, Nature Communications 9, 3337 (2018).

Bright Future for Lead-Free Brass

Dr Kevin Laws

Researchers have developed a lead-free brass alloy to replace traditional plumbing brass materials that have been shown to release lead into drinking water supplies, which can lead to significant detrimental health and developmental effects, particularly in young children.

Dr Kevin Laws and his research team developed a 'high-entropy' alloy system in 2015 that is very similar to brass and bronze. From this work the breakthrough alloy, which the group has named 'Bright Brass', was designed to retain all the advantages that lead provides to brass for its manufacturing ability but without the toxicity.

"Developing a viable alternative to standard plumbing fixtures and hardware became a high priority, particularly when it became known how widespread lead contamination in NSW drinking water is, with reports that 56% of households in NSW are contaminated and 8% exceeded the recommended limit of 10 micrograms per litre set in the Australian Drinking Water Guidelines." Currently there is no legislation in Australia which limits the use of lead in brass fittings, with standards allowing up to 4.5% lead content in brass used in plumbing, while the US, Europe and Canada have recently introduced legislation to dramatically limit lead content in all new brass material. It is expected the governments of Australia will shortly follow and Dr Laws is working closely with them.

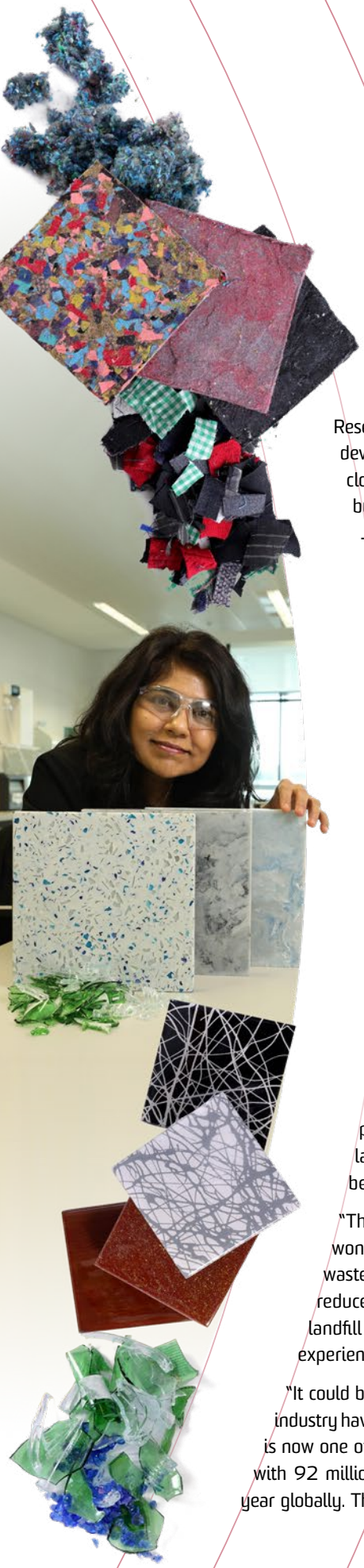
Up until now, lead has played an important role in how brass plumbing parts are manufactured. "The lead forms tiny soft globules, in the alloy which provide lubrication, which helps with 'free-machining' and associated manufacturing processes reducing both material and manufacturing costs, as well as helping the brass fittings to seal once in service." Say Dr Laws. The key to the Bright Brass discovery was that the new particles to replace lead (their composition still under wraps by the UNSW team) meet all these criteria. "We have successfully cast Bright Brass that includes safe, lubricating particles that form as the alloy cools. Our new alloys are silver in colour to allow for better identification for these lead-free brass applications. They are cost-competitive and perform mechanically similarly, if not better, than leaded brass" says Dr Laws.

The research project was funded in collaboration with UNSW Spin-Off company, Advanced Alloy Holdings and the NSW State Government's Boosting Business Innovation Program. "Within a few months, the UNSW team delivered an alloy which can be made by existing manufacturers to solve a water contamination problem that has affected Australians and essentially the world for more than a century," said Advanced Alloy Holdings CEO Dr Warren McKenzie.

Bright Brass products may be available as early as 2020 once the R&D process and stringent water quality testing are complete. Already, the company has been approached by others who are watching the lead-free plumbing space with interest.

Excerpts taken from "New alloy to solve lead problem in drinking water" by Lachlan Gilbert, published on the UNSW Newsroom.

The breakthrough lead-free alloy 'Bright Brass' was designed to retain all the advantages that lead provides to brass for its manufacturing ability but without the toxicity.



SMaRT Report

Innovation in Microfactory Technology: Turning old clothes into high-end building materials

Researchers at UNSW Sydney have developed an effective process to turn old clothing and textiles into high-quality building products such as flat panels.

These high-end composite products can have a wood veneer look or a ceramic-style finish and were lab tested for qualities such as fire and water resistance, flexibility, acoustic and load-bearing capabilities but have not undergone any formal regulatory assessment.

This follows a separate but related research exercise that converted used glass into high-quality ceramics suitable for benchtops and tiles in kitchens and bathrooms that can come in all sort of sizes, colours and finishes.

Researchers led by Professor Veena Sahajwalla, Director of UNSW's Centre for Sustainable Materials Research and Technology (SMaRT), have been scientifically reforming common waste items using prototype technology developed for a laboratory-scale 'green microfactory' to be launched in 2019.

"These newly published results of the wonderful products developed from waste come as an effort to find ways to reduce waste and address our unsustainable landfill problems, which all countries are experiencing," she said.

"It could be said that consumers and the fashion industry have a lot to answer for, given that clothing is now one of the biggest consumer waste streams, with 92 million tons estimated to be thrown out a year globally. The clothing and textiles industry is the second most polluting sector in the world, accounting for 10% of the world's total carbon emissions."

Reforming old clothing and mixed waste glass into various high-quality building products represents a new way to convert low-value waste into high-value products and materials. This new work builds on technology which can recover and reform materials from electronic waste from UNSW's demonstration e-waste microfactory launched in April 2018.

Veena said that when considering that the population growth trend is expected to jump from a current world population of 7.6 billion to 9.8 billion by 2050, the earth's resources need to be preserved and re-used rather than put in landfill or incinerated.

"There is much that can be done right now given that scientifically-developed, proven methods are currently available through our green microfactory technology," she said. "Rather than export our rubbish overseas and to create more land fill, green microfactory technology has the potential to enable small- and large-scale creation of newly manufactured products instead."

While the textiles materials tested exceptional well in labs to mechanical performance properties including strength, flexibility and resistance, further lab testing is required to explore these properties ahead of consideration of applying for any formal assessment against construction regulations.

Veena said green microfactories can not only produce high performance materials and products, they eliminate the necessity of expensive machinery, save on the extraction from the environment of yet more natural materials, and reduce the waste burden.

Recent UNSW consumer research showed most people did not believe the waste materials they put out in their recycle bins is actually recycled but ends up in landfill, with 91.7% of people saying is it very or somewhat important for Australia to invest in technology to 'reform' most common waste to reduce landfill.

The clothing and textiles industry is the second most polluting sector in the world, accounting for 10% of the world's total carbon emissions.

A major impediment to new solutions to the waste problem, Veena said, was getting the technology commercialised and into the market, and without government incentives to attract industry and change behaviour progress would be slow.

Glass stockpiles alone amount to more than one million tonnes per year nationally. In total, Australia produces nearly 65 million tonnes of industrial and domestic solid waste each year, but it is now cheaper to import than recycle glass here. About 60 per cent of waste is reportedly recycled but much of this is low value.

E-waste microfactory background

The NSW Environment Minister launched the world's first demonstration e-waste microfactory in April this year. This showcases a process developed by the UNSW SMaRT Centre which transforms the components of discarded electronic items like mobile phones, laptops and printers in to new and reusable materials that can then be used to manufacture high value products such as high value metal alloys, carbon and products such as 3D printer filament.

Our e-waste mircofactory involves a number of small machines for this process and they fit into a small room. The discarded electronic devices and items are first placed into a module to break them down. The next module may involve a special robot to extract useful parts. Another module uses a small furnace to separate the metalic parts into valuable materials, while another one reforms the plastic into filament suitable for 3D printing.

UNSW is now finalising a second demonstration green microfactory which converts glass, plastics and other waste materials in to value-added products. Mixed waste glass is used to create engineered stone products. Wood, plastic and textile waste is used to create valuable insulation and building panels.

UNSW, through its ARC Green Manufacturing Hub, has developed this technology with support from the Australian Research Council and is in partnership with several businesses and organisations including recycler TES and manufacturer Moly-Cop. And through the Commonwealth funded CRC-P initiative, SMaRT is partnering with Dresden, which makes spectacles, in the use of recycled plastics.

Audio, images, vision:

The full published papers of the new textiles and glass research are available from the contact listed below. Broadcast quality audio and video by Veena about microfactory technology and results on consumer attitudes to waste and recycling, as well as photos of the e-waste microfactory in our laboratory, are available at: http://bit.ly/UNSWRecycling

Author: Stuart Snell

Current Research Grants

ACARP Competitive Grant Funding

Ostrovski O, Sharp J, Mahoney M, Monaghan B, Rogers H, Zhang G, Zulli P, Xing X, *Characterising the degradation of cokes made from Australian coals and subjected to simulated blast furnace operating conditions*, $362,620

Sorrell C, **Koshy P**, **Toppler K**, **Xing X**, Chavara D, Chen WF, Drew M, Gupta S, Lomas H, *In-Situ High Temperature Strength of Low CSR Cokes*, $190,000

AINSE

Primig S, **Maric M**, Muransky O, *Assessing the effect of cold-work on the corrosion resistance of 316L Stainless Steel and Ni based superalloys – AINSE Honours Scholarship for Mia Maric*, $5,000

Seidel J, **Vats G**, Gilbert E, *Formation of a stable long range magnetic skyrmion lattice in thin films of the room temperature chiral material Co8Zn8Mn4, PhD student - Gaurav Vats*, $7,500

Valanoor N, Bhattacharyya D Zeng, J, *Ion irradiation on Multilayered Oxide Heterostructure with Possible Topological Properties - PhD student Jiali Zeng*, $7,500

Valanoor N, **Burns S**, Deng G, *Exploring magnetoelectric coupling in ferroics; neutron scattering experiments probing the magnetic phases of BiFeO3. PGRA for Stuart Burns, $20,068*

Valanoor N, Paull O, Hamish C, *Interfacial magnetism effects and multiferroic thin films for device applications - PGRA for Oliver Paull*, $7,500

ARC Centre of Excellence

Valanoor N, **Seidel J**, *ARC Centre of Excellence in Future Low-Energy Electronics Technologies FLEET*, $3,590,096

ARC DECRA

Primig S, *Engineering hierarchical microstructures in high strength low alloy steels*, $666,553

ARC Discovery Project

Ferry M, *A new crystallographic approach to deformation and annealing of metals*, $425,500

Hart J, *Advanced anodisation methods and materials for solar water splitting*, $30,000

Hart J, **Sorrell C**, **Koshy P**, *Engineering Quantum-Size Bioceramics: Photocatalytic / Sonocatalytic Ceria*, $301,500

Li S, Koumoto K, *High Performance Complex Oxide Heterostructures for Nanoelectronic Devices*, $373,500

Munroe P, **Valanoor N**, Morozovska A, Weyland M, *'Designer defects' - A new approach to functional oxide interfaces*, $473,900

Sahajwalla V, **Joshi R**, Bhattacharya S, *Thermal isolation: a novel pathway to transforming complex waste*, $267,804

Seidel J, Manske D, Rubhausen M, Ulrich C, *Topological spin systems as basis for novel multifunctional materials*, $355,000

Valanoor N, Morozovska A, *Engineered control of polarization rotation in ferroelectric bilayers*, $400,500

Wang D, Dai J, Tan X, Tan X, *Lead-free oxide perovskites for highly efficient solar cells*, $300,000

ARC Future Fellowship

Cazorla Silva C, *Rational Design of Novel Multiferroic Materials for Energy Harvesting and Energy Efficiency*, $778,874

Chu D, *Building Novel Solid State Electric Double Layer Transistors with Interface Engineering of Ionic Conductive Oxide Superlattices*, $735,144

Wang D, *Oxide-Semiconductor Epitaxy: Towards Next Generation Nanoelectronics*, $1,612,189

Current Research Grants *CONTINUED*

ARC Industrial Transformation Research Hub

Sahajwalla V, **Ostrovski O**, Dippenaar R, Douglas A, Fernandes M, Lloyd S, Prusty G, Rasmussen K, Singh R, Tooze I, *Transforming Waste Directly in Cost-effective Green Manufacturing*, $3,706,756

Yang R, *"Grindability" test: modelling, measurement and mill fingerprinting*, $50,000

ARC Laureate Fellowship

Sahajwalla V, *Fundamental high temperature e-waste investigations for high-value products*, $6,009,331

Sahajwalla V, *Contract No. 17/18-083 for the participation as a member of the ARC Australian Laureate Fellowships Selection Advisory Committee*, $3,955

ARC LIEF Grant

Li S, Bilek M, Conibeer G, Gooding J, Guo Z, Mai Y, Phillips M, Waite T, Xie Y, *Nanoimprint Systems: Expanding Research Capability of Roll to Roll Printer*, $450,000

Li S, **Wang D**, Bao Q, Chen Y, Cheng W, Glushenkov A, Kalantar Zadeh K, Kim J, Li D, Li L, Moss D, Razal J, Wang H, Yang W, *Chemical Vapor Deposition System*, $30,000

Seidel J, Bach U, Bansal V, Edmonds M, Fuhrer M, Kalantar Zadeh K, Kalantar-Zadeh K, Karel J, Lu Y, Ou J, Suzuki K, Wang L, Yi J, *Facility for electric and magnetic probes of materials at extreme conditions*, $48,750

Sorrell C, Aharonovich I, Bao Q, Dou S, Du Y, Greentree A, Jin D, Kuhlmey B, Motta N, Ou J, Palomba S, Phillips M, Toth M, *National Facility for Nanoscale Characterisation of Luminescent Materials*, $37,500

ARC Linkage Project

Sorrell C, **Koshy P**, *Fibre-Reinforced Composites: Single-Crystal Mullite Fibres from Topaz*, $535,000

Sorrell C, **Koshy P**, Pandolfelli V, da Luz A, *New Paradigm for Materials Technology for AZS Glassmaking Refractories*, $580,000

Yang R, *Preparation and use of lignite-iron ore composite briquettes for ironmaking*, $110,000

Zhang J, Huang H, Jiang Z, Wang L, *Understanding the role of nanoparticles in water-based lubrication*, $45,000

CRC for Low Carbon Living

Sahajwalla V, **Heriyanto H**, *Glass recycling for waste reduction in built environments - Scholarship for Heriyanto*, $105,000

Sahajwalla V, **Pahlevani F**, **Gaikwad V**, **Ghose A**, Douglas A, *Prototyping, testing, optimising and demonstrating the industrial scale production of composite engineered stone from reclaimed glass*, $70,000

CSIRO PG Scholarship

Daniels J, **Ly T**, Miljak D, *CSIRO Mineral Resources Top-Up Scholarship for Thai Ly*, $48,626

CSIRO PG Scholarship

Daniels J, **Yap E**, *Postgraduate Student Agreement for Emily Yap*, $47,667

Current Research Grants *CONTINUED*

Industry

Cazorla Silva C, **Chu D**, *Development of Advanced Cathode Materials for High Performance Li-ion Batteries*, $265,627

Chan S, *Construction of two demonstration Solid Hydrogen Storage and Fuel Cell Systems*, $43,019

Chan S, **Yao Y**, *Titanium Matrix Composites with High Volume Fraction of Reinforcements for Mining & Minerals Processing Industries*, $20,940

Daniels J, Cain T, Dean C, Doisy M, Kurusingal V, Pham Thi M, *Exploring electro-mechanical response of textured ceramics for underwater acoustics applications - PhD student Scarlet Kong*, $17,377

Daniels J, *Development of electric field diffraction cells*, $19,977

Ferry M, **Laws K**, Lin P, *Reducing the environmental impact of passenger vehicles by the design of lightweight alloy components*, $307,000

Laws K, **Conway P**, *Deep-Draw Lead-Free Brasses - Techvoucher Project*, $31,988

Laws K, Park E, *The Australia-Korea Advanced Metal Alloys/Metal Technology Project*, $61,980

Li S, **Chu D**, *Development of RRAM*, $699,884

Li S, **Chu D**, **Wang D**, *Graphene enhanced performance of transmission power cables and High performance power grid scaled graphene supercapacitors*, $2,500,000

Li S, *Projects II: Graphene Enhanced Performance of Electric Transmission Lines*, $1,000,000

Li S, Zhang J, Ionescu M, Klose F, *Isotope Engineering and Nuclear Characterisation of Novel Nanoscale Thin Film Functional Materials*, $321,480

Munroe P, **Palmer N**, Wang Z, *Assessment of the Radiation Damage of Graphite for Molten Salt Reactor (MSR) Systems - Scholarship for Nicholas Palmer*, $6,000

Munroe P, Rasse D, *Implementing biochar-fertilizer solution in Norway for climate and food production benefits*, $32,300

Ostrovski O, **Zhang J**, Zhang C, *Investigation of CaO-Al2O3-based flux for high Al steel continuous casting of high-Al steel*, $150,000

Pahlevani F, **Cholake S**, *Enhancing the fire resistance of wood-based panels*, $103,207

Pahlevani F, *Production of one prototype spongeblock from waste for demonstration purpose*, $65,000

Primig S, *High security safety feature (HSF) coin blank analysis*, $6,000

Primig S, *Hot ductility of Ni-based alloy Rene 41*, $157,500

Primig S, Ringer S, Liao X, *Microstructure Control in Metal Additive Manufacturing*, $870,000

Primig S, **Theska F**, Oberwinkler B, *High resolution analysis of strengthening effects in Ni-based alloys. Student Project Agreement for Felix Theska*, $236,046

Sahajwalla V, **Joshi R**, Bailey T, *Generation of Gases from End-of life Tyres and Purification Using Novel Graphene Molecular Sieve - Scholarship for Xiaoheng Jing*, $75,000

Sahajwalla V, **Joshi R**, *Developing Graphene Integrated Super-Composite Materials using End-of-Life Tyres - PhD Scholarship Yi You*, $75,000

Sahajwalla V, **Joshi R**, **Gaikwad V**, **You Y**, Bustamante H, *Industrial scale use of graphene oxide membranes for water and wastewater applications*, $100,000

Sahajwalla V, **Joshi R**, *Graphene Oxide Project*, $205,000

Sahajwalla V, **Joshi R**, **You Y,** *Super Desiccants for Odour Abatement in Sewer Vents*, $89,296

Sahajwalla V, *Prepayments held in trust for upcoming ARC Industrial Transformation Research Hub IH19 application*, $125,000

Current Research Grants *CONTINUED*

Industry *CONTINUED*

Sorrel C, Koshy P, *Regional EnviroScience - TechVoucher Project*, $30,000

Sorrell C, Amin M, *Attendance at 2018 Materials Research Society Fall Meeting - PhD Candidate Md Lutful Amin*, $3,922

Sorrell C, *Intelliparticle - NSW Tech Voucher Project*, $15,000

Sorrell C, *Intelliparticle - NSW Tech Voucher Project*, $15,304

Sorrell C, Koshy P, *Analysis of impurities in quartz resources - stage 1*, $2,000

Sorrell C, Koshy P, Chen WF, *Development of Fly Ash-Based Composite Ceramics insert*, $4,506

Sorrell C, Koshy P, *Development of X-ray probe*, $3,982

Sorrell C, Koshy P, Gupta S, *Characterization of Anthracite/Thermal Coal Grain Interfaces in Cokes and Determination of their Implications on the Evolution of High-Temperature Mechanical Strength*, $76,090

Sorrell C, Koshy P, *Optimisation of Processing Parameters for Superior Biomedical Product Characteristics*, $9,075

Sorrell C, Koshy P, Schreck L, Chen WF, Hanaor D, Kamutzki F, Schmidt F, *Synthesis of doped pyroxene phase change materials*, $19,500

Sorrell C, Koshy P, *UV Visualisation of Avian Fauna*, $7,700

Valanoor N, Sando D, Bellaiche L, *Topological functionalization of ferroelectrics and multiferroics*, $33,000

Yang R, Chan K, Cheng S, Kourmatzis A, *Development of computational models to predict delivery of inhalation drug powders: from deagglomeration in devices to deposition in airways*, $101,956

Young D, *Corrosion in CO2*, $103,562

Seed Grant

Daniels J, Wang K, *Fabrication of advanced electro-ceramics for actuators and sensors*, $15,000

UNSW Research Infrastructure Scheme

Laws K, *FIP-High temperature high purity thermal treatment facility*, $159,697

Laws K, Primig S, Ferry M, Kruzic J, *Network Lab: Technical Support Engineer*, $240,010

Mawad D, *FIP - Dynamic mechanical testing electro force*, $199,300

Publications - Book Chapters

Jin X, Poon C, Joshi R, *Chapter 8: Graphene-based membranes for purification and separation applications*, RSC Nanoscience and Nanotechnology, pp 163-187, 2018

Shirsath S, Jadhav S, Mane M, Li S, *Ferrites obtained by sol–gel method*, Handbook of Sol-Gel Science and Technology, pp 1-41, 2018

Melhem G, Munroe P, Sorrell C, Livingstone A, *Field trials of aerospace fasteners in mechanical and structural applications*, Encyclopedia of Aluminum and Its Alloys, Taylor and Francis, pp 1007-1021, 2018

Maroufi S, Echeverria Encina C, Pahlevani F, Sahajwalla V, *Green manufacturing: unmaking waste to value added material*, Unmaking Waste in Production and Consumption: Towards Circular Economy, Emerald Publishing Limited, First edition, pp 251-269, 2018

Bianchi C, Pirola C, Stucchi M, Cerrato G, Galli F, Di Michele A, Biella S, Chen W, Koshy P, Sorrell C, Capucci V, *Photocatalytic TiO_2: from airless jet spray technology to digital inkjet printing*, Titanium Dioxide – Material for a Sustainable Environment, IntechOpen, pp 261-279, 2018

Publications - Conference Papers

Aye K, Zhang J, Young D, *Chlorine-induced corrosion of chromia forming alloys in wet CO_2 atmospheres at 650^{0}C*, Corrosion & Prevention 2018, Adelaide, 2018

Concepcion C, Hsu Y, Xie Y, Zhang J, *Corrosion behaviour of Ni-Cr in oxygen at high temperature, corrosion & prevention*, Australasian Corrosion Association, Adelaide, 2018

Handoko W, Pahlevani F, Sahajwalla V, *Effect of retained austenite stability in corrosion mechanism of dual phase high carbon steel*, 20th International Conference on Sustainable Materials and Structural Systems, Amsterdam, Netherlands, 2018

Mathrmool K, Kumar N, Sumang R, *Fabrication of (1-x)Ba($Zr_{0.2}Ti_{0.8}$) O_3-x($Ba_{0.7}Ca_{0.3}$)TiO_3 ceramics saving energy by molten-salt synthetic method*, 3rd International Conference on Applied Physics and Materials Applications, Thailand, 2018

Hossain R, Pahlevani F, Sahajwalla V, *Solid state phase transformation mechanism in high carbon steel under compressive load and with varying Cr percent*, TMS 2018 147th Annual Meeting & Exhibition, USA, 2018

Chen H, Miller H, Wu S, Lamei Ramandi H, Crosky A, Saydam S, *Stress corrosion failure of cable bolts in underground mines*, 2018 European Rock Mechanics Symposium, Russia, 2018

Kapelyushin Y, Sasaki Y, Zhang J, Ostrovski O, *A study of cementite formation in the reduction of hematite by CO-CO_2 gas mixture using high temperature XRD*, Extraction Proceedings of the First Global Conference on Extractive Metallurgy, 2018

Publications - Journal Articles

Ren F, Ward L, Williams T, Laws K, Wolverton C, Hattrick-Simpers J, Mehta A, *Accelerated discovery of metallic glasses through iteration of machine learning and high-throughput experiments*, Science Advances, Vol 4, No 4, 2018

Hu L, Zhang Z, Patterson R, Hu Y, Chen W, Chen C, Li D, Hu C, Ge C, Chen Z, Yuan L, Yan C, Song N, Teh Z, Conibeer G, Tang J, Huang S, *Achieving high-performance PbS quantum dot solar cells by improving hole extraction through Ag doping*, Nano Energy, Vol 46, pp 212-219, 2018

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Young D, Zhang J, *Alloy corrosion by hot CO_2 gases*, The Journal of The Minerals, Metals & Materials Society, Vol 70, No 8, pp 1493-1501, 2018

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Mobbs R, Rao P, Phan K, Hardcastle P, Choy W, McCartney E, Druitt R, Mouatt C, Sorrell C, *Anterior lumbar interbody fusion using reaction bonded silicon nitride implants: long-term case series of the first synthetic anterior lumbar interbody fusion spacer implanted in humans*, World Neurosurgery, Vol 120, pp 256-264, 2018

Xu J, Sun T, Jiang S, Munroe P, Xie Z, *Antimicrobial and biocorrosion-resistant MoO_3-SiO_2 nanocomposite coating prepared by double cathode glow discharge technique*, Applied Surface Science, Vol 447, pp 500-511, 2018

You Y, Jin X, Wen X, Sahajwalla V, Chen V, Bustamante H, Joshi R, *Application of graphene oxide membranes for removal of natural organic matter from water*, Carbon, Vol 129, pp 415-419, 2018

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Ghasemian M, Rawal A, Liu Y, Wang D, *Approaching piezoelectric response of Pb-piezoelectrics in hydrothermally synthesized $Bi_{0.5}(Na_{1-x}K_x)_{0.5}TiO_3$ nanotubes*, ACS Applied Materials and Interfaces, Vol 10, No 24, pp 20816-20825, 2018

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Allan N, Thomas L, Hart J, Freeman C, Mohn C, *Calcite–magnesite solid solutions: using genetic algorithms to understand non-ideality,* Physics and Chemistry of Minerals, Vol 46, No 2, pp 193-202, 2018

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Cazorla Silva C, Errandonea D, *Comment on "High-pressure phases of group-II difluorides: Polymorphism and superionicity"*, Physical review B: Condensed matter and materials physics, Vol 98, pp 186101-186101, 2018

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Taherymoosavi S, Joseph S, Pace B, Munroe P, *A comparison between the characteristics of single- and mixed-feedstock biochars generated from wheat straw and basalt*, Journal of Analytical and Applied Pyrolysis, Vol 129, pp 123-133, 2018

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Younis A, Shirsath S, Shabbir B, Li S, *Controllable dynamics of oxygen vacancies through extrinsic doping for superior catalytic activities*, Nanoscale, Vol 10, No 39, pp 18576-18585, 2018

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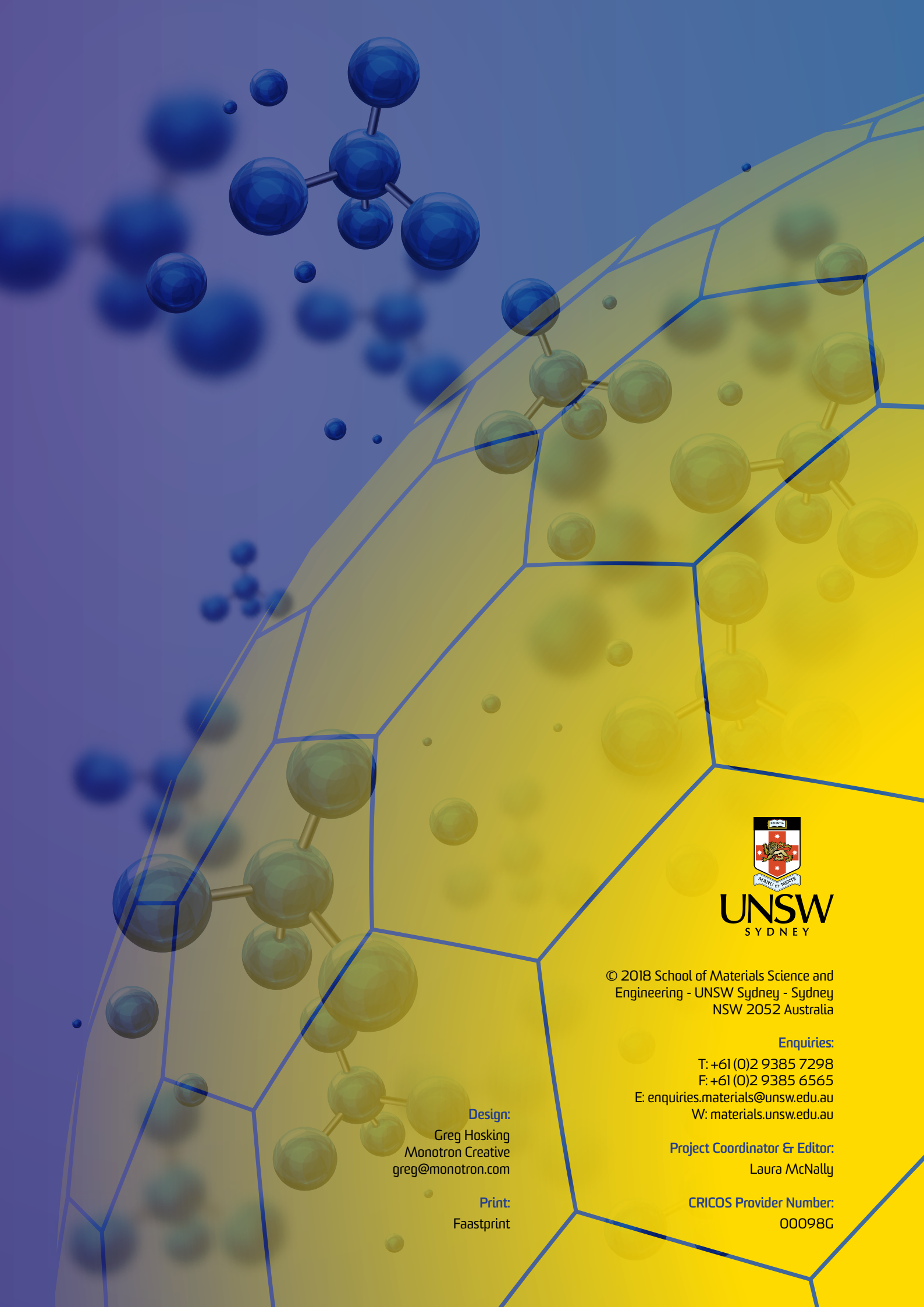

Enquiries:
T: +61 (0)2 9385 7298
F: +61 (0)2 9385 6565
E: enquiries.materials@unsw.edu.au
W: materials.unsw.edu.au

Project Coordinator & Editor:
Laura McNally

CRICOS Provider Number:
00098G

Design:
Greg Hosking
Monotron Creative
greg@monotron.com

Print:
Faastprint