
UNSW
SYDNEY
Australia's
Global
University
2020
ANNUAL REPORT
SCHOOL OF MATERIALS SCIENCE & ENGINEERING

# HoS WELCOME 2020

## I AM PLEASED TO INTRODUCE THE SCHOOL OF MATERIALS SCIENCE AND ENGINEERING 2020 ANNUAL REPORT.

I would like to start by expressing my sincere gratitude to all staff, students and colleagues for their incredible support as the School navigated through a very difficult year affected by bushfires and floods at the beginning of the year, only to be confronted by the COVID19 pandemic for the rest of the year.

## CHALLENGES

During Term 1, the deteriorating situation in Australia forced the closure of the University for several months, and we were all faced with the strange situation of working and studying from home. Staff also took up the challenge of rapidly transitioning their lectures, tutorials, lab classes and exams to fully online, and arranging work for their research students who were unable to access laboratories.

These changes had a major impact on our students as they adjusted to the situation. It has been a particularly difficult time for our international students who have been separated from their families and friends all year, or simply unable to travel to Australia to either commence or continue their studies.

## PERFORMANCE

Despite a year like no other, the School continued to perform strongly across UNSW's three pillars of Educational & Research Excellence, Social Impact, and Innovation & Engagement. The various achievements of our staff and students are highlighted throughout this report.

The School received excellent myExperience teaching scores for most of our courses, which is a tribute to the efforts of our teaching and support staff in delivering high quality and engaging courses in an online format. The accompanying student feedback was invaluable as it enabled staff to better understand their concerns and challenges associated with learning online.

## STAFF ACHIEVEMENTS

The School celebrated several academic staff promotions in 2020: Nima Haghdadi and Pankaj Sharma were promoted to Lecturer and Sammy Chan and Dewei Chu were promoted to Professor! Several staff also received a Dean of Science Award for outstanding contributions to the School and Faculty throughout the year.

Dewei Chu received a Research Excellence Award, Anthony Zhang received an Operational Excellence Award, Sophie Primig received a Collaboration & Partnership Award, Damia Mawad received an Equity, Diversity & Inclusion Award, and Owen Standard received the Dean of Science Standout Award!

## MSE INTEGRATED STRUCTURE

On research, the School introduced its new integrated structure, consisting of an enabling platform that supports the four themes containing our research groups and centres.

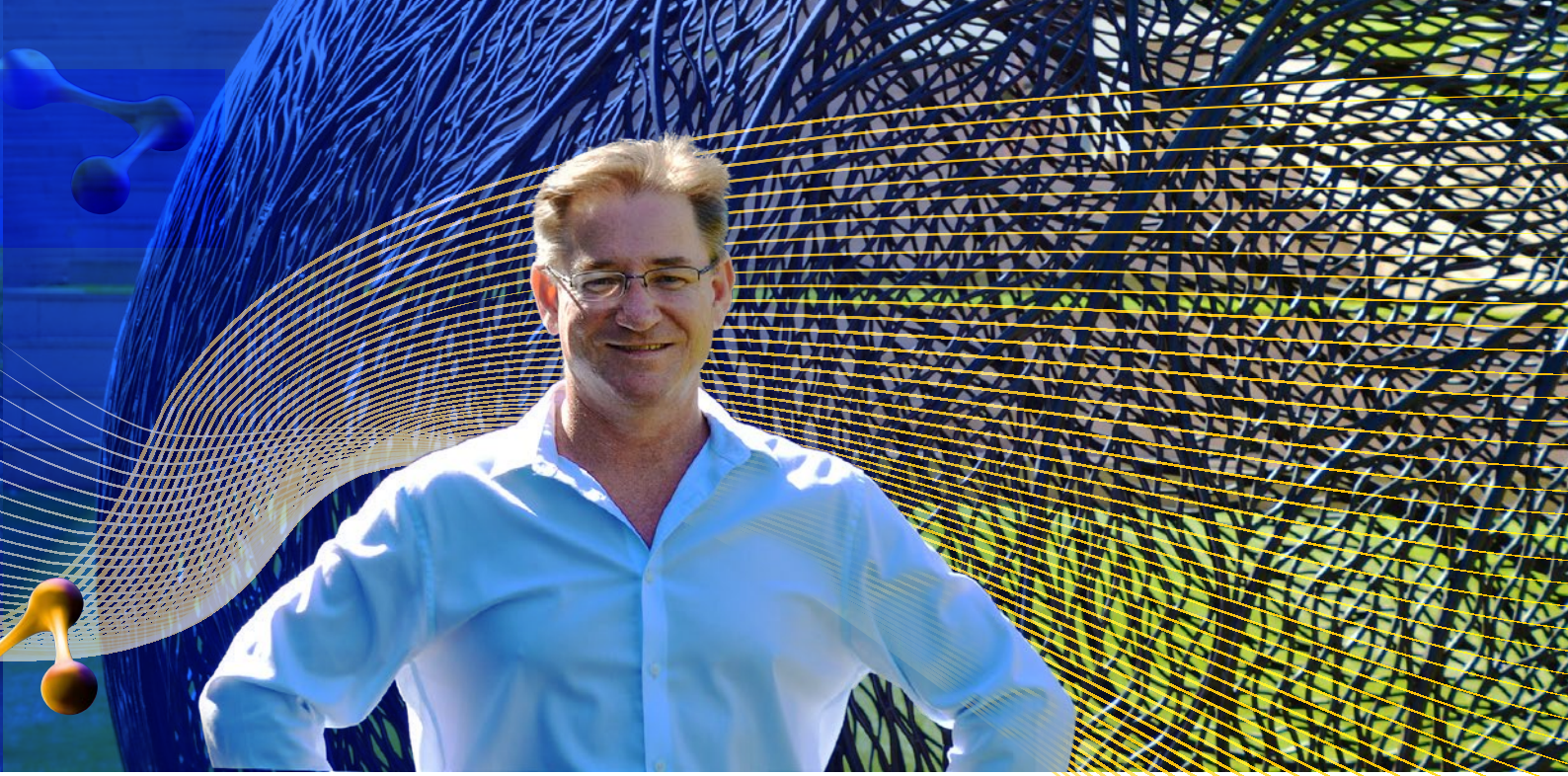
Our newly-appointed Theme Leaders are Rakesh Joshi (Energy & Environment), Sophie Primig (Transport & Infrastructure), Dewei Chu (Electronics & Communications), and Kris Kilian (Biomedical & Health). An update from each of them is provided herein.

## FUNDING

Staff were highly successful with Australian Research Council funding via a total of 6 Discovery and 6 Linkage grants, which is a fantastic achievement for our modest-sized School.

Staff also received several other government and industry grants, most notably from ARENA, ACARP, US National Cancer Institute, US Department of Defence, Australia-India Strategic Fund, Impresario Investments, and Baxter International. A list of both our research grants and publications is contained herein.

The funding highlight of the year goes to Scientia Professor Veena Sahajwalla and her SMaRT Centre team who received $17M from the National Environmental Science Program to establish 'The Sustainable Communities and Waste Hub'. As leader of the Hub, Veena will coordinate research on reducing the impact of plastic and enhancing sustainable people-environment interactions,



develop ways to minimise impacts of hazardous substances and pollutants, and deliver cutting edge technical capabilities, particularly in the fields of waste and materials processing.

## STUDENT ACHIEVEMENTS

The School is immensely proud of our students and their various achievements are highlighted herein. This year is particularly special as five of our graduating students who completed their degrees in late 2019 were awarded the University Medal for academic excellence. The School conveys its warm congratulations to Vicki Zhong, Gajan Shivaramanan, Keenan Burrough, Alan Cen and Liam Stephenson.

The NSW branch of Materials Australia held its annual undergraduate student thesis presentation competition for the first time on Zoom. Nine students from universities across NSW presented their thesis projects in front of an expert panel. Our students performed remarkably well, with Bernadette Pudadera, Coco Kennedy and Aurpa Bhuiyan awarded 1st, 2nd and 3rd place, respectively!

Our very active student societies continued their tireless work in engaging with both new and existing students and our industry partners. Highlights of their face-to-face and online events are given in this report, including MATSOC's BBQ Welcome (F2F), Peer Support Trivia, Games Night, Movie Nights, and League of legends tournament (all online), and PGSOC's BBQ Welcome (Term 3), Friday Socials (F2F & online), Industrial Site Visits (F2F), Peer Mentoring Afternoon Tea (online) and Christmas celebration (F2F).

The School is grateful to everyone involved for the massive effort in making these events an outstanding success and keeping our students engaged.

## MOVING ON

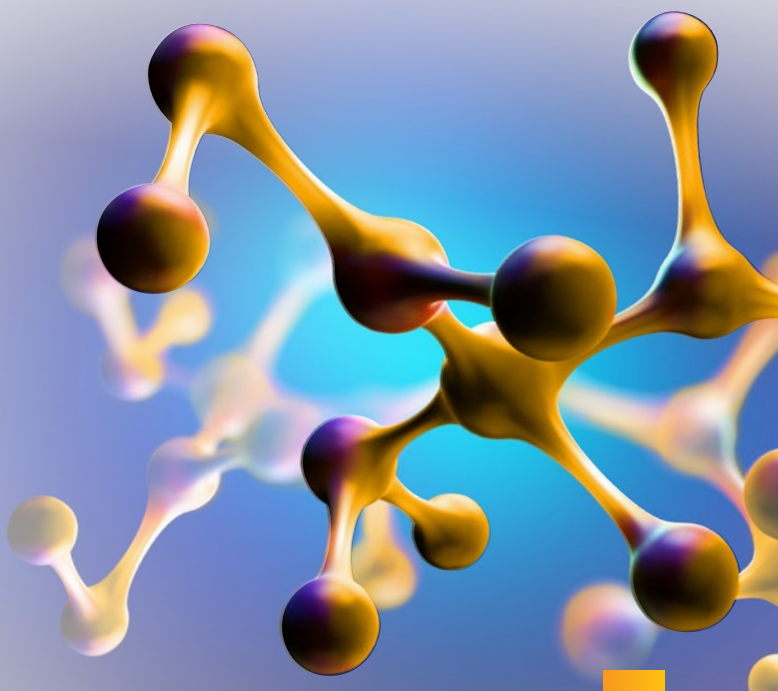
COVID19 created a major financial headache for the University that resulted in a round of workplace change and the unfortunate loss of valuable School staff. We farewelled our IT support specialist, Danny Kim, our pyrometallurgy Technical Officer, Rahmat Kartono, our Project Officer, Vanessa Jaraenroogvised, and two academic staff, Claudio Cazorla and Sammy Chan. Mark Hoffman also left the University in February to take up the position of Deputy Vice-Chancellor Academic at the University of Newcastle. As Head of School from 2008 to 2013, Mark played a key role in persuading the University to invest in a new building to accommodate the School's rapidly expanding research.

In summary, despite the ongoing pandemic, the School is in a strong position and is delivering excellent outcomes on all fronts.

I close by thanking Nicole Cooney and various other staff and students for producing this annual report. I hope you enjoy reading about our various achievements in 2020.

**PROFESSOR MICHAEL FERRY**

**HEAD OF SCHOOL**



MASTERS BY COURSEWORK

60

HIGHER DEGREES STUDENTS

151

ACADEMIC STAFF

61

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UNDERGRADUATES

# 240

ARC LAUREATE FELLOW

# 1

FUTURE FELLOWS

# 4

RESEARCH FUNDING

# $6,441,174

PROFESSIONAL AND TECHNICAL STAFF

# 24

STRATEGIC UNSW INCOME 2020

# $1,483,944

RESEARCH STAFF

# 98

# ACADEMIC STAFF

## 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 design, fabrication and printing of metal oxides and suflides based nanoionic materials for nanoelectronics (including sensors, memories and transistors), as well as energy storage and conversion materials (including supercapacitor electrodes, solid-state electrolytes, and electro-catalysts). His group targets to develop solution processed, printable and flexible nanoionic materials for cost-effective and energy-efficient wearable electronics.

## Associate Director of EMU **Associate Professor Shery Chang**

Shery Chang joined UNSW in 2020 as an Associate Professor and Associate Director of the Electron Microscope Unit, Mark Wainwright Analytical Centre. Her research uses state-of-the-art transmission electron microscopy and spectroscopy to study structure-property relationships in a range of advanced functional materials, including nano-photonics materials, wide bandgap materials and nano catalysts. In addition, she is developing new strategies to enable an understanding of material properties over multiple length and energy scales, including machine learning of big data sets, as well as correlative, multi-modal strategies.

## Professor **Alan Crosky**

Alan's research focuses on the effect of structure (both micro and macro) on mechanical behaviour. 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.

## 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.

## 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.

## 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.

## 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.

## ARC Future Fellow & Scientia Fellow **Associate Professor 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 Rakesh Joshi**

Dr Rakesh Joshi FRSC AFIChemE is a Senior Lecturer at the School of Materials Science and Engineering and leading a Graphene Research Group. He is the Fellow of the Royal Society of Chemistry (FRSC), A/Fellow of the Institution of Chemical Engineers (AFIChemE) and among a select group of researchers who have been awarded each of the world's most prestigious relevant International Research Fellowships; the JSPS Invitation Fellowship; the Humboldt Fellowship and the Marie Curie International Fellowship. He is currently leading various industry funded research projects on application. His research interest includes experiment design for application of graphene and 2D materials, membranes, separation and purification, diffusion mechanism.

## 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 conductive polymers as active materials in flexible organic bioelectronic devices. She leads a multidisciplinary research team that brings expertise in chemistry, physics and material science aimed at developing chemical strategies and electronic circuitry towards the realisation of flexible bioelectronics with advanced functionalities.

## NHMRC Early Career Fellow **Scientia Senior Lecturer Tushar Kumeria**

Tushar is a Scientia Senior Lecturer and an Australian National Health and Medical Research Council (NHMRC) Early Career Fellow with the School. He has co-authored over 84 journal publications in top-tier journals in the field of nanomaterials, biomaterials, drug delivery, and sensing. Tushar has been successful in securing over $3.6 million in competitive research grants including an NHMRC fellowship, 2 ARC Discovery projects, a US. Dept of Defence grant, and several others. Tushar's group focuses on: 1. Porous materials-based drug delivery systems for efficient and targeted delivery. 2. Porous materials/Polymer composite scaffolds and implants for tissue engineering. 3. Porous photonic crystals-based point-of-care sensors for diagnostics and environmental applications.

# 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.

## Lecturer **Benjamin Pace**

Dr Ben Pace joins us as an Education Focused Lecturer, with a teaching focus primarily in foundational materials science and sustainable materials. He also maintains a number of research interests spanning the range of thin film deposition technologies, particularly for highly tailored mechanical, biomedical and electrical/energy applications such as photovoltaics. More broadly, Ben maintains a strong interest and publishes in the: 1. Characterisation of coating morphology and behaviours, and; 2. Exploration of micro and nanoscale interactions that occur at interfaces between organic and metallic or mineral phases in composite products, biochars, soils and plant matter.

## ARC DECRA Fellow & Scientia Fellow **Associate Professor Sophie Primig**

Sophie's current research contributions are in processing-structure-property relationships of structural metallic materials for high-performance applications such as aerospace. Currently, these materials include Ni-based superalloys and advanced steels processed by industrial forging or metal 3D printing. She combines state-of-the-art microscopy techniques with mechanical testing and contemporary modelling approaches. Her research philosophy is to achieve a balance between fundamental discovery and industrial application.

## **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.

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

As a leading expert in the field of recycling science, and founding Director of the Centre for Sustainable Materials Research & Technology at UNSW, Professor Veena Sahajwalla is producing a new generation of green materials, products and resources made entirely, or primarily, from waste. Veena also heads the ARC Industrial Transformation Research Hub for 'green manufacturing' – a leading national research centre that works in collaboration with industry to ensure new science is translated into real world environmental and economic benefits. Veena has been extensively recognised for the innovation and significance of her work, including via election to be a Fellow of the esteemed Australian Academy of Science.

## **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's research has been the processing of ceramics, including fabrication, forming, and densification of bulk materials, thick films, and thin films. While his overarching approach is the use of phase equilibria to inform his strategies, his emphasis on publications is the elucidation of phenomenological mechanisms underpinning the data. His current research is focussed on chemocatalytic, biocatalytic, and photocatalytic nanomaterials for energy, environmental, and biomedical applications.

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

Owen's research is in the processing/microstructure/ property relationship ofadvanced 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. Nagy is also our postgraduate coordinator.

## Professor Tom Wu

Tom's research focuses on the vapour- 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 Danyang Wang

Danyang's most significant contribution is in the field of growth and characterization of functional oxide thin films and heterostructures for nanoelectronic and energy applications. Areas of research include thin film technology, functional materials and devices, micro/ nanofabrication techniques, heterointerface effects.

## 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 behaviour 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.

## 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 COMMITEES

## School Advisory Committee

Michael Ferry *(Chair)*
Bill Joe
Farshid Pahlevani
Lucy Zhang
Owen Standard
Sophie Primig

## Research Committee

Jan Seidel *(Chair, Director of Research)*
Michael Ferry *(Head of School)*
Dewei Chu *(Electronics & Communications)*
Sophie Primig *(Transport & Infrastructure)*
Rakesh Joshi *(Energy & Environment)*
Kris Kilian *(Biomedical & Health)*
Sean Li *(MMFI Director)*
Veena Sahajwalla *(SMaRT Director)*

## Learning & Teaching Committee

Owen Standard *(Chair)*
Caitlin Healy
Michael Ferry
Judy Hart
Nagarajan Valanoor
Runyu Yang
Sammy Lap Ip Chan

## WHS Committee

Jianqiang Zhang *(Chair)*
Anthony Zhang *(MSE HSE Coordinator)*
Michael Ferry
Rakesh Joshi
Rahmat Kartono
David Miskovic
Florence Lui *(Postgrad Student Rep.)*
Theresa McDonnell *(Kahwati) (Science WHS BP)*
John MacLeod *(UNSW Sydney, in attendance)*

## Equity, Diversity & Inclusion Committee

Damia Mawad *(Chair)*
Andrew Addie
Jeremy Platt
Lucy Zhang
Michael Ferry
Owen Standard
Paul Munroe
Vanessa Jaraenroogvised
Brenda Shi *(Postgraduate Student Rep.)*
Brenda Leung *(Undergraduate Student Rep.)*

## School Scholarship Committee

Michael Ferry (Chair)
Lucy Zhang
Owen Standard

## School Co-op Scholarship Representative

Owen Standard

## Postgraduate Research Coordinator

Nagarajan Valanoor

## 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

## Overseas Degree Programs/Asia Engagement

Danyang Wang

## Women in Materials

Judy Hart

## Faculty Enterprise Committee

Dewei Chu

# SCHOOL STAFF

## Research Staff

| | |
|---|---|
| *Postdoctoral Fellow* | Joseph Arsecularatne |
| *Postdoctoral Fellow* | Ghazahleh Behman Rokh |
| *Postdoctoral Fellow* | Nima Hanghdadi |
| *Postdoctoral Fellow* | Long Hu |
| *Postdoctoral Fellow* | Chandara Jayasundara |
| *Senior Research Fellow* | Pramod Koshy |
| *Postdoctoral Fellow* | Chun-Ho Lin |
| *Postdoctoral Fellow* | Sukriti Mantri |
| *Senior Research Associate* | Samane Maroufi |
| *Postdoctoral Fellow* | Tiziana Musso |
| *Senior Research Fellow* | Farshid Pahlevani |
| *Research Associate* | Bo Qu |
| *Senior Research Associate* | Daniel Sando |
| *Postdoctoral Fellow* | Peggy Schoenherr |
| *Research Associate* | Pankaj Sharma |
| *Research Fellow* | Sara Taherymoovi |
| *Postdoctoral Fellow* | Felix Theska |
| *Postdoctoral Fellow* | Lorenzo Travaglini |
| *Postdoctoral Fellow* | Tao Wan |
| *Postdoctoral Fellow* | Yun Xie |
| *Postdoctoral Fellow* | Xing Xing |
| *Research Fellow* | Martin Xu |
| *Senior Research Associate* | Jianliang Yang |
| *Postdoctoral Fellow* | Ji Zhang |
| *Postdoctoral Fellow* | Le Zhang |
| *Postdoctoral Fellow* | Qi (Peggy) Zhang |

## Technical Staff

| | |
|---|---|
| *Technical Officer* | Soo Woon Chong |
| *ITC Support Officer* | Jane Gao |
| *Technical Officer* | Anirban Ghose |
| *Technical Officer* | William (Bill) Joe |
| *Technical Officer* | Rahmat Kartono |
| *ITC Support Officer* | Danny Kim |
| *Technical Officer* | Hamid Lashgari |
| *Technical Officer* | Xi Lin |
| *Laboratory Manager* | Irshad Mansuri |
| *Technical Officer* | David Miskovic |
| *Senior Research Scientist* | Thiam Teck (TT) Tan |
| *Interim Technical Officer* | Xing Xing |
| *Technical Officer* | George Yang |
| *Safety Officer* | Anthony Zhang |
| *Technical Officer* | Qi (Peggy) Zhang |

## Administrative Staff

| | |
|---|---|
| *Administrative Officer* | Alan Chow |
| *Executive Assistant to Prof Sean Li* | Kim Foster |
| *Projects Officer/Executive Assistant to HoS* | Vanessa Jaraenroogvised |
| *Student Advisor* | Michael Lai |
| *Research & Administration Assistant, SMaRT* | Peggy Leung |
| *Community & Current Students Engagement Officer* | Jeremy Platt |
| *Research & Administration Assistant, SMaRT* | Nahid Sultana |
| *Research Support Officer* | Qing Xia |
| *School Manager* | Lucy Zhang |

## Industry Advisory Board

| | |
|---|---|
| Dr Adam Berkovich | *Rio Tinto Aluminium* |
| Prof. Lyndon Edwards | *ANSTO* |
| 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* |
| Prof. Emma Johnston | *UNSW* |
| Prof. Michael Ferry | *UNSW* |
| Dr Owen Standard | *UNSW* |
| Mrs Lucy Zhang | *UNSW* |
| Dr Jason Hodges | *BlueScope Research* |
| Dr George Melhem | *Perfect Engineering* |
| Ms Holstein Wong | *Emescent* |
| Mr Andrew Petersen | *Sustainable Business Australia* |
| Mr Sean Windred | *BG&E* |

# 2020 FINANCIAL PERFORMANCE

**LUCY ZHANG – SCHOOL MANAGER**

## FINANCIAL REPORT 2020

For the 2020 financial year, budget was calculated based on estimated 2019 costs plus incremental increases for the full year impact of hires made in 2019, 0.944% EBA increases to salaries, successful promotions during 2019 and any approved new roles commencing in 2020.

The 2020 budget also includes an efficiency saving of 2.3%.

Additional budget of $70k has been approved compared to 2019 to fund the Scientia support package and support for the Deputy Dean of Research. Due to the onset of Covid, the University had asked for a budget saving across the board, the School was impacted by over half a million.

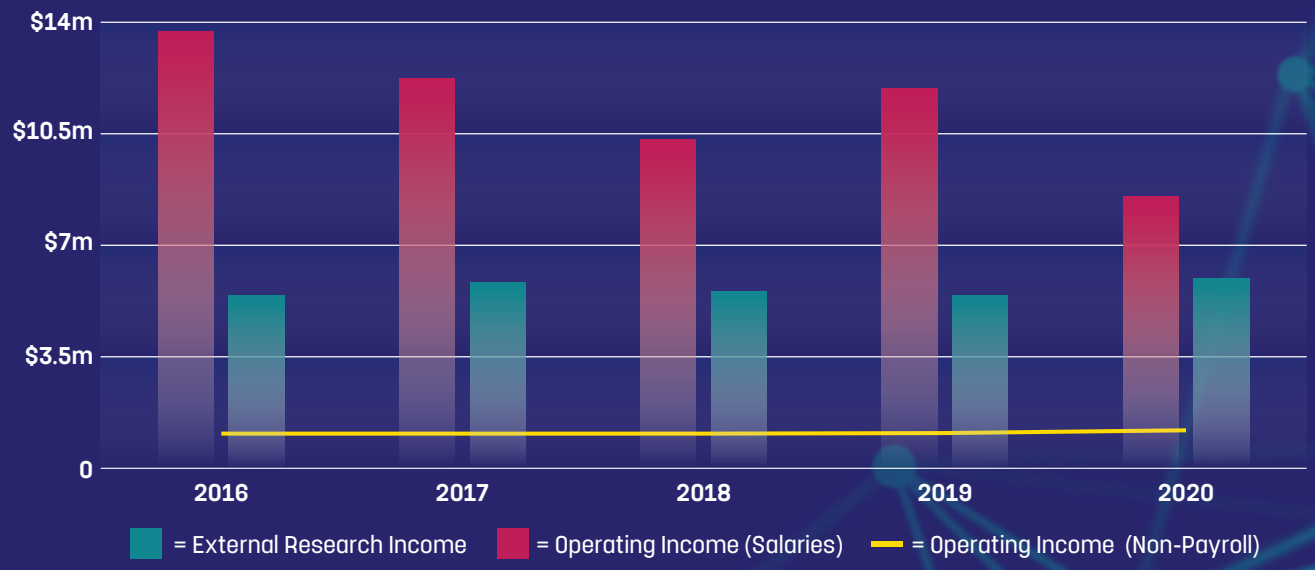
## INCOME

The School receives its income from three primary sources:

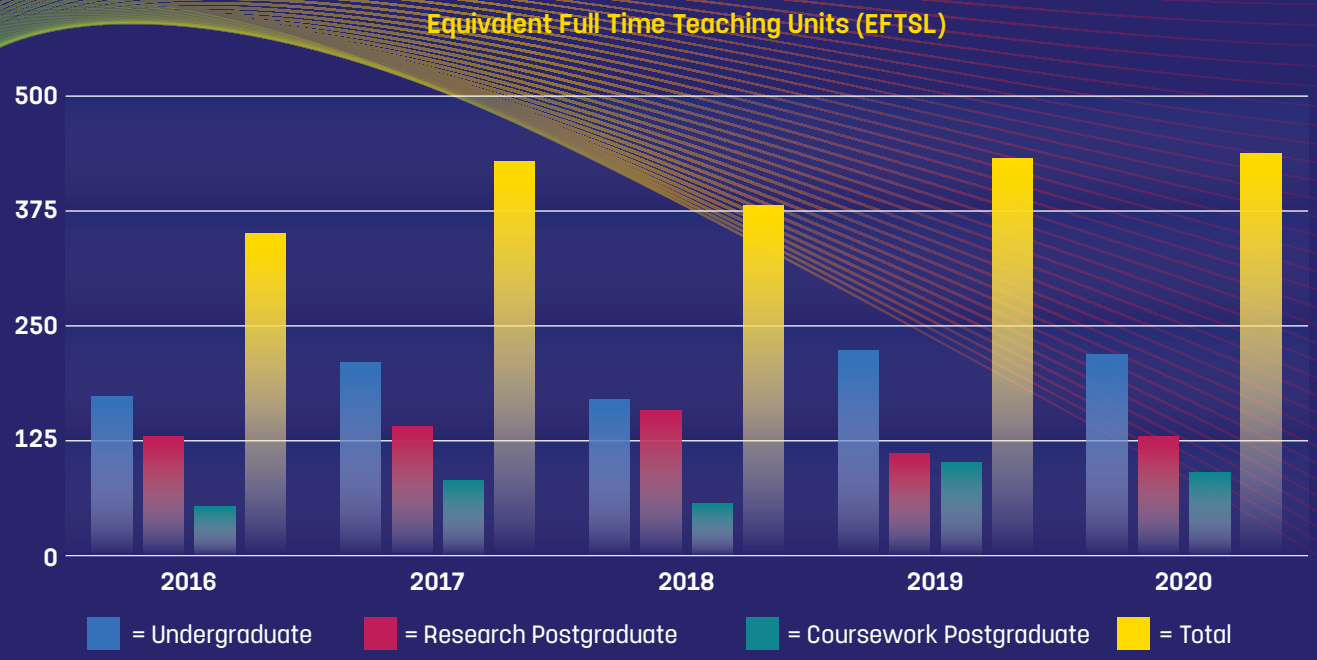
*Operating income* is allocations from the University, via the Faculty, to fund the day to day running of the School. For the 2020 financial year, budget allocations have been made using our current budget allocation principles. It is still based on enrolment plan student load from local and international undergraduates, postgraduate course work and higher degree research students.

*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. Our non payroll income remains very flat over the years.

**INCOME**




*2020 OP budget has included Ring-fenced SHaRP and Scientia $82,103, minus efficiency saving of $162,134, made 10% increase compare with 2019*




## OPERATING INCOME

Operating income budgets have been 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. Even though a number of the School's academic staff hold externally-funded research fellowships, there is invariably a shortfall in these fellowships which the School covers from its operating budget allocation, deriving a specific, though capped, allocation from the University for this purpose. Transitional fellow fund has been introduced to expect School to cover the gap over a three-year period.

This budget is also used to pay for casual teaching staff. 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 provide start-up funds for newly started staff. We have Dr Tushar Kumeria joined us in BioMaterials and Dr Ben Pace joined us as teaching focussed academic.

The table right shows the breakdown of School operating income. Due to Covid budget cut, we did not receive capex as allocation. Capital expenses are through individual's own allocations and school initiatives of small amount funds to support critical first year teaching labs.

| **INCOME** | | |
|---|---|---|
| University: | | |
| Teaching | $14,268,264 | |
| Other | $98,540 | $14,366,804 |
| Allocation to School: | | |
| Operating Costs | $7,049,301 | |
| Ring-fenced Scientia | $82,103 | |
| Efficiency saving | -$162,134 | |
| Confederated ShaRP | $657,503 | |
| | | $7,626,773 |
| **EXPENDITURE** | | |
| Salaries | $5,899,695 | |
| Non-salary | $505,410 | |
| Capital expenses | $75,245 | $6,480,350 |
| Variance | | $15,513,227 |

The primary driver for operating income at the School level is undergraduate and postgraduate teaching load. The graph at the top of this page shows the strong growth which the School has succeeded in recent years especially the number of Coursework Postgraduate and Research Postgraduate students. We have made good income contribution to the University.

# 2020 FINANCIAL PERFORMANCE

## 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.

Some of our staff are key players in the UNSW Future Institute in Materials and Manufacturing. As projects are approved, they are enabled financially through strategic allocation.

In 2020, these included:

| Project Name | Project Manager | Amount ($) |
|---|---|---|
| SHARP hire | Tom Wu | 426,051 |
| SHARP: Lance Li | Sean Li | 40,000 |
| Scientia Fellow Support | Tushar Kumeria | 50,000 |
| MM Future Institute Special Fund | Danyang Wang | 10,000 |
| MM Future Institute Special Fund | Jack, Jianliang Yang | 10,000 |
| Fellow Transitional Fund | Dewei Chu | 95,081 |
| Fellow Transitional Fund | Claudio Cazorla | 101,169 |
| Strategic Research Support | Sean Li | 391,854 |
| Strategic Award Stephen Joseph | Paul Munroe | 57,017 |
| Strategic post Laureate | Veena Sahajwalla | 160,497 |
| Intelligent E-Waste | Veena Sahajwalla | 29,375 |
| SPF04 Materials | Various | 112,900 |
| **Total:** | | **1,483,944** |

## RESEARCH INFRASTRUCTURE SCHEME

The University receives a Research Infrastructure Block Grant. Through competitive internal grant process, UNSW is able to provide a world-class research environment to attract and retain a critical mass of research excellence.

In 2020, the School was awarded the following major items:

| Lead Chief Investigator | Project Title | Grant ($) |
|---|---|---|
| John Daniels | ResTech Support Scheme | 15,000 |
| Rakesh Joshi | AEkiA for Surface Analysis | 90,000 |
| Jan Seidel | Scanning Thermal Microscope | 70,000 |

## 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 University.

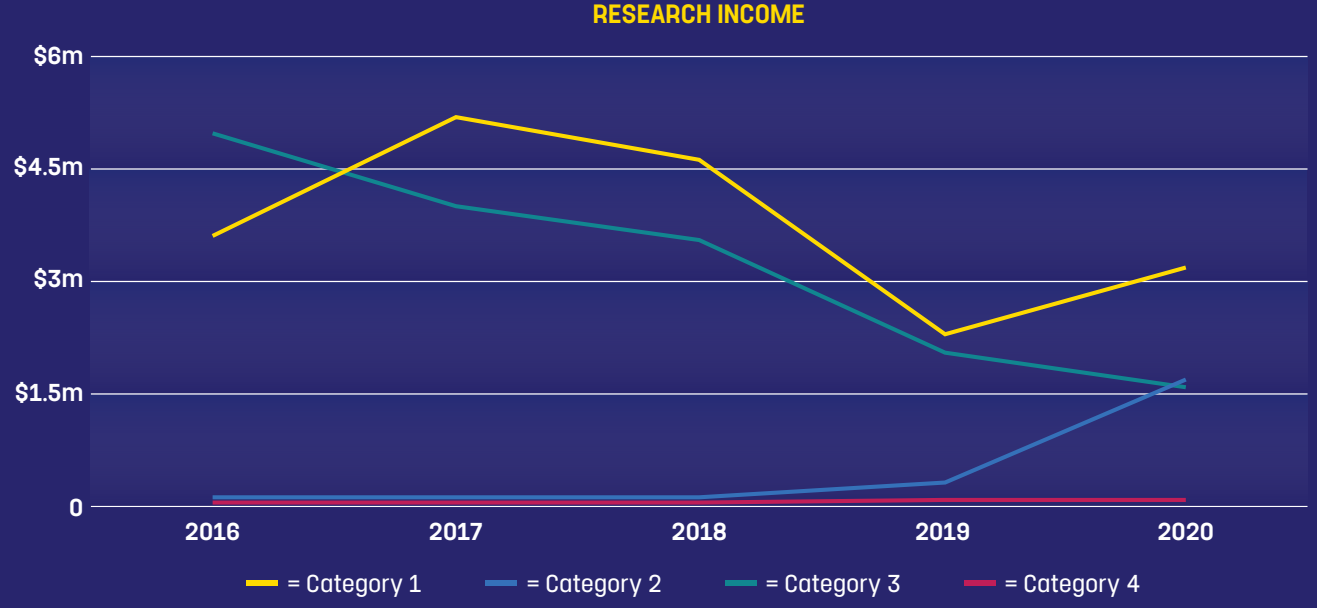
The table right shows the School's main expenditure items in 2020 after meeting the Covid saving target.

| Item | Amount ($) |
|---|---|
| Student Research Allocations | 50,000 |
| Undergraduate scholarships | 40,000 |
| Publications allocation | 60,000 |
| Teaching laboratories | 84,963 |
| Computer lab upgrade | 49,092 |
| Safety | 10,000 |
| School Office | 25,000 |
| Staff Start Up | 90,000 |
| Marketing | 25,000 |
| Repair, Maintenance & building utilities | 15,000 |
| Undergraduates association support | 5,000 |
| Postgraduates association support | 5,000 |

## RESEARCH INCOME

The School's research income comprises the largest fraction of the overall income of the School. Though our overall experienced slight drop possible due to the stalling geopolitical climate.

We had a successful outcome winning six new ARC Discovery Grants.



# 2020 UNDERGRADUATE STUDIES

## 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, Functional Materials, 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, and so on.

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.

## 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. There was a significant decrease in the first year intake in 2019 (this was attributed, in part, to the new trimester structure) but this showed recovery in 2020. Despite this, the School continues to have the largest undergraduate program in the discipline nationwide by a considerable margin and the total number of undergraduate students enrolled remains stable as shown in Figure 1. Similar to previous years, the quality of the new local students was high as indicated by ATAR entry scores of >87 for the School's undergraduate programs with approximately 30% being female.

*TABLE 1:* **FIRST YEAR INTAKE** (2016-2020).

| Program | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| 3131 BE(Materials Sci. & Eng.) | 94 | 98 | 95 | 35 | 52 |
| 3132 BE(Materials Sci. & Eng.)/BEngSci. | 5 | 2 | 6 | 1 | 6 |
| 3133 BE(Materials Sci. & Eng.)/MBiomedE | 19 | 20 | 33 | 19 | 11 |
| 3136 BE(Materials Sci. & Eng.)/BCom | 3 | 6 | 1 | 0 | 0 |
| Total: | 121 | 126 | 135 | 55 | 69 |

## GRADUATING CLASS

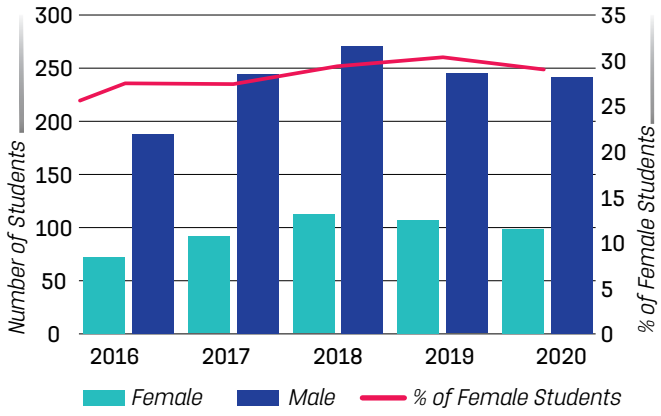
The BE degree is awarded at Honours First Class (H1); Second Class Division 1 (H2/1), Second Class Division 2 (H2/2), or Pass classifications as determined by a weighted average mark calculated based on the year of study and the relative weighting of each course in the curriculum for that year. In addition, an exceptionally high level of attainment for H1 may be recognised by the awarding of the University medal. A summary of the graduating class is given in Table 2.

### *TABLE 2:* 2020 GRADUATING CLASS

*Note that in 2016 the following program code changes occurred:*
*3135-3136-3137-3138 changed to 3131-3134-3132-3133 respectively, hence had some students graduating from both sets in 2020.*

| Program | H1 + Medal | H1 | H2/1 | H2/2 | Pass | Total |
|---|---|---|---|---|---|---|
| 3131 BE(Materials Sci & Eng) | 1 | 4 | 4 | 11 | 2 | 22 |
| 3132 BE(Materials Sci & Eng)/BEngSc | - | 1 | 2 | - | - | 3 |
| 3133 BE(Materials Sci & Eng)/MBiomedE | 1 | 1 | 1 | 2 | - | 5 |
| 3136 BE(Materials Sci & Eng)/BCom | - | 1 | 1 | - | - | 2 |
| 3135 BE(Materials Sci & Eng) | - | 1 | - | - | 1 | 2 |
| 3137 BE(Materials Sci & Eng)/BE(ChemEng) | - | - | - | - | - | 0 |
| 3138 BE(Materials Sci & Eng)/MBiomedE | - | 3 | - | - | 1 | 4 |
| 3972 BAdvSci(Materials Sci) | – | 3 | – | – | – | 3 |
| 3970 BSc (Materials Sci) | - | - | - | - | 8 | 8 |
| **Total:** | **2** | **14** | **8** | **13** | **4** | **49** |

### *FIGURE 1:* TOTAL ENROLMENT NUMBERS IN THE SCHOOL'S UNDERGRADUATE BE PROGRAMS (2016-2020).




## COVID19 PANDEMIC AND THE SHIFT TO ONLINE TEACHING AND LEARNING

The COVID19 pandemic impacted significantly on all School and University activities from early 2020.

For undergraduate (and postgraduate coursework) courses in particular, it necessitated all face-to-face teaching to stop abruptly midway through Term 1 (March 2020) and be replaced by fully online delivery.

This was a sudden and dramatic change to way in which the School (and the University as a whole) teaches coursework and was a significant challenge to all staff involved – the School commends the efforts and professionalism of all staff in successfully dealing with the transition to online learning.

# 2020 UNDERGRADUATE STUDIES

## COVID19 PANDEMIC AND THE SHIFT TO ONLINE TEACHING AND LEARNING (CONTINUED)

Despite the challenges and difficulties, the School adapted well with academics adopting a range of strategies and methods to adapt their courses to online delivery including:

- exploration of various online lecture delivery platforms
- exploration of various online recording techniques
- shifting some lecture content to asynchronous delivery, using either video lectures or online tutorials
- recording or live streaming of practical demonstrations and laboratory classes
- enabling effective student online presentations
- use of online exams delivered via Moodle
- use of alternative examination assessment methods such as oral exams

Teaching workshops were hosted by the School (typically once per term) to provide training to academics in online teaching methods and practices, to learn new methods and trends for course delivery and assessment, to receive current Faculty/University advice and directives, and opportunity to share practices and experiences.

The School received funding from the Faculty of Science to purchase a suite of computer equipment to support online teaching and this included high-quality web cameras, high-quality microphones, and document cameras. The Faculty of Science established two dedicated online teaching studios for academics to produce synchronous and asynchronous lecture and class content as well as mobile "hybrid delivery" production kits specifically for the purposes of delivering synchronous content simultaneously in face-to-face and online modes. These facilities and resources are supported by the Science Education Team (SET) which has been established to provide innovative, data-driven and student-focused solutions to meet the wide variety of educational needs across all Science disciplines. Online delivery of courses continued in Terms 2 and 3 of 2020 with only limited face-to-face teaching (mainly laboratory classes) resuming in Term 3. Although the COVID19 pandemic was a major challenge to the School's teaching, the accelerated learning and implementation of online methods of teaching and assessment in 2020 has established a strong platform for ongoing development of online delivery of the School's teaching programs.

## BE PROGRAM REVISION

As part of the School's newly-developed strategic vision based on societal themes of transport and infrastructure, energy and environment, biomedical and health, and electronics and communications, a revision of the School's undergraduate BE program commenced in 2020. The following proposed changes to the program and its teaching delivery were developed by the School's Learning and Teaching Committee:

1) Revise the School's BE(Materials Science and Engineering) program to remove the current (outdated) academic streams of materials engineering physical metallurgy, process metallurgy, functional materials, and ceramic engineering and to replace them by developing an integrated theme driven program based on the 4 themes.
2) Introduce a new suite of Professional Electives based on the 4 societal themes.
3) Incorporate explicit materials selection and design in each Professional Elective.
4) Review and revise the content and arrangement of core courses in Years 2 and 3 of the program (especially to address any overlap or deficiencies).
5) Explicit integration of computational methods in selected courses throughout all years of the BE program.
6) Design of courses/program to optimise online, face-to-face, and blended modes of course delivery and assessment.

Presentation of the need and guiding principle of the proposed program revision were presented to the School Industry Advisory Board at its annual meeting in 2019 and the Board gave unanimous support for it. Progress to the program revision for was made in 2020 with the view to submitting it to the University's academic approval process by March 2021 and to seek EA accreditation


approval. However, owing to significant disruption to School operations caused by the COVID19 pandemic, this deadline was not able to be met and instead the School considered it prudent to not rush and instead to continue to properly develop the revised courses/program in 2021 for submission to the 2022 approval process (for implementation in the 2023 academic year).

### DEVELOPMENT OF NEW BE(HONS)/BDATASCI PROGRAM

A significant initiative developed in the 2019 School Strategic Planning day and endorsed by the School Advisory Board in its 2020 annual meeting was to introduce a new BEHons(MatSciEng)/BDataScience combined program based on the core content of the existing BE(Materials Science and Engineering) and BDataSci single-degree programs. This combined program was developed in 2020 and entered into the University academic approval process with approval anticipated in 2021.

**DR OWEN STANDARD**

Undergraduate Program Coordinator

## OUR MSE STUDENT REACHES THE TOP 100 FUTURE LEADERS LIST!

**Angela Abraham** is currently at 5th year Materials Science and Biomedical engineering student at UNSW.

Her award was within the Broad-spectrum Innovation Category, where she was prestige to be selected with 11 other students from across Australia.

The Top 100 Awards is a yearly process by both the AFR and GradAustralia to select the Top 100 Graduates in a variety of categories across Australia.

The Top 100 Future Leaders awards, jointly hosted by GradConnection and The Australian Financial Review, aim to connect emerging talent from Australia's graduate pool with leading employers.

Students took part in a highly competitive process, including psychometric testing, video interviews, a three-minute presentation, and participation in an assessment event with top employers.

"Our graduates enter the workforce with an advantage as they have the real-world skills and experiences that employers value. It's wonderful to see so many of our top students recognised last night – congratulations".

**Professor Merlin Crossley**
(Deputy Vice-Chancellor, Academic).

Congratulations to Angela Abraham on her outstanding achievements as a student of Materials Science and Engineering at UNSW.

# 2020 CO-OP SCHOLARSHIP PROGRAM

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.

Co-op scholarships in Materials Science and Engineering were introduced in 1989 and since then there have been a total of 130 scholarships from 30 different industrial sponsors.

Co-op scholars are selected on the basis of their academic ability (successful students have ATARs typically 99+) as well as 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 2020, a total of 3 scholarships (Table 1) were provided by three industrial sponsors – Rio Tinto, Weir Minerals, and Bluescope Steel.

The companies have been involved in the Co-op program for many years and their contribution to it and their role in the development of the Co-op scholars they have supported is highly valued.

The Co-op scholar who commenced in 2015 was employed by one of the sponsors upon completing his degree at the end of 2019 and on graduation in 2020 was also awarded the University medal in recognition of his outstanding academic achievement in the BE program – this is testament to the quality and purpose of the Co-op program, namely, to develop of high-quality graduates with high potential for leadership in industry.

*TABLE 1*: **STATISTICS OF CO-OP PROGRAM IN MATERIALS SCIENCE AND ENGINEERING – (2016 TO 2020).**

| Intake Year | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|
| Number of Scholars | | | | | | |
| Ceramic Eng. | – | – | – | – | – | 0 |
| Materials Eng. | – | – | 2 | – | 1 | 3 |
| Physical Met. | – | – | – | – | – | 0 |
| Process Met. | – | – | – | – | – | 0 |

Co-op Scholars complete at least 68 weeks of structured and highly relevant industrial training with the sponsor companies which, from 2019, consists of 4 weeks at the end of year 1 (optional), 20 weeks during Term 3 of Year 2, and two 24 week placements in Year 3. Students are paid a scholarship stipend 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.

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.

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.

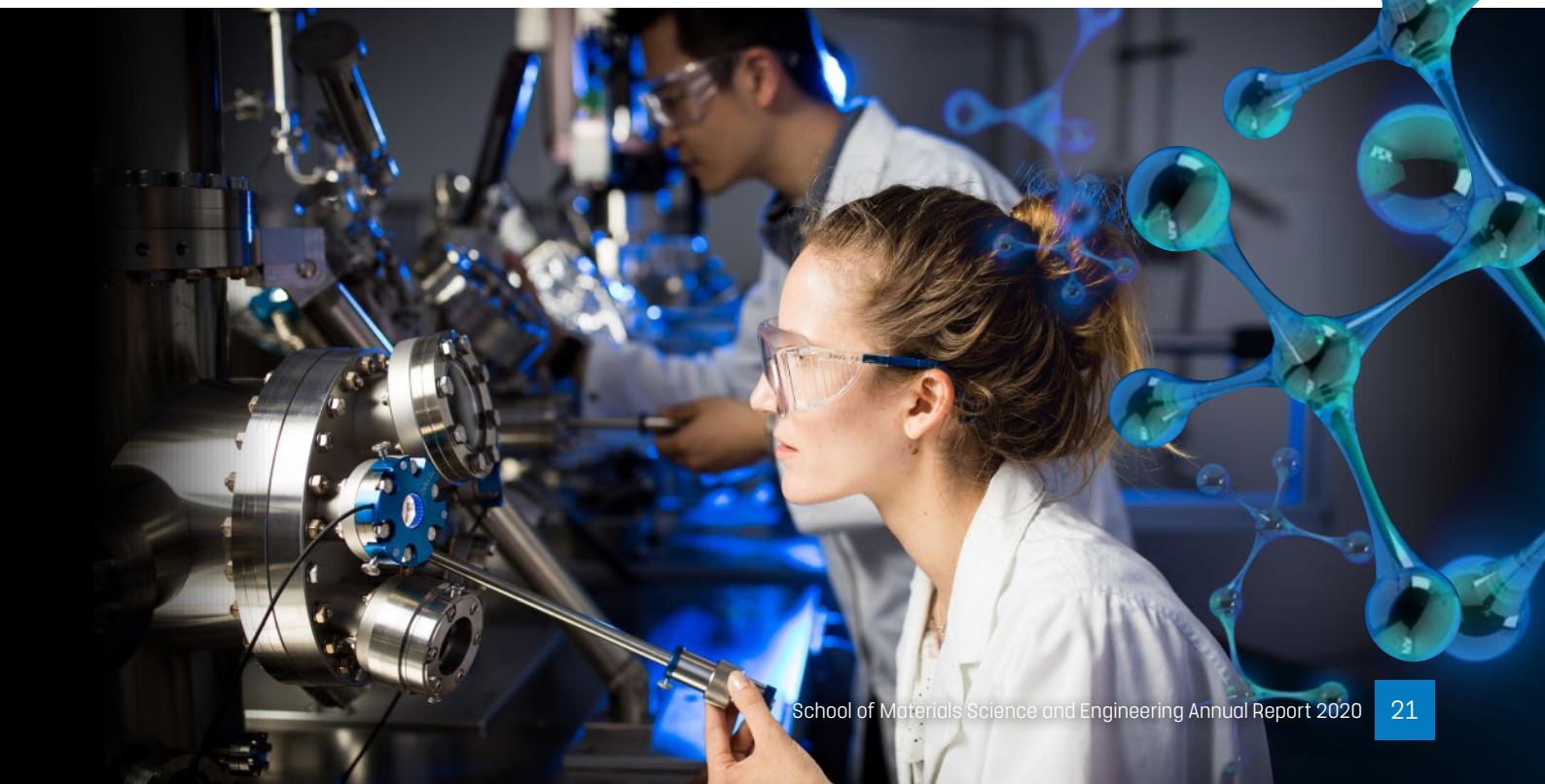
The School takes this opportunity to again thanks its Co-op sponsors for the efforts they put into organising the placements as well as their training, guidance, and support of scholars during the placements, and for their continued generous support of the Co-op Program.

**OWEN STANDARD**

Academic Coordinator

Co-op Program in Materials Science and Engineering

www.coop.unsw.edu.au



# RESEARCH THEMES UPDATE 2020

## RESEARCH THEMES, STRUCTURE & GROUPS OVERVIEW

The field of materials science and engineering offers unlimited possibilities for innovation and development. Australia is a country rich in minerals and materials science is a priority area for research and development.

Advanced materials and improvements in sustainability can give manufacturing companies, in virtually any industry, the edge over their competitors.

Beyond our basic scientific curiosity and the thrill of discovery, we consciously design materials and sustainable processes that impart a substantial benefit to society through the way they positively impact the environment, improve human health, increase our standard of living, increase productivity of our vital resources, enhance national security, or by simply promoting economic prosperity. Taking this fact into account, we have restructured our research to create four new interconnected society centred research themes (right).

Underpinning this new thematic structure is our enabling platform, which is the necessary suite of skills and expertise that materials scientists and engineers need to possess to be able to create the materials of use to society. It consists of a deep understanding of fundamental phenomena, multi-scale computational methods, correlative structural analysis techniques, and the behaviour and properties of materials. The cornerstone of the platform is advanced manufacturing, which is the critical path for creating all those wonderful materials of significant benefit to a contemporary society.

Our four Theme Leaders are responsible for coordinating the various research groups within their theme and encouraging communication and collaboration between groups through to cross disciplinary collaboration between Themes and other Schools, and Research Centres, Hubs and Institutes both within UNSW and externally.

The close relationship between our four interconnected research themes and our enabling platform is illustrated in the diagram Figure 1 (opposite page).

**TRANSPORT & INFRASTRUCTURE:**
**THEME LEADER – SOPHIE PRIMIG**

Primarily structural materials used expressly for creating the means of transportation, to large-scale structures and infrastructure that dominate our daily lives, including land, sea and aerospace vehicles to buildings, superstructures, machines and any other fixed or moving infrastructure.

**ENERGY & ENVIRONMENT:**
**THEME LEADER – RAKESH JOSHI**

Materials that play a critical role in the production, storage and conversion of energy, through to eco-materials, created by sustainable processes using either raw constituents or recycled waste, that impart an overall positive impact on the environment. These are integral materials in next generation fuel cells, solar devices, gas-powered generators, electric vehicles, water purification systems, recycled products.

**ELECTRONICS & COMMUNICATIONS:**
**THEME LEADER – DEWEI CHU**

Primarily functional materials with structural requirements used in electrical, electronics and microelectronics applications, including components and devices that comprise integrated circuits, circuit boards and visual displays, to cables, wires and optical fibres for transferring power and information.

**BIOMEDICAL & HEALTH:**
**THEME LEADER – KRISTOPHER KILIAN**

Structural materials exhibiting specific functionality to largely functional materials that are designed to interact with biological systems for therapeutic and diagnostic medical purposes. These materials are used in dental devices, orthopaedic implants, artificial organs, implantable devices, artificial skin, drug delivery.

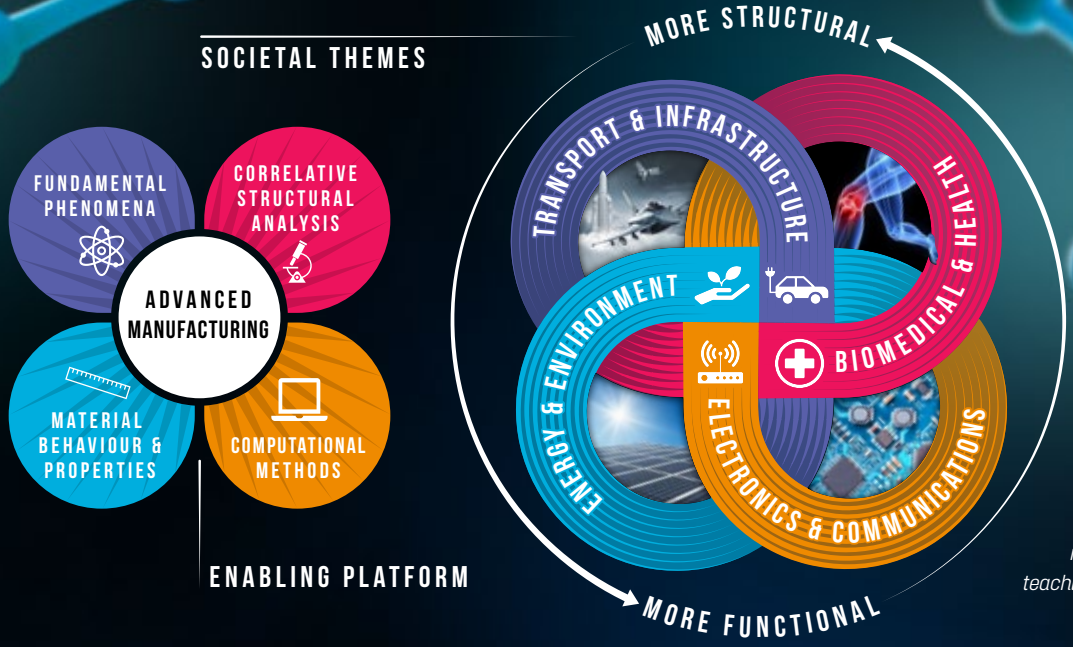



*Figure 1: The School's new structure for teaching and research.*

## TRANSPORT AND INFRASTRUCTURE THEME UPDATE

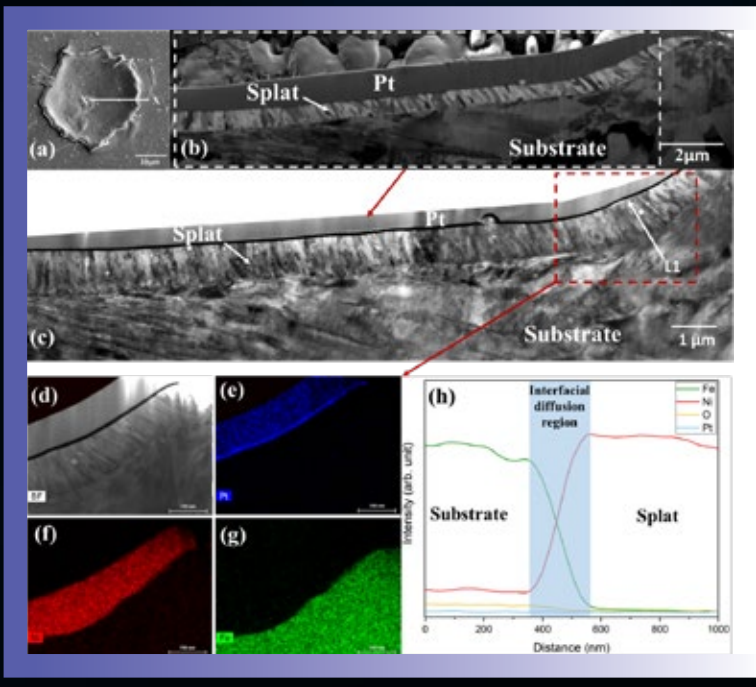
Future engineering innovations in transport and infrastructure fundamentally depend on the design and discovery of next generation of structural materials enabling better performance under more challenging conditions. Next generation structural materials often need to combine a number of outstanding properties including superior strength, ductility, and corrosion resistance, often at higher temperatures, while also being lighter, safer, more cost efficient, and more recyclable than currently available materials. All of these properties can be unlocked by advancements in materials synthesis and manufacturing, and this is further closely tied to the detailed evolution of the microstructure during manufacturing and service. Examples of applications for next generation structural materials are in aerospace, automotive, biomedical, construction, defence, energy, and tooling.

The academics within this theme are leaders in processing-structure-property relationships of next generation structural materials. They possess complementary skills in areas including design of complex alloys, advanced thermo-mechanical routes, 3D printing, microstructure design of alloys and coatings, multiscale materials characterization, advanced mechanical and corrosion testing, and computational tools.

This theme group was launched in 2020 and is led by AProf Sophie Primig. Early day initiatives focused on a major refurbishment of the School's website, planning activities to streamline Higher Degree Research presentations, expansion of thermo-kinetic and other relevant modelling software packages, purchase of thermal treatment facilities, and coordination with the other theme leaders within the School.

The handpicked 2020 research example below by Prof Paul Munroe's team showcases coatings for corrosion/oxidation resistance of aerospace components made by high velocity oxy-fuel thermal spray processing. Understanding the microstructural interactions between the sprayed (nickel) particles and the spray (stainless steel) substrate are critical for predicting the performance and behaviour of the coating during service.

- **AProf Sophie Primig** — Engineering Microstructures (Theme Group Leader)
- **Prof Michael Ferry** — Frontier Alloys & Processes
- **Dr Kevin Laws** — Metal Physics & Advanced Alloy Research Team
- **Prof Paul Munroe** — Structure-Property Optimisation Group
- **Prof David Young** — High Temperature Materials Group
- **Prof Jianqiang Zhang** — Advanced Corrosion Resistant Materials




TEM image of a doughnut-shaped nickel splat formed on a stainless steel substrate: (a) Bright field TEM image (including plan view image of the splat showing the location of the TEM section), EDS elemental maps for (b) Ni, (c) Fe, and (d) elemental line-scan showing diffusion profile across the area of interest. [Abbas et al., Surface and Coating Technology, 394, (2020), 125909.]

# 2020 RESEARCH THEMES UPDATE

## BIOMEDICAL AND HEALTH THEME UPDATE

2020 was the year that we established our four research themes in the school. Late in the year the theme leaders met to discuss opportunities within each theme and across themes, with the intention to build a tightly connected environment for research and education. The Biomedical & Health theme was established to bring together the diverse biomedical and health-based research conducted in the school, in order to establish a centralised structure that would provide regular interactions among members, disseminate opportunities to the theme through emails, and connect materials science students and staff to biomedical colleagues across all faculties. The first step in organising the themes was to establish a website with theme-centric layout. The groups that are part of the Biomedical & Health theme are as follows:

- **Polymer Research in Therapeutics (PRinT) group** – led by Dr. Damia Mawad
- **Laboratory for Advanced Biomaterials & Matrix Engineering (LAB&ME)** – led by A/Prof. Kris Kilian
- **Novel Engineered Materials for Conventional and Advanced Technologies (NEMCAT) group** – led by Prof. Charles Sorrell
- **Laboratory for Advanced Porous Nano-Biomaterials** – led by Dr. Tushar Kumeria
- **Electron Imaging for Advanced materials (EIAM) group** – led by A/Prof. Shery Chang
- **Comupational Granular materials (CGM) group** – led by A/Prof. Runyu yang

To initiate theme activities, the group leaders met to discuss activities and priorities of the theme. There were three major action items that came from this early meeting: (1) develop a theme group email to disseminate items of interest (biomedical related seminars, funding opportunities, job postings, etc.); (2) develop a website for the theme (coming soon); and (3) organise a yearly symposium where group leaders present vision talks followed by an interactive poster session from students and staff within the theme (currently being organised for early 2022). This event will include group leaders and trainees from other biomedical schools across UNSW. In addition to these three action items, we also identified a pressing need to ensure that the School of Materials Science and engineering is involved with the new biomedical and health ventures on campus and in the new Randwick health precinct. We are now actively engaged with the planning for the health precinct.

Overall, 2020 was the year to establish the themes and begin formulating a vision for the future. The global pandemic presented and continues to present many challenges, that has delayed our research activities and some of our social plans within the theme. Nevertheless, we are actively working to establish remote activities within the theme to keep our people thinking and working together. We believe that fostering an open environment where materials scientists and engineers working on biomedical and health problems can interact with colleagues in medicine, biotechnology and related disciplines, is critical to maximise the depth and breadth of our research.

## ENERGY AND ENVIRONMENT THEME UPDATE

The Energy and Environment (EE) theme is ideally aligned with UNSW's 2025 vision. The research groups in the EE theme collaborate very actively via joint research student supervision, writing research projects together and co-author publications. Research group leaders of the EE theme are in constant exchange of ideas, engaging in formal and informal meetings to strengthen their research collaboration and maximising the vast potential of their combined expertise.

In the last year EE theme researchers have performed very well by developing highly innovative, internationally competitive research projects, by contributing ground-breaking publications in high impact journals and by pioneering projects of national benefit. EE theme research groups have been successful in securing multiple ARC Discovery and Linkage Projects.

Dr Judy Hart received one ARC Discovery Project and one Linkage Project and Prof. Dewei Chu received over $1.2 million as lead CI in one Discovery and two Linkage Projects. SMaRT Centre was successful in securing Sustainable Communities and Waste hub as part of the National Environmental Science Program. In addition, the SMaRT Centre is leading a $5 million ARC Industrial Transformation Research Hub on sustainable materials processing.

This theme has been highly productive in knowledge exchange programs by promoting industry-academia collaborative partnerships and has attracted a substantial amount of industry funding for commercializing research. Dr Joshi's team has been successful in securing over $850K in industry funding for scaling technologies. Chan' group received $500K in 2020 to work on hydrogen storage for onboard systems.

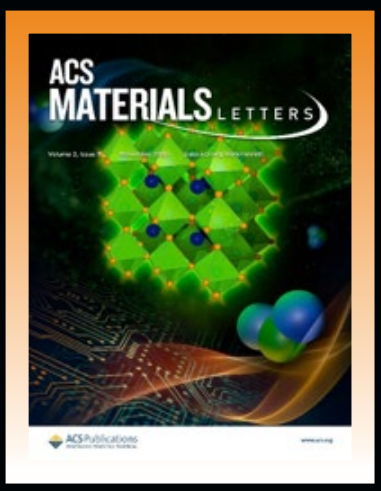
Some notable publications of EE theme are Hart's group- Advanced Energy Materials 10, 2001381(2020), Nano Energy 72,104732 (2020). Joshi's group- Advanced Materials 32, 1907580 (2020), ACS Nano 15, 9201 (2021). Wang's group- Advanced Functional Materials 30, 2004641 (2020), Nano Letters 20, 1262, (2020). SMaRT Centre- Advanced Functional Materials 31, 2170221 (2021), Green Chemistry 23, 5511-5523. Chu's Group- Chemical Engineering Journal 398, 125660, (2020), Journal of Materials Chemistry A 8 (27), 13437-13442, (2020).

## ELECTRONIC AND COMMUNICATION THEME UPDATE

Despite the pandemic, the EE research team performed extremely well in terms of competitive funding, research outputs, industry engagement as well as research collaboration. In 2020, the team have received the largest numbers of ARC funding in the school, including 4 Discovery projects, 3 LIEF grants, and 1 Linkage project. In particular, Prof. Seidel has secured 2 Discovery projects as lead CI in the field of next generation Skyrmion materials and multiferroics. The three-year grants will be used to (i) investigate fundamental properties of multiferroic skyrmion materials, i.e. their nanoscale structure, surface topology, dynamics and their interaction with external stimuli; and (ii) to deliver insight into synthesis and properties of new topotactic magnetic materials for high density data storage applications.

Electronic materials have attracted more and more attention because of their specific properties or functionalities which are attributable to the flow, control, manipulation and exploitation of electrons, and their interactions with atoms and molecules. Understanding these materials and integrating them into useful products require truly multidisciplinary approach, which is the expertise of EE research team. In 2020, through exciting innovations and developments in the area of electronic materials, the team have significantly advanced ground breaking technologies in this area and published more than 100 high impact papers in leading journals including Science, Advanced Materials, Nature Communications, Advanced Functional Materials, and Nano Letters, etc.

The team have built solid framework for internal and external collaboration through joint-supervision, publications, workshops, and grant applications. The Theme is organizing monthly online seminars to provide a platform for all academic staff and HDR students in the school to meet world leading researchers in electronic materials.




Cover of ACS Materials Letters: Prof. Tom Wu et al, ACS Materials Letters 2020, 2, 11, 1368-1374

# 2020 SMaRT CENTRE REPORT

SMaRT@UNSW
Sustainable Materials Research & Technology

The Centre for Sustainable Materials Research and Technology (SMaRT) at the University of New South Wales works with industry, national and international research partners, and governments across Australia, on the development of innovative environmental solutions for the world's biggest waste challenges, with a strong focus on end users, to help UNSW achieve its strategic goals of academic excellence, innovation and engagement, and creating social impact. The SMaRT Centre has a track record of delivering research and multiple technologies suitable for implementation, the latest being various MICROfactorie™ technologies for which extensive future research and development initiatives are planned. The core aims of the SMaRT Centre are to develop novel research for sustainable materials and manufacturing processes, build industry partnerships to activate research for real world, end user impact, and to disseminate and commercialise green materials and manufacturing technologies that benefit industries, local communities, and enhance sustainable economic growth while delivering important environmental and social benefits.

## ARC MICRORECYCLING HUB

The year started positively for SMaRT with the Federal Government and the Australian Research Council (ARC) awarding the UNSW SMaRT Centre its second ARC Research Hub, this time into Microrecycling of Battery and Consumer Wastes. Professor Veena Sahajwalla, founding Director of SMaRT, leads the new collaborative Hub as it aims to transform Australia's waste and resource recovery industry by developing advanced manufacturing capabilities that focus on small-scale processing of materials produced from battery and consumer wastes.

In collaboration with mining manufacturer Molycop and other industry and research partners, the project is delivering new information about high-temperature reactions of waste and selective synthesis techniques to transform waste into valuable materials and products, including metallic alloys, oxides and carbon. The aim is for industry to adopt commercially viable technology and processes where low value or complex waste is reformed into high-value materials, creating jobs and environmental and social benefits.

www.smart.unsw.edu.au/research-programs/arc-microrecycling-research-hub

## MICROFACTORIES™

MICRO factorie®

SMaRT's MICROfactorie™ technologies continued to evolve and expand, with one highlight being partnering with a commercial manufacturer setting up and operating the first commercially run MICROfactorie™. The Green Ceramics MICROfactorie™ in regional NSW was made possible with funding from NSW Office of Chief Scientist and Engineer under its Physical Sciences Fund. MICROfactorie™ can transform waste into new and reusable materials that can be used to manufacture high value products. MICROfactorie™ can reshape waste where it is created, enabling local businesses and communities to tackle local waste problems and develop a commercial opportunity from the valuable materials that are created, and considerable commercialisation engagements and prospects continue to unfold.

www.smart.unsw.edu.au/technologies-products/microfactorie-technologies

## NEW NESP HUB

2020 finished for SMaRT in winning hosting rights for the new National Environmental Science Program (NESP) Sustainable Communities and Waste (SCaW) Hub, which involves six research nodes working on various Impact Priority areas including the UNSW SMaRT Centre-directed area of reducing the effects of plastic waste and other common waste streams. NESP is operated by the federal Department of Agriculture, Water and Environment (DAWE). UNSW SMaRT Centre is leading this consortia of research institutions that includes Commonwealth Scientific and Industrial Research Organisation (CSIRO), Monash University (MU), Swinburne University of Technology (SUT), Curtin University (CU), and the University of Tasmania, with industry and community partners across the nation. See https://www.smart.unsw.edu.au/research-programs/sustainable-communities-and-waste-hub.

## ENGAGEMENT AND IMPACT

SMaRT continued to implementing a comprehensive stakeholder engagement/collaboration effort to enhance outcomes of its future research strategy. This is activated via knowledge transfer, and communications initiatives to support SMaRT's operational objectives to deliver optimised impact and outcomes, all supporting and in alignment with the UNSW 2025 Strategy.

The proactive stakeholder engagement program involves Veena and other SMaRT personnel regularly attending and speaking at major events all over Australia and around the world (online during COVID restrictions), to the media and industry, resulting in hundreds of media stories and stakeholder engagements. And, in line with past practices, SMaRT continued to make formal and informal government consultation submissions to both the Federal and state governments and provides "evidence" to government inquiries into waste and other issues. This is in addition to Veena's ongoing and new memberships of multiple government advisory committees (eg, Victorian EPA; and NSW EPA; and NSW Treasury, NSW Dept Premier and Cabinet, and NSW DPIE).

## ADVOCACY AND MEDIA HIGHLIGHTS

*Parliamentary report highlights SMaRT innovations*

www.smart.unsw.edu.au/news-events/news/parliamentary-report-highlights-smart-innovations

*Green aluminium breakthrough*

www.smart.unsw.edu.au/news-events/news/green-aluminium-breakthrough

*Report: Towards a Waste Free Future*

www.smart.unsw.edu.au/news-events/news/report-towards-waste-free-future

*TEDI London: Why all waste should be treasured*

www.smart.unsw.edu.au/news-events/news/why-all-waste-should-be-treasured

*Industry spotlight: Revolutionising recycling science*

www.smart.unsw.edu.au/news-events/news/revolutionising-recycling-science

*Make Australia 'make' again*

www.smart.unsw.edu.au/news-events/news/make-australia-make-again

*SMaRT submissions to NSW Government*

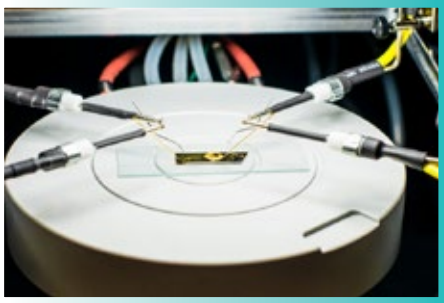
www.smart.unsw.edu.au/news-events/news/smart-submissions-nsw-government

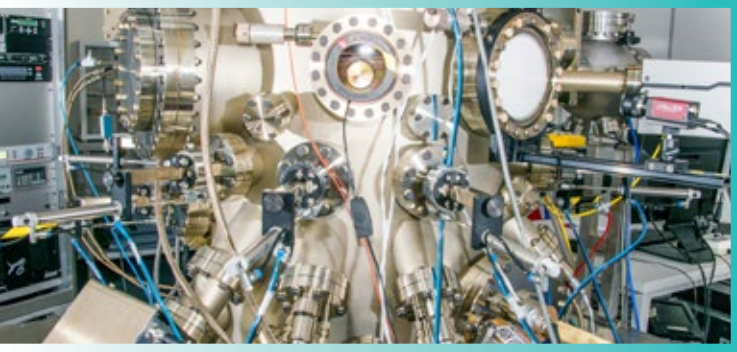
*Why we need a circular economy*

www.smart.unsw.edu.au/news-events/news/why-we-need-circular-economy

# UNSW MATERIALS & MANUFACTURING FUTURES INSTITUTE

During 2020, the UNSW Materials and Manufacturing Futures Institute ("MMFI") has proven to be responsive and adaptable in the current climate. During this time, we have strengthened our culture, created more awareness and desirability for our products and services by engaging with industry and government bodies, scientific leaders and academics, various commercial and community organisations as well as the broader University community.





UNSW MMFI has a dynamic interdisciplinary network which utilises the power of advanced materials and manufacturing principles to establish productive partnerships with external partners.

We have invested in our people and their research and produced deliverable solutions with tangible results, including patent applications, driving innovation in hydrogen technology and water treatment systems, healthcare technologies, sustainable building materials, IoT development and hosting a series of workshops featuring machine learning.

We will continue to communicate with our fellow Institutes and Institute stakeholders through best practice strategies and engagement of local and international industry. We will also continue to search and secure external funding to support UNSW and MMFI's research activities and, as we direct our efforts into these emerging opportunities, we will look to the future but remain mindful of the challenges of 2020.

For a full version of UNSW MMFI's 2020 Annual Report, please visit:
**https://issuu.com/unswmmfi/docs/annual_report_mmfi_2020_update**


## A YEAR LIKE NO OTHER FOR RESEARCH IN THE SCHOOL

2020 will be remembered as a year unlike any before. A global pandemic has left people reeling with an influx of ever greater regulations and rules and uncertainty around jobs and the way of life in general compared to what it used to be. The impact for our School has been manifold. Lab access became restricted, students could only go to their desks at specific times and social distancing had become the new normal.

Apart from the impact on research taking place in the School, the effect on social cohesion and a sense of belonging can not be underestimated. Students working in a research group thrive through personal contacts and discussions, removing this aspect to some degree has been challenging.

## RESILIENCE AND IMPROVISATION

Despite all these things, our students and staff have displayed an overwhelming amount of resilience and improvisation, ranging from the organization of new online meetings and groups to exchange personal news and views, to new forms of online exams and beyond. Judging from the number of publications of the School, which was higher than the previous year, we have certainly done well in research metrics in 2020. This aspect was likely caused by people suddenly having more time at their hands to write down their findings. How we do with that in the coming years we will see. Getting new students certainly has been a challenge for the continuation of research for many academics, and many groups in the School have been shrinking in size, given the fact that our HDR cohort has a large international student number, which has been impacted by travel restrictions.

## RESEARCH GRANTS

Regarding research grants, the School has done well in 2020, with main ARC and NHMRC schemes mostly unaltered and still in place, and larger industry related projects being funded.

Some smaller schemes run by the Faculty and UNSW internally like RIS have been affected, and start-up support for younger colleagues has been more challenging than usual because of funding difficulties throughout the university landscape.

COVID has also brought opportunities with dedicated funding schemes being quickly established and larger strategic opportunities, for example for mRNA vaccines related university infrastructure on the horizon.

## KEEPING THE SPIRIT ALIVE

Overall, the people in the School deserve a commendation for keeping the spirit of the School and active materials research alive through these difficult times.

I'm looking forward to seeing people again in person, and coffee breaks full of discussion with colleagues, staff and students in the School, hopefully very soon.

# 2020 STAFF AWARDS & ACHIEVEMENTS

## GRANTS

Staff were highly successful with Australian Research Council funding via a total of 6 Discovery and 6 Linkage grants, which is a fantastic achievement for our modest-sized School. Staff also received several other government and industry grants, most notably from ARENA, ACARP, US National Cancer Institute, US Department of Defence, Australia-India Strategic Fund, Impresario Investments, and Baxter International.

The funding highlight of the year goes to **SCIENTIA PROFESSOR VEENA SAHAJWALLA** and her SMaRT Centre team who received $17M from the National Environmental Science Program to establish '*The Sustainable Communities and Waste Hub*'.

**A/PROF. KRIS KILIAN** was awarded US$1.1m from the US National Cancer Institute of the National Institutes of Health

**DR TUSHAR KUMERIA** was awarded US$200k from the US Department of Defence Army Medical Research and Development Command Program and another $574k from the Australia-India Strategic Research Fund

**PROF. DEWEI CHU** and team in SPREE received $1.76m from the Australian Renewable Energy Agency (ARENA).

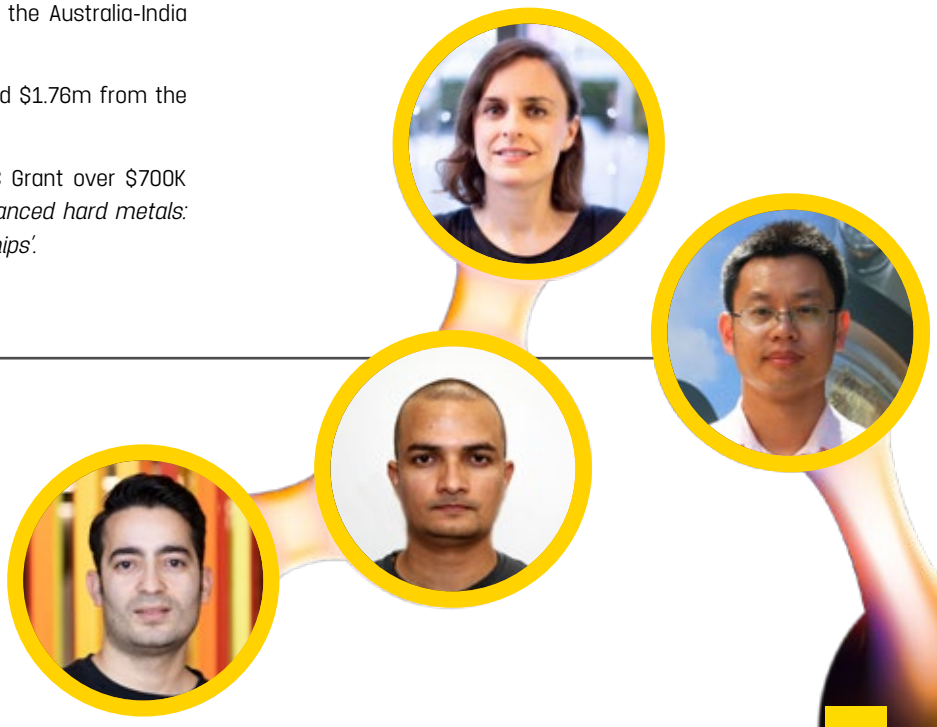
**A/PROF SOPHIE PRIMIG**'s Team Awarded ARC Grant over $700K The awarded ARC grant's project title is *'Advanced hard metals: microstructure-property-processing relationships'.*

**PROF CHRIS SORRELL, DR PRAMOD KOSHY** and **DR JUDY HART** have been awarded $406K from ARC Grant and $300K from industry partner. The project title is New Ceramic: Fully Stabilised Monoclinic ZrO2.

**DR CLAUDIO CAZORLA**, **ASSOCIATE PROFESSOR DEWEI CHU** and **PROFESSOR TOM WU** have been awarded over $300K from ARC Grant. The awarded project is *High-performance metal oxide inks for printable memory arrays*.

The awarded ARC grant *'High-load powder dispersion and aerosol delivery: an integrated approach'* **A/PROFESSOR RUNYU YANG** is pushing the limits of high load inhalers to deliver antibiotics for serious respiratory infections.

**DEWEI CHU; CLAUDIO CAZORLA; DA-WEI WANG; NEERAJ SHARMA**. Engineering Nanoionic Interfaces towards High Performance Cathode Coatings



## ACADEMIC PROMOTION

**NIMA HAGHDADI** - Lecturer

**PANKAJ SHARMA** - Lecturer

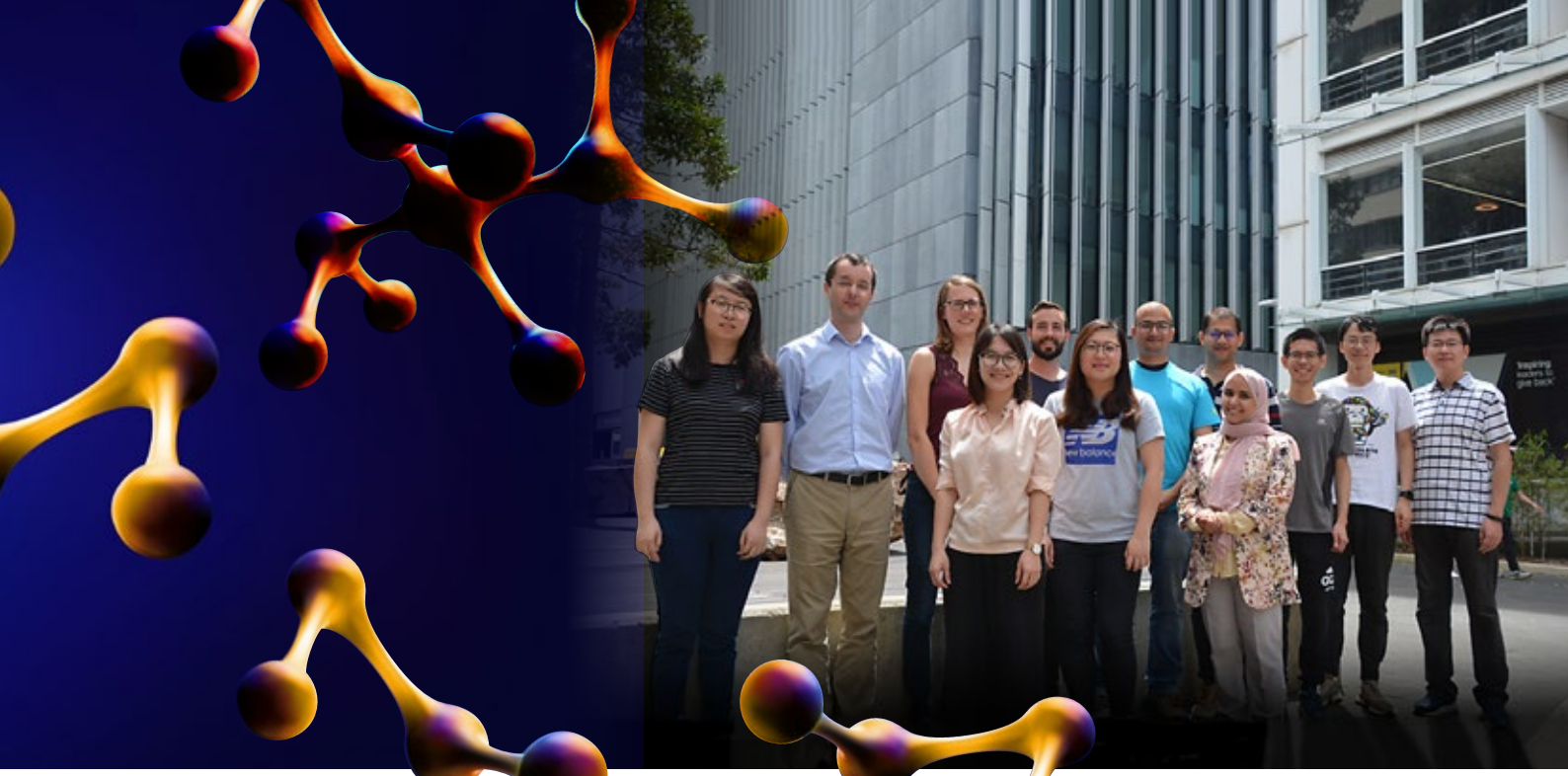
**SOPHIE PRIMIG** - Associate Professor

**DANYANG WANG** - Associate Professor

**KRISTOPHER KILIAN** - Associate Professor

**SAMMY CHAN** - Professor

**DEWEI CHU** - Professor

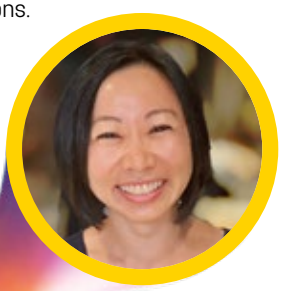


## WELCOME TO NEW STAFF

The School welcomed new academics including:

### ASSOCIATE PROFESSOR SHERY CHANG

Shery moved from Arizona State University to take up a joint position between the School and UNSW's Electron Microscope Unit, where she is Associate Director. Shery received her PhD in Materials Science from the University of Cambridge, then carried out research in several major electron microscopy laboratories in UK, Germany, Australia, and USA. Shery is an expert in aberration-corrected electron microscopy, a technique that can image individual atoms, which is being used extensively to carry out her research on nano-diamond materials for quantum sensing and biomedical applications.



### DR BENJAMIN PACE

Ben moved from the University of Sydney to take up an education focused lecturing position. He received his PhD from our School, then worked as a postdoctoral fellow at ACMM, University of Sydney. Ben's research interests span a broad range of thin film deposition technologies, structural characterisation, and sustainable materials processing. He has major teaching interests focused on innovative methods for improving the online learning experience of our students.

### DR TUSHAR KUMERIA

Tushar moved from the University of Queensland to take up a position as Senior Lecturer in the growing field of Biomaterials, where he is also an NHMRC Early Career Fellow and UNSW Scientia Fellow. He received his PhD in Chemical Engineering from the University of Adelaide, then held postdoctoral positions at the same institution, University of California-San Diego, and University of Queensland. Tushar's current research and teaching focus is on porous nanomaterials and composites for drug delivery, sensing, and tissue engineering.

## OTHER AWARDS

**DR FARSHID PAHLEVANI** has been recognised in the list of Australia's Most Innovative Engineers for 2020.

**PROFESSOR JAN SEIDEL** received UNSW Arc Postgraduate Council Outstanding Research Supervisor Award!

Several staff also received a Dean of Science Award for outstanding contributions to the School and Faculty throughout the year.

**DEWEI CHU** - Research Excellence Award

**ANTHONY ZHANG** - Operational Excellence Award

**SOPHIE PRIMIG** - Collaboration & Partnership Award

**DAMIA MAWAD** - Equity, Diversity & Inclusion Award

**OWEN STANDARD** - Dean of Science Standout Award

# STUDENT AWARDS & ACHIEVEMENTS 2020

## UNIVERSITY MEDAL

The University Medal is one of the most distinguished awards to be bestowed on an undergraduate student and recognises outstanding academic performance. We are overjoyed to have two university medallists this year;

**Joel Luke Abraham** (Honours supervisor Kevin Laws) who won the award in the Bachelor of Engineering (Materials Science) (Honours) program, and;

**Madi Moar** (Honours supervisor Koshy) who won the award for the Bachelor of Engineering (Materials Science) (Honours)/Master of Biomedical Engineering.

Congratulations to our inspirational medal winners and their supervisors!

## FACULTY PRIZES

| | |
|---|---|
| The Cochlear Prize: | **Jiachen Jiang** |
| The Rio Tinto Aluminium Prize: | **Jacqualine Huynh** |
| The Perfect Engineering Prize: | **Brenda Leung** (Process Metallurgy Plan)<br>**Edward Thomas Whitelock** (Ceramic Engineering Plan)<br>**Aurpa Bhuiyan** (Materials Engineering Plan)<br>**Young Park** (Physical Metallurgy Plan) |
| Sir Rupert Myers Prize: | **Alexander Danon** |
| The Hugh Muir Prize: | **Anthony Zhang** |
| The Max Hatherly Prize: | **Marcus Anton Pericles Miljak** |
| The Wallarah Minerals Prize: | **Bernadette Pudadera** |
| The Australasian Corrosion Association Prize: | **Bernadette Pudadera** |

## MATERIALS AUSTRALIA STUDENT THESIS PRESENTATION WINNERS

**1. Bernadette Pudadera:** Platinum Electrode Dissolution (supervisor - Pramod Koshy)

**2. Coco Kennedy:** Superdomains in Highly Strained Bismuth Ferrite Thin Films (supervisor - Nagy Valanoor)

**3. Aurpa Bhuiyan:** Glass Crystallization in Nuclear Waste Storage (supervisor - Pramod Koshy)

## ARC PGC STUDENT AWARDS

**Scarlet Kong** - Outstanding Research Student Award

**Musharaf Abbas** - Research Student Award

## DEAN'S AWARD FOR OUTSTANDING PHD THESIS

**Gaurav Vats**

# ONLINE LEARNING

## TURNING CIRCUMSTANCES INTO OPPORTUNITIES

With increasing development of digital educational technologies, the past few years have seen a progressive increase in online delivery of our courses as well as increased use of online technologies to support face-to-face learning. However, the COVID-19 pandemic in 2020 obviously greatly accelerated this trend – in March 2020, with ~1 week's notice, the School moved to fully online delivery of all courses with limited face-to-face teaching (e.g. laboratory activities) only restarting in the last few months of the year.

### BENEFITS

While this situation was obviously intensely challenging for both students and staff, it did bring with it some positives. Firstly, it forced us to rethink how we teach and to move outside our comfort zones. University education has been delivered in much the same way for generations. Due to COVID-19, we all had to experiment with teaching in different ways and to reconsider what we have previously taken for granted about the nature of university teaching. While not all experiments with online teaching were 100% successful, we have found some benefits for both teachers and students. For example, many students have enjoyed asynchronous content delivery – they can work through video lectures and online tutorials in their own time and at their own pace, taking breaks whenever they want and immediately rewinding to anything that they have not understood rather than the whole class moving forwards together.

Secondly, the sudden move to online teaching highlighted the collegiality of our School. In the one week transition from face-to-face teaching to teaching fully online, communications were flying between academic staff, with information being shared about which online technologies people had tried, which worked well, what were the problems and limitations that needed to be considered. This sharing of ideas and experiences continued throughout the year to help everyone adapt as well as possible and make the best learning experiences possible for our students.

Different approaches were used in different courses – some predominantly relied on pre-recorded videos of lectures, while some continued live teaching through platforms such as Zoom and Teams. We have found that it is essential to maintain at least some live teaching even if most course content is delivered asynchronously, so there is some interaction between staff and students and opportunities for students to ask questions. However, the ability to deliver at least some course content asynchronously has allowed the way live sessions are used to change, with more focus on interaction, reviewing and discussing the content, Q&A, etc.

### CHALLENGES

Ongoing challenges remain the delivery of online labs and assessment. Some courses have trialed live-streaming of labs, which helps students to get a sense of the real lab environment and the practical aspects of lab work, although ensuring our graduates still develop the hands-on skills that employers expect is critical. Various strategies have been used to ensure integrity of assessment, including trials of oral exams in some smaller courses.

We were greatly assisted in the transition to online teaching by Digital Uplift projects that have been completed for several courses over the past few years as part of a UNSW-wide scheme. Both the School and the Faculty of Science have also made significant investments in technology to support online teaching, such as purchasing high-quality microphones and a green screen as well as wireless headsets and face-tracking webcams that allow staff to move around while they are teaching.

Of course, we hope to return to teaching on campus as soon as possible – there is much that is missed in online teaching, such as hands-on laboratory experiences and the critically important social aspects of learning, while many teaching staff have also highlighted the lack of non-verbal communication as a vital cue to when the class has understood something or not – there is probably much that has been irreversibly changed about what teaching and learning at university looks like. Hybrid delivery is likely to be a future trend, giving students flexibility and choice in how they engage with learning at university. Hopefully, in the future, we will be able to hold on to the aspects of online teaching where we have discovered benefits and find a happy medium between conventional face-to-face and fully online teaching.

Photo: Anna Kucera

# UNSW TO LEAD SUSTAINABILITY RESEARCH HUB

UNSW Professor Veena Sahajwalla will spearhead a new national research centre investigating technology for waste reduction and materials processing. UNSW will take a lead role in national research into sustainable communities and waste, as part of the federal government's $149 million second phase of the National Environmental Science Program (NESP).

The Sustainable Communities and Waste Hub will be led by Australian Research Council Laureate Scientia Professor Veena Sahajwalla, a materials scientist, engineer, inventor and a founder and director of UNSW's Centre for Sustainable Materials Research and Technology.

The Centre has pioneered microfactories for turning plastic waste into 3D printing material, green-steel technology that recycles tyres and plastics, and transforming textile waste into tiles and benchtops.

Professor Sahajwalla said she was delighted with the government's announcement of four mega science hubs, with waste a key priority.

"Waste and recycling have been made a national agenda item by government and through this new hub we will create actionable knowledge, methods, tools and data for transformation towards circular economies in our cities and regions. Our capabilities, proposed research activities and transition pathways will deliver the environmental, social and economic outcomes and impacts that are sought by the NESP which funds the hub," Professor Sahajwalla said.

The Sustainable Communities and Waste Hub consortium is comprised of six research institutions led by UNSW Sydney, and working in partnership with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Monash University, Swinburne University of Technology, Curtin University and the University of Tasmania.

It will coordinate research on reducing the impact of plastic and enhancing sustainable people-environment interactions, develop ways to minimise impacts of hazardous substances and pollutants, and deliver cutting-edge technical capabilities, particularly in the fields of waste and materials processing.

Professor Sahajwalla said value needs to be placed on the materials from which a product is made, and it needs to be recognised that these materials can be recycled or reformed.

The NESP has for the past six years delivered practical environment outcomes through almost 400 successful science projects and helped to shape the nation's environmental science agenda.

Environment Minister Sussan Ley said: "It is fitting to make this announcement in a week that marks the passing of our landmark Recycling and Waste Reduction Act 2020.

"The Morrison government is the first to make waste and recycling a national agenda item and we are investing in science, industry and technology that will help our environment and our economy."

Research will be prioritised to meet the most pressing environmental management and policy needs, with an emphasis on climate adaptation, threatened species, protected places and waste impacts.

The new hubs will come into effect in early 2021, with the existing hubs running until mid-2021. This will ensure NSEP continues to deliver valuable research throughout the transition.

# 2020 MATSOC REPORT

## FOREWORD

Over 2020, the MATSOC executive committee have successfully organised and executed a range of events for all undergraduate Materials Science and Engineering students. We had social and professional events, and collaborations with the School of Materials Science and Engineering (MSE), the Materials Postgraduate Society (PGSOC) and other engineering school societies. This year we were able to expand the scope of our activities with engagement with industry, school-based community events and through the introduction of online events due to COVID-19.

Our events this year would not have been successful without the tireless effort from the MATSOC executive committee, the support from Arc and the generous sponsorship from Cochlear and the School of Materials Science and Engineering.

## EVENTS SUMMARY

Over the course of 2020, we hosted a total of 12 events, 9 were solely run by MATSOC, with the remainder being collaborative events with other societies. Due to the COVID-19 pandemic, many of our events were postponed or replaced entirely, however this has not detracted the quality of the events that are run by the society. This has led to the creation of the MATSOC Discord channel to provide an online platform for students in MATSOC to socialise with each other via the voice or text channels. This platform has also allowed us to provide 4 of our online events through this channel to get them through these challenging times.

## EVENTS HIGHLIGHT

Creation of a MATSOC Discord channel to allow for an online platform for students to call and talk to each other as well as providing a place for MATSOC to run online events

Running many online events for the first time such as the Online Games Night, Virtual Scavenger Hunt, Online Movie Nights, and a League of Legends tournament.

Virtual Scavenger Hunt

## END OF YEAR COCKTAILS NIGHT

Industry Speed Networking Night sponsored by Cochlear and Engineers Australia

## CONCLUDING REMARKS

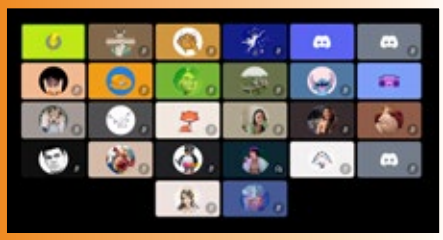
2020 has been a challenging year for MATSOC – adjusting to COVID and finding new ways to engage the society through different online means. This year has seen significant changes in the way we run our events and has allowed us to explore alternate ways in which we can engage the students. Even through these tough times, the continued engagement from the new students through our online platforms has provided us great feedback on our newer events we ran, and we hope to see this continues into the next year.

Finally, we would like to extend our deepest gratitude to the School of Materials Science and Engineering, as well as our Industry Sponsor for 2020, Cochlea, your generous support this year has been instrumental in MATSOC's capability and capacity to achieve our 2020 resolutions.

## ANTHONY ZHANG

2020 MATSOC President


MATSOC
Arc




MATSOC
Arc


Arc Club
MATSOC
Arc
Supported by UNSW Student Life

# 2020 PGSOC REPORT

### 2020 HAS BEEN A CHALLENGING BUT VIGOROUS YEAR.

Due to the pandemic, PGSOC were unable to hold most of our signature events such as the poster competition. In response, PGSOC has set up anonymous online platforms for students to seek support during these difficult times. Online chatroom server was also set up to make communications easier. Social media activity was also paramount in these difficult times. Community news were shared via Twitter and Facebook more so than before.

### BORAL SITE INDUSTRY VISIT

Industrial site visit at Boral lab in Marulan was held just before the pandemic hit. The trip was a great way to form connections with the industry and broaden future career path.

### MID-YEAR SOCIETY LUNCH

The Mid-year society lunch was held to celebrate the return to campus after the first lockdown. During the lunch, the communication was promoted and encouraged us to move on with the support of peers.

### WEEKLY FRIDAY SOCIAL (ONLINE AND LIVE)

PGSOC persisted with Online Friday Socials to connect students during difficult times. Ice breaking games and various board games were played with group voice chat to elevate stress and unwind as well as to stay connected with fellow peers during lockdown.

On the latter half of the year, in-person Friday socials were re-instated with precautions in accordance with public health orders. Themed Socials such as Halloween and Eid Special Socials remains one of our best ways to promote engagement and inclusiveness.

### PEER MENTORING-WELCOME BBQ

Welcome BBQ was held at Maroubra beach at the beginning of Term 3 as restrictions eased. This was done in collaboration with the Peer Mentoring program. The first big party of the year, it's a great way to bring the new students into the fold through ice-breaking games and delicious BBQ.

### CHRISTMAS CELEBRATION

The Christmas celebration this year was held in round house. The free food and drinks are sharing to celebrate the festival before long holiday.

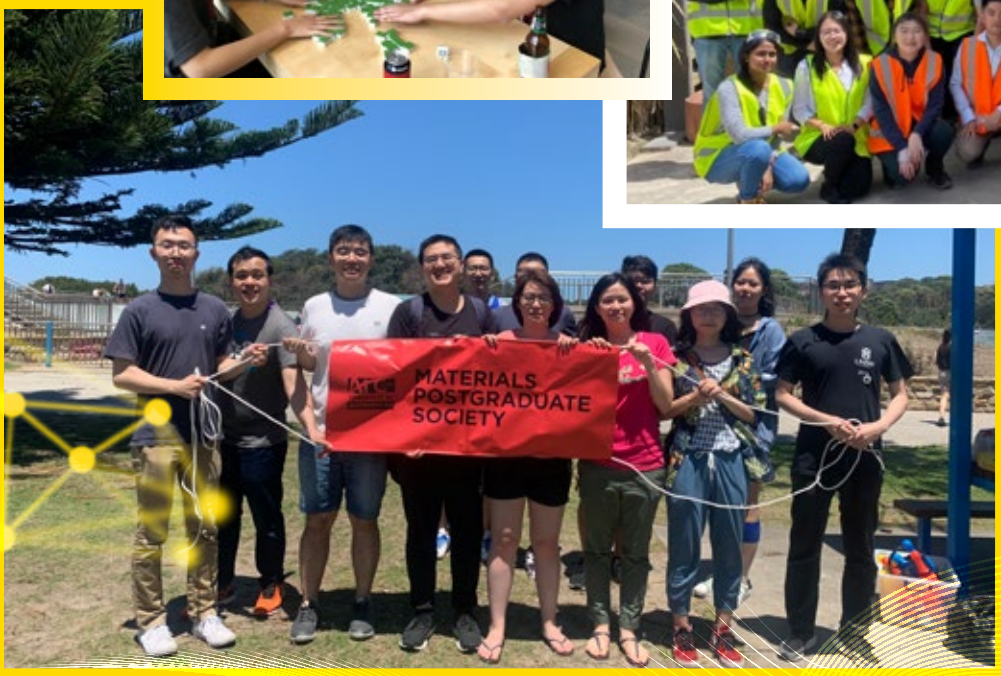
It has been without a doubt year full of challenge, but it also proves the teamwork is the best approach to overcome the difficulties. The PGSOC will always stand with all of postgraduates and the school, and be active in student engagement.

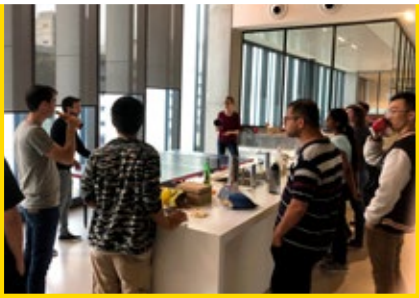
The PGSOC team is very grateful for the continued support from the School of Material Science and the students during these difficult times. We couldn't have done it without you!

**YUE JIANG**

2021 PGSOC President


Boral Cement
Maruian Mine Site


MATERIALS
POSTGRADUATE
SOCIETY



# EQUITY, DIVERSITY, AND INCLUSION

## SAFE, SUPPORTED, INCLUDED

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 and wellbeing.

## COVID 19

The COVID pandemic of 2020 created big challenges for everyone, and as such the main objective of the School's Equity Diversity and Inclusion (EDI) Committee was to support our student and staff during periods of lockdown and imposed physical distancing.

Throughout the year, the EDI Committee worked closely with PGSOC on a series of online activities to ensure that our undergraduate and postgraduate students remain connected and feel part of a considerate community.

## FEEL AND FILL

The EDI committee hosted also an online workshop titled "Feel and Fill" run by one of our student alumni. The objective of the workshop was to enhance emotional awareness and social connectedness, with benefits of improved mental health and compassionate communication. Through a variety of interactive exercises, attendees were able to connect , share the difficulties they were facing, and how they are responding to challenges imposed by the pandemic.

# WORK, HEALTH & SAFETY (WHS)

## WHS COMMITTEE COMPOSITION

The members of the School WHS Committee in 2020 were Jianqiang Zhang (Chairperson), Michael Ferry (HOS, management representative), Owen Standard (Deputy HOS), Anthony Zhang (School Safety Officer), David Miskovic (technical and administrative staff representative), Rakesh Joshi (Academic representative), and Florence Lui (postgraduate student representative).

School WHS committee would like to thank all staff and students in the School for all their understanding, cooperation and compliance with WHS requirements and procedures.

## BRIEF SUMMARY OF 2020 WHS ACTIVITIES

- Covid-19 Challenges
- Completing QR coding implementation to all areas of our building.
- Purchasing personal protective equipment.
- Physical distancing in all labs and open-plan seating areas.
- Hand hygiene and sanitiser & workspace cleaning.
- UNSW Safe return to campus and visitor/contractor controls.

## BUILDING

- Updating and installing new first aid boxes in our building (two boxes on each level).
- Building management System (BMS) access for technical staff to monitor our building remotely.
- Integrating new route for dangerous goods transport through basement of Hilmer and SEB building.
- Completing annual checks for RCD, life safety system, and fume cupboards.
- Continuation of good neighbors meeting with staff in Hilmer, SEB and F10.
- Appointing a new chief warden for the School and updating Hilmer building Emergency Control Organisation and First Aid officers.

## COMPLIANCE

- Revising and implementing new afterhours access policy in the School.
- Checking and updating all high-risk safe work procedures (SWPs) in the School.
- Auditing/updating MSE Chemicals in JAGGAER including schedule 14s.
- Updating/completing UNSW Bio register for the School.
- Reviewing Lasers in our School under UNSW RECS.

## INSPECTIONS

- Building visit by all the WHS School reps in the Faculty.
- Completion of electrical test and tagging for the year.
- Technical staff training to do 3 Phase test and tagging.
- Quarterly workplace/laboratory safety inspections and completion of corrective actions.
- End of year WHS committee lab inspection and corresponding corrective actions.

## TRAINING

- External company SUPAGAS training in March this year for both staff and students.
- Implementing WHS monitor to the School, new program for our inspections and incident reporting.
- Updating warden training (during Covid).
- Completing Refresher WHS Awareness and Ergonomics and Sexual Harassment online by all staff.
- Completing University "Supervisor Training" course by all academic and research staff.
- Mandatory School WHS info sessions (~11 per year) for all new staff, postgrad and Honours students.
- UNSW Laser Course (UNSW ADFA).
- Completing contractor engagement training by laboratory staff.

# 2020 MARKETING OUTREACH

## MARKETING OUTREACH REPORT 2020

The new decade saw a massive change to the marketing strategy with the arrival of the COVID-19 Pandemic.

While we missed seeing smiling faces on campus, 2020 allowed us to create a strong online presence that will benefit the school for years to come. Some highlights include:

### NEW WEBSITE

After 9 years of service, the website got a complete overhaul to make it more powerful, functional and mobile friendly. New features include a detailed and interactive outline for each course, an overhaul to our award-winning online tutorials and a new research themes section.

The new platform allows the inclusion of a much greater variety of media types and can quickly adapt to a wide variety of screen sizes ensuring a quality and consistent experience for all of our prospective and current students.

### ONLINE WORKSHOPS

We didn't let the lack of physical events hamper us this year and kept busy with a range of online experiences including:

### OPEN DAY

Usually the biggest event of the year, in 2020 liquid nitrogen ice creams were replaced with interactive lab tours and a range of virtual activities allowing students from all around NSW and beyond to participate in ways they haven't before. The academic advisory was also recreated online using a platform that allowed students to stroll through an online version of the Scientia building to ask questions about our course from our academics who answered their queries via chatrooms.

### EXPERIENCE UNSW DAY

This event saw hundreds of students tune in to watch a range of simulive experiences – a mixture of live and pre-recorded content. Our contribution was a workshop demonstrating the advantages of composite materials using pykrete, a composite of frozen water and paper. Ice dropped from a height will smash spectacularly while ice reinforced with paper is incredibly tough and can withstand being dropped from tremendous heights. As a result pykrete almost ended up being the material of choice for aircraft carriers during WWII.

### ATAR NOTES SEMINAR ON STEM CAREERS: MATERIALS

Figuring out study options after high school is always a tough decision for year 12 students. ATAR Notes ran a series of online seminars in 2020 with UNSW on STEM Careers to help students understand more about the different STEM career opportunities available. Scarlet presented for our school, talking about why they should consider Materials Science and Engineering as a degree option. She shared her journey from high school into UNSW, why she chose to study with us and the different experiences she gained while she was our undergraduate student. Scarlet also showed the different opportunities available to our graduate, through short virtual demonstrations.

### UNIVERSITY OF THIRD AGE

Our first event under lockdown, Scarlet delivered an online workshop to retirees from the University of Third Age (U3A) program, about Materials Science and Engineering. The workshop started with the basics, that most materials are polycrystalline, to materials properties and how that influences their applications. She also performed a few bending tests using the 3D printed testing jig from our HSC lesson plans. Around 30 participants tuned in to Scarlet's presentation and some were even UNSW Alumni that remembered the tiny School of Metallurgy before it transitioned to our current School of Materials Science and Engineering.

## PEER MENTORING

The peer mentoring program this year straddled a pre and post pandemic lockdown which divided the cohort into two phases. The first saw an enthusiastic group of students come together for a range of activities including weekly pizza catch ups and trivia sessions organised in conjunction with MATSOC. The second half saw these students and mentors move online for online trivia sessions and common computer gaming sessions via Discord.

## HSC LESSON PLANS

Based on the feedback of HSC Teachers in 2019, we released a series of lesson plans focused on Materials Science & Engineering and aimed at the HSC Engineering Studies syllabus. These plans accompany flexural bending tests created on 3d printers and CAD analysis software freely available to teachers and students. So far, the feedback has been positive with praise given by teachers to the modern approach and real world applications.

## SCIENCE COMMUNICATION WORKSHOP

Communicating effectively is becoming increasingly important in the workplace and superior communication skills allow our graduates to work in a wider range of industries. To foster these skills, we created a science communication workshop for our students which provides the tools to create a professional profile on our new website displaying their strengths, including examples of their writing for news articles and opinion pieces. This platform has great exposure and SEO and allows future employers to see the impact our students can have at their workplaces.

With all the changes to routines and lifestyles during the pandemic it was particularly important to prioritise mental health. To do this we ran a full schedule of events aimed at wellness including:

## WORLD MENTAL HEALTH DAY

This event saw a trained counsellor from the Black Dog Institute address questions from students and staff relating to how they can maintain wellness and good mental health during the trying times of the pandemic. Following on from this, a meditation professional took the group through a relaxation session

## WELLNESS WORKSHOP

A speaker from Beyond Blue kindly volunteered their time to describe their battle with depression – how it started, where it went, how they found help and how to recognise it and seek help for yourself, friends and family.

## FEEL & FILL WORKSHOP

Meditation is an excellent way of winding day and creating healthy routines and we were incredibly lucky that a friend of one of our students was happy to guide a group of students and staff through a 45 minute session focusing on breath work and positive thoughts.

## SOCIAL MEDIA

Engagement on Instagram grew markedly throughout 2020, with the number of followers almost doubling from 2019 and significantly greater engagement on posts. Our Facebook account also kept up the steady upward trend of followers.

# 2020 RESEARCH GRANTS

## AINSE AWARDS

**Koshy, P**, *Development of titanate glass-ceramics for actinide immobilization--in situ structural and spectroscopic studies - Honours scholarship: Aurpa Bhuiyan* ($5,000)

**Munroe, PR**, *Radiation-induced damage of C/C composite and Graphite - Honours scholarship: Guangyu Hu* ($,5000)

**Seidel, J**; Gilbert, E, *Formation of a stable long range magnetic skyrmion lattice in thin films of the room temperature chiral material Co8Zn8Mn4 - Postgraduate research award: Gaurav Vats* ($16,332)

**Valanoor, N; Paull, OH**, *Interfacial magnetism effects and multiferroic thin films for device applications - Postgraduate research award: Oliver Paull* ($22,500)

## ANSTO GRANTS

**Koshy, P;** Gregg, D, *Cementitious wasteforms for high sulphate wastes - for Honours student Clayton Feng* ($4,800)

**Koshy, P;** Gregg, D, *Corrosion of hot-isostatically pressed nuclear waste glass - Student Agreement for Jialuo (Carol) Ke* ($5,820)

**Laws, KJ**, *Molten Salt Corrosion of Nickel Alloys for Applications in Energy-Generation and Energy-Storage Systems for Honours Student Ming Lee* ($5,455)

**Laws, KJ**; Muransky, O, *Atomistic-Simulations-Assisted Development of Novel Materials for Extreme Environments - for Kaili Xue* ($2,000)

**Munroe, PR**, *Atomistic-Simulations-Assisted Development of Novel Materials for Extreme Environments - for Shannon Lee* ($2,000)

**Munroe, PR**, *Radiation-induced damage of Graphite and its high-temperature recovery for Honours Student Guangyu Hu* ($1,818)

## ARC CENTRE OF EXCELLENCE

Hamilton, A; Fuhrer, MS; Ostrovskaya, E; Helmerson, K; Wang, X; Kalantar Zadeh, K; Kalantar-Zadeh, K; Bao, Q; Culcer, DM; Davis, J; Davis, M; Klochan, O; Medhekar, N; Parish, M; **Seidel, J**; Schiffrin, A; Sushkov, OP; **Valanoor, N**; Vale, C; Wang, L; Cole, J, *ARC Centre of Excellence in Future Low-Energy Electronics Technologies FLEET* ($10,088,738)

## AUSTRALIAN RESEARCH COUNCIL FELLOWSHIPS

**Primig, S** (*ARC DECRA). Engineering hierarchical microstructures in high strength low alloy steels* ($368,446)

**Sahajwalla, VH** *(ARC Laureate Fellowship), Fundamental high temperature e-waste investigations for high-value products* ($2,370,000)

**Wang, D** (*ARC Future Fellowship). Oxide-Semiconductor Epitaxy: Towards Next Generation Nanoelectronics* ($873,125)

**Kilian, KA** (*ARC Future Fellowship). Synthetic extracellular matrices for control of cellular reprogramming* ($870,125)

## NATIONAL HEALTH & MEDICAL RESEARCH COUNCIL FELLOWSHIPS

**Kumeria, T** (*NHMRC Early Career Fellowship). Bioresponsive Porous Silicon for Site Specific Oral Delivery of Antibodies for the Treatment of Inflammatory Bowel Disease* ($160,257)

Poole, K; Ariotti N; Gaus K; **Kilian KA**, Sianati, S (NHMRC Ideas Grant). *Mechanosensors in Cancer* ($1,185,410)

## ARC DISCOVERY PROJECTS

**Ferry, M; Primig, S**; Birbilis, N; Nakashima, P, *Unlocking the diverse property profile of ultra-lightweight Mg alloys* ($490,000)

**Kumeria, T;** Kumeria, T**,** *Cell Membrane Coated Photonic Crystal to study Receptor-Ligand Interactions* ($414,000)

**Li, S**, *Thin Combinatorial Films for Heat Management in Microelectronics* ($410,000)

**Mawad, D**; Officer, D; Lauto, A, *Bioelectronics: addressing the biointerface challenge* ($393,215)

**Munroe, PR;** Xie, Z, *Designed to last: Novel gradient coatings for extreme environments* ($600,000)

**Sahajwalla, VH**; Bhattacharya, S**; Joshi, RK**, *Thermal isolation: a novel pathway to transforming complex waste* ($267,804)

**Wu, T**; Hu, B, *Light-Responsive Spin Transport and Spintronics with Stable Perovskites* ($450,000)

**Zhang, J; Young, DJ**, *High temperature corrosion induced by multiple secondary oxidants* ($554,000)

**Zhang, J; Young, DJ**, *Reducing gas and ash corrosion in advanced power generation* ($480,000)

# RESEARCH GRANTS 2020

## ARC LINKAGE PROJECTS

**Chu, D; Cazorla Silva, C; Wu, T;** Chesman, A; Howard, M, *High performance metal oxide inks for printable memory arrays* ($324,074)

**Chu, D; Cazorla Silva, C; Wang, D;** Sharma, N, *Engineering Nanoionic Interfaces towards High Performance Cathode Coatings* ($422,881)

**Primig, S**, *Advancing the Australian specialty alloy processing capability* ($330,000)

Saydam, S; Lamei Ramandi, H; **Kumar, N; Crosky, A;** Manefield, M; Canbulat, I, *Microbiologically Induced Stress Corrosion Cracking in Underground Mines* ($675,318)

**Sorrell, CC; Koshy, P**, *Fibre-Reinforced Composites: Single-Crystal Mullite Fibres from Topaz* ($340,000)

**Sorrell, CC; Hart, J; Koshy, P;** Swain, MV, *New Ceramic: Fully Stabilised Monoclinic $ZrO_2$ by $Al_2O_3$ + $SiO_2$ Additions* ($406,100)

**Yang, R;** Kourmatzis, A; Chan, H, *High-load powder dispersion and aerosol delivery: an integrated approach* ($231,800)

## ARC LINKAGE INDUSTRY PARTNER CONTRIBUTIONS

Chu, D; **Cazorla Silva, C**; **Wang, D**; Sharma, N, (funded by AOTOL Pty Ltd) *Engineering Nanoionic Interfaces towards High Performance Cathode Coatings* ($99,843)

**Chu, D; Wu, T; Cazorla Silva, C**; Howard, M, (funded by Australian Advanced Materials Pty Ltd)**.** *High performance metal oxide inks for printable memory arrays* ($158,886)

**Chu, D; Cazorla Silva, C;** Sharma, N; **Wang, D**, (funded by Qidong QiAo New Materials Technology Co Ltd) *Engineering Nanoionic Interfaces towards High Performance Cathode Coatings* ($10,000)

**Primig, S**, (funded by Western Australian Specialty Alloys Pty Ltd) *Advancing the Australian specialty alloy processing capability* ($149,000)

**Sorrell, CC**, **Hart J; Koshy, P**, (funded by Vecor Australia Pty Ltd) *New Ceramic: Fully Stabilised Monoclinic $ZrO_2$ by $Al_2O_3$ + $SiO_2$ Additions* ($300,000)

**Sorrell, CC; Koshy, P**, (funded by Top Fibre Pty. Ltd.), *Fibre-Reinforced Composites: Single-Crystal Mullite Fibres from Topaz* ($265,000)

**Yang, R;** Kourmatzis, A; Tong, Z; Chan, H, (funded by Singapore Medical Device Design & Development Pte Ltd) *High-load powder dispersion and aerosol delivery: an integrated approach* ($105,000)

## ARC INDUSTRIAL TRANSFORMATION RESEARCH HUB GRANTS

**Yang, R**, *"Grindability" test: modelling, measurement and mill fingerprinting* ($80,000)

**Zhang, J; Ostrovski, O** (Baosteel ITRH Partner Project). *Investigation of CaO-Al2O3-based flux for high Al steel continuous casting of high-Al steel* ($150,000)

## AUSMURI PROGRAM

**Primig, S;** Ringer, SP; Liao, X (DIIS - Dept of Defence US-Australia International Multidisciplinary University Research Initiative). *Microstructure Control in Metal Additive Manufacturing* ($1,450,000 apportioned)

## ARENA RESEARCH & DEVELOPMENT PROGRAM

Green, M; **Chu, D**; Chang, NL; Ekins-Daukes, N; Pillai, S; Zhou, Z; Tkachenko, SA; Bilbao, J; Egan, RJ; de Silva, C; Jiang, Y; Keevers, MJ; Timchenko, V, *UNSW – R&D Project – Advanced Silicon - Reduced Solar Module Temperature R&D Project* ($1,767,730)

## ACARP RESEARCH PROGRAM GRANTS

**Koshy, P**; Xing, X; **Chen, W; Gupta, SK; Sorrell, CC**, *Effect of Blend Characteristics on the High-Temperature Strength Evolution and Relevant Mechanisms in Cokes* ($309,800)

**Koshy, P;** Xing, X**; Gupta, SK; Sorrell, CC; Ostrovski, O**, *Effect of Coke Properties on High-Temperature Strength and Hot Metal Reactivity Under Blast Furnace Conditions* ($369,000)

## CSIRO

**Daniels, JE;** Ly, TC; Miljak, D (CSIRO - Top Up Scholarship). *CSIRO Mineral Resources Top-Up Scholarship for Thai Ly* ($47,126)

**Koshy, P** (CSIRO - Commonwealth Government Contract). *Characterisation of surfaces and advanced thin film materials for devices* ($8,107)

**Munroe, PR** (CSIRO - Meat & Livestock Australia Limited (MLA) Subcontract). *B.GBP.0032 Fit-for-purpose biochar to improve efficiency in ruminants* ($31,000)

**Sahajwalla, VH** (CSIRO - Dept of Industry, Science, Energy and Resources – Australia-India Strategic Research Fund (AISRF) - COVID-19 Collaborative Research Project Subcontract). *India - Australia Industry and Research Collaboration for Reducing Plastic Waste coordinated by the CSIRO* ($450,000)

# RESEARCH GRANTS 2020

## FEDERAL GOVERNMENT GRANTS

### *Innovation Connections Contract*

**Kilian KA**; Romanazzo S (Cynata Therapeutics LTD) *Programming Therapeutic Activity of Mesanchymal Stem Cells Through Engineered Extracellular Matrices* ($100,000)

## NEWS SOUTH WALES GOVERNMENT GRANTS

### *NSW DPIE Boosting Business Innovation Program*

Gibson, IR; **Koshy, P**; Stevens, M; Van der Meyden, R; Lim, ET; Hao, X; Szymanska, JM; Gross, M; Oliver, S; Bridge, W; Pettit, CJ; **Laws, KJ**; Davies, JE; Anderson, DJ; Miller, BM; Cassis, G; Tripovich, JS; Li, B; Alvarez Gaitan, JP; Yao, L; Noone, JH; Hu, W; Hredzak, B; Afrooz, AE; Liu, K; Abbasi, A; Glennon, EP; Howe, D; Das, A; Shen, X; Waters, S; Tan, T; Antoun, C; Maghrebi, M; Jenkins, RB; Boyer, CA; Tng, K; Rey, D; Rogers, SL; Joseph, SD; Amal, R; Ho-Baillie, AW; Katupitiya, J; Le Clech, P; Leslie, GL; Lovell, N; Lucien, F; Song, C; **Sorrell, CC**; Sowmya, A; **Munroe, PR**; Rabhi, F; Timchenko, V, *UNSW SME Global Innovation Connections Program* ($1,243,284)

### *NSW DPIE - NSW Circular Economy Innovation Network*

**Sahajwalla, VH**; McLean, L, *NSW Circular Economy Innovation Network* ($3,300,000)

### *DPIE - NSW Physical Sciences Fund*

**Sahajwalla, VH;** Heriyanto, .; Sterbic, M; Ghose, A, *SMaRT Microfactories Recycled Glass Panel Line* ($790,000)

### *NSW DPIE - RAAP - ARC Industrial Transformation Research Program*

**Sahajwalla, VH; Joshi, RK;** Boehme, T; Boxall, N; Sharma, N; **Maroufi, S;** Wang, H; Forsyth, M; Perez, P; **Pahlevani, F**; Giurco, D; Bhattacharya, S; O'Mullane, A; Florin, NH; Kerr, R; Tricoli, A; Malik, A; ,Florin, NH, *ARC Research Hub for Microrecycling of battery and consumer wastes* ($100,000)

### *NSW Department of Primary Industries*

**Munroe, PR** (CRC for High Performance Soils Ltd Subcontract). *Amelioration of subsoil constraints using innovative products and precision placement of soil amendments - PJA3.3.002* ($35,000)

**Sorrell, CC; Koshy, P** (Grains Research & Development Corporation (GRDC) Subcontract). *Tailoring an integrated solution to effectively address subsoil constraints by incorporation of chemically-balanced nano-amendments* ($15,000)

### *NSW Environment Protection Authority*

**Sahajwalla, VH; Maroufi, S** (EPA Product Improvement Program). *Transforming complicated waste into value-added products* ($50,000)

### *Sydney Water Corporation*

**Joshi, RK** (State Government Contract). *Scaleup of GO-based membrane for commercial applications* ($113,000)

### *Lord Mayor's Charitable Foundation Seed Innovation Shared Grant*

**Joshi, RK;** Matthews, J, *Help our marine life to stop eating microplastic "Junk" food* ($13,636)

## CONTRACT RESEARCH

**Chan, SL; Chan, SL;** Meng, K; Kartono, R (with Weir Minerals Australia). *Wear Mechanisms of Hot-Isostatic Pressed Cemented Tungsten Carbide for Mining & Minerals Processing* ($9,995)

**Chu, D; Li, S** (with Australian Advanced Materials Pty Ltd). *Development of RRAM* ($770,999)

**Chu, D; Cazorla Silva, C;** Jiang, Y (with YCGC Pty Ltd). *Enhancing the performance of photovoltaic panels by phase change inhibited materials* ($102,000)

**Chu, D; Cazorla Silva, C** (with YCGC Pty Ltd). *Enhancing the performance of photovoltaic panels by phase change inhibited materials* ($6,000)

**Chu, D; Tan, TT; Chan, SL** (with Weir Minerals Australia). *Preparation of carbide ceramics by sparking plasma sintering* ($33,500)

**Daniels, JE** (with DSTG Defence Science Partnering Deed). *Multiscale Characterisation of Relaxor Ferroelectric Single Crystals* ($99,180)

**Daniels, JE**; Cain, T; Kurusingal, V; Dean, C; Doisy, M; Pham Thi, M (with DMTC Limited). *Exploring electro-mechanical response of textured ceramics for underwater acoustics applications - PhD student Scarlet Kong* ($22,956)

**Joshi, RK** (with Vesi Water Pty Ltd). *Graphene Oxide Desiccant Project* ($73,141)

**Joshi, RK; Sahajwalla, VH** (Tyre Stewardship Research Fund - Scholarship Stream). *Generation of Gases from End-of life Tyres and Purification Using Novel Graphene Molecular Sieve - Scholarship for Xiaoheng Jing* ($75,000)

**Koshy, P** (with Brickworks Building Products Pty Ltd). *Characterisation of Building Products* ($33,688)

**Koshy, P** (with BHP Group Ltd). *Effect of Gasification Conditions on Extent of Coke Reduction* ($69,549)

**Munroe, PR; Taherymoosavi, S** (with Castle Mountain Zeolite Pty Ltd). *Analysis of zeolite-based biochars* ($2,000)

**Munroe, PR; Taherymoosavi, S** (with CHT Australia Pty Ltd). *Analysis of liquid-based biochars* ($5,000)

**Munroe, PR; Taherymoosavi, S** (with Ironwood Clean Energy Technologies Pty Ltd). *Analysis of zeolite-based biochars* ($1,100)

# 2020 RESEARCH GRANTS

**Munroe, PR; Taherymoosavi, S** (with Rainbow Bee Eater Pty Ltd). *Analysis of Slow Release Biochars* ($6,500)

**Munroe, PR; Taherymoosavi, S** (with Rainbow Bee Eater Pty Ltd). *Analysis of Biochars (With and Without Wood Vinegar)* ($9,900)

**Pahlevani, F; Sahajwalla, VH** (with Bradken Resources Pty Ltd). *Conducting in-situ investigation of microstructural change and carbide formation as indicated in proposal 19-38PR-2 from Bradken* ($29,870)

**Primig, S** (with Infrabuild Steel Pty Ltd). *Advancing Australian steelmaking for next generation construction applications* ($80,000)

**Sorrell, CC; Koshy, P** (with Allegra Orthopaedics Limited). *Optimisation of Processing Parameters for Superior Biomedical Product Characteristics - Part 1* ($57,531)

**Sorrell, CC; Koshy, P** (with Vecor Australia Pty Ltd). *Development of Fully Stabilised $ZrO_2$ – Support for Pramod Koshy* ($108,042)

## INTERNATIONAL CONTRACT RESEARCH

**Chan, SL; Chu, D**; Prusty, G (with Impresario Investments Ltd). *A Game Changing Hydrogen Production and Storage Technology for On-Board System (Phase 1)* ($505,375)

**Koshy, P; Gupta, SK**, **Sorrell C.C.** (with POSCO). *Survey of coal study trend and property database for developing high temperature coke property analysis methods* ($96,114)

**Koshy, P; Sorrell, CC** (with Vecor Labs, Philippines) *Development of Fly Ash-Based Composite Ceramics insert* ($8,430)

**Li, S** (with Zhejiang Hangdian Graphene Tech Co., Ltd). *Projects II: Graphene Enhanced Performance of Electric Transmission Lines* ($1,000,000)

**Mawad, D**; Zeglio, E; Herland, A (with KTH Royal Institute of Technology - Swedish Research Council). *Bio-functionalized Organic Electrochemical Transistors* ($34,592)

**Munroe, PR;** Joseph, SD (with Standard Bio). *Analysis of Biochars* ($150,000)

**Munroe, PR;** Joseph, SD, *Analysis of Biochars* ($80,000)

**Munroe, PR;** Joseph, SD (Norwegian Research Council Shared Grant). *Catch & Kill - Sustainable low-cost materials for air and water disinfection* ($303,777)

**Ostrovski, O**; Xing, X (with POSCO). *Characterisation of cokes for the blast furnace ironmaking at POSCO* ($37,327)

**Primig, S;** Stanojevic, A (with voestalpine BÖHLER Aerospace GmbH & Co K). *Direct ageing plus: process design through high resolution characterisation of Alloy 718* ($248,951)

**Primig, S;** Plesiutschnig, E; Turk, C; Kapp, M; Leitner, T; Kleber, S (with voestalpine BOHLER Edelstahl GmbH & Co KG). *Processing-structure-property relationships of forged Ni-based superalloys* ($283,769)

**Valanoor, N; Sando, D;** Bellaiche, L (DARPA - Topological Excitations in Electronics Subaward). *Topological functionalization of ferroelectrics and multiferroics* ($132,677)

**Yang, R** (with Jiangsu Industrial Technology Research Institute - Industrial Transformation Research Hub Partner Project). *"Grindability" test: modelling, measurement and mill fingerprinting* ($80,000)

**Young, DJ** (with ExxonMobil). *Dilute pentane metal dusting* ($56,030)

# RESEARCH PUBLICATIONS 2020

## BOOK CHAPTERS


Gan, J., & Qiao, L. (2020). Colloidal Quantum Dots for Highly Efficient Photovoltaics. In *Quantum Dot Optoelectronic Devices* (pp. 49-82). Springer International Publishing. https://doi.org/10.1007/978-3-030-35813-6_2

Hanaor, D. A. H., Koshy, P., & Sorrell, C. C. (2020). Phase stability and transformations in $TIO_2$. In *Rutile: Properties, Synthesis and Applications* (pp. 11-28).

Li, W. (2020). Magnetic Responsive Mn02 Nanomaterials. In *Springer Series in Materials Science* (pp. 139-163). Springer International Publishing. https://doi.org/10.1007/978-3-030-39994-8_4

Meier, D., Seidel, J., Gregg, M., & Ramesh, R. (2020). *Domain walls: From fundamental properties to nanotechnology concepts* [10.1093/oso/9780198862499.001.0001]. https://doi.org/10.1093/oso/9780198862499.001.0001

Rewatkar, P., Kumeria, T., & Popat, A. (2020). Size, shape and surface charge considerations of orally delivered nanomedicines. In *Nanotechnology for Oral Drug Delivery* (pp. 143-176). Elsevier. https://doi.org/10.1016/b978-0-12-818038-9.00005-3

Seidel, J., & Ramesh, R. (2020). Electronics based on domain walls. In *Domain Walls: From Fundamental Properties to Nanotechnology Concepts* (pp. 340-350). https://doi.org/10.1093/oso/9780198862499.003.0015

Sharma, P., & Seidel, J. (2020). Interfacial responsive functional oxides for nanoelectronics. In *Springer Series in Materials Science* (pp. 197-214). https://doi.org/10.1007/978-3-030-39994-8_6


## CONFERENCE PAPERS


Azam, A. B. M. S., Schmidt, W. H., Knudstrup, C., & Elford, K. (2020/11/09). *Saturation of Current Transformer in a Coordinated Substation towards Optimal Power Flow*. 2020 IEEE Electric Power and Energy Conference (EPEC),

Chou, A. S., Shen, P. C., Cheng, C. C., Lu, L. S., Chueh, W. C., Li, M. Y., Pitner, G., Chang, W. H., Wu, C. I., Kong, J., Li, L. J., & Wong, H. S. P. (2020/06/01). *High On-Current 2D nFET of 390 \mu A/\mu m at V_{DS = 1V using Monolayer CVD $MoS_2$ without Intentional Doping*.

Chung, Y. Y., Cheng, C. C., Kang, B. K., Chueh, W. C., Wang, S. Y., Chou, C. H., Hung, T. Y. T., Wang, S. Y., Chang, W. H., Li, L. J., & Chien, C. H. (2020/12/12). *Switchable NAND and NOR logic computing in single triple-gate monolayer $MoS_2$n-FET*.

Escobedo, J. P., Ameri, A. A. H., Gonzales, M., Miller, R., Wang, H., Quadir, M. Z., & Hazell, P. J. (2020/11/02). *Effect of peak stress and deformation history on the dynamic tensile behavior of a dual phase steel*.

Hazarabedian, M. S., Quadir, Z., Iannuzzi, M., & Lison-Pick, M. (2020/01/01). *Precipitation on the precipitation-hardened nickel alloy UNS N07725: Double-loop electrochemical potentiokinetic reactivation*.

Hora, H., McKenzie, W., Kirchhoff, J., Kirchhoff, G., Miley, G. H., Eliezer, S., & Nissim, N. (2020/08/01). *CPA Pulses for non-thermal ignition of clean and abundant Laser Boron Fusion for Electricity Generator*.

Hung, T. Y. T., Wang, S. Y., Chuu, C. P., Chung, Y. Y., Chou, A. S., Huang, F. S., Chen, T., Li, M. Y., Cheng, C. C., Cai, J., Chien, C. H., Chang, W. H., Wong, H. S. P., & Li, L. J. (2020/12/12). *Pinning-free edge contact monolayer $MoS_2$FET*.

Lee, K. C., Retamal, J. R. D., Xue, F., Cheng, B., Tang, H. L., Chiu, M. H., Hu, W. J., Wu, C. I., Chen, M. H., Li, L. J., Lien, C. H., & He, J. H. (2020/08/01). *Giant Electroresistance Switching of Two-dimensional Ferroelectric α-In2Se3 on p+-Si*.

Maroufi, S., Ciezki, G., Tangstad, M., Jahanshahi, S., & Ostrovski, O. (2020/01/01). *Characterisation and reduction of high-silicon monstone ore by CO gas*.

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