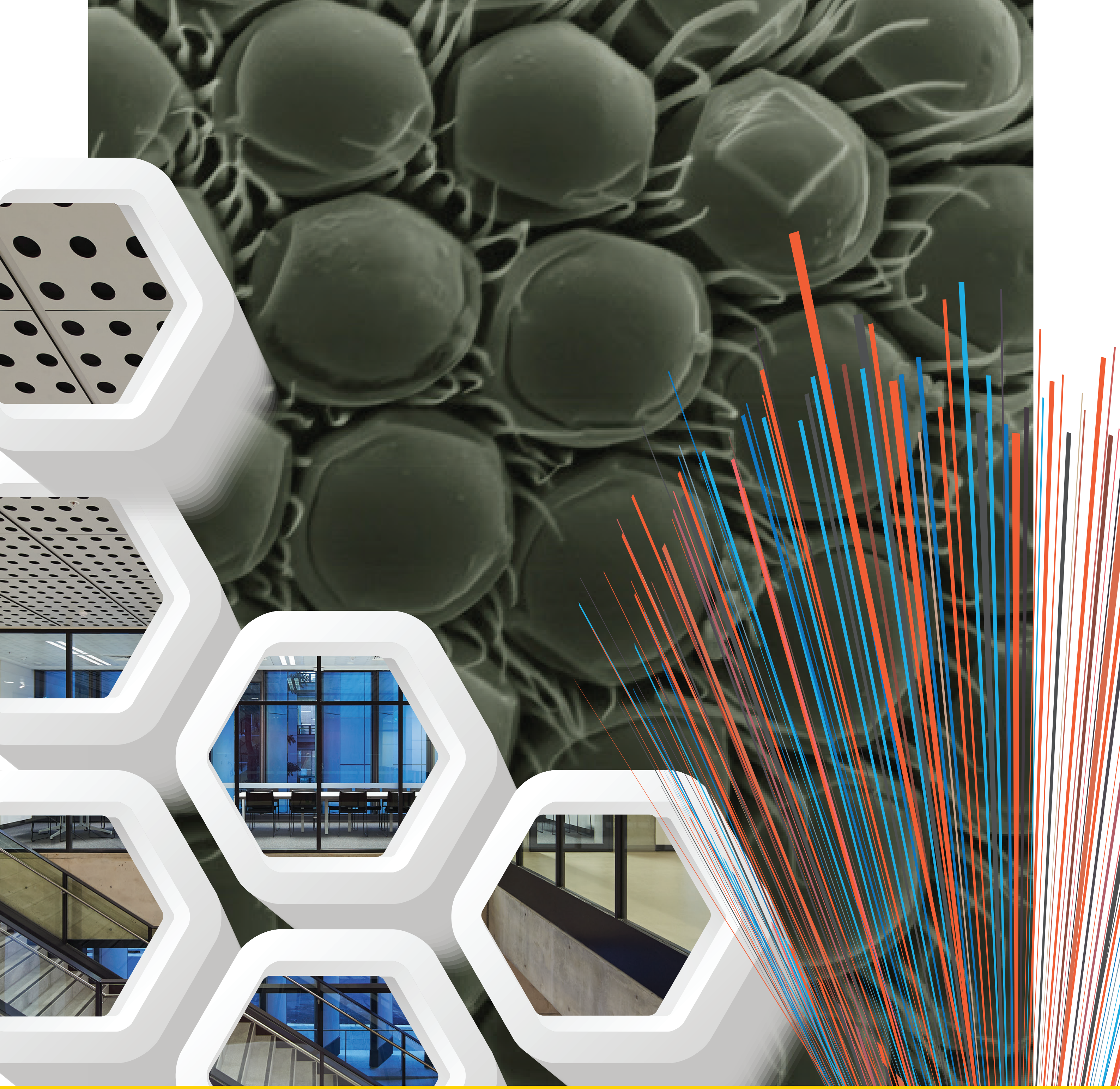


UNSW AUSTRALIA

School of Materials Science and Engineering

Annual Report 2014

Never Stand Still | Faculty of Science | School of Materials Science and Engineering

CONTENTS

PART ONE:

OVERVIEW

WHO WE ARE

From its foundation over 60 years ago, the School of Materials Science and Engineering at UNSW Australia has developed an international reputation for research and teaching excellence, innovation and development.

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

This year our research income totaled more than $11.9m – an outstanding achievement for a school with less than 25 academic staff.

The School is consistently ranked number 1 in Australia (QS World Rankings 2014) and, out of approximately 640 materials schools currently in existence around the world, Materials Science and Engineering at UNSW continues to sit well within the top 50.

Academic Staff	**22**
ARC Laureate Fellow	**1**
Research Staff	**31**
Professional Staff	**18**
Undergraduate and Masters by Coursework Students	**302**
Higher Degree Students	**144**
Refereed Research Publications	**260**
Grant Funding	**$11.9m**
Strategic UNSW Income	**$1.88m**

Foreward from Head of School

It is my pleasure to introduce the School of Materials Science and Engineering 2014 Annual report.

2014 was an extraordinarily successful year for the School.

Professor Veena Sahajwalla was highly successful on two related fronts. First, she was awarded an ARC Industrial Transformation Research Hub for "*Transforming e-waste directly in cost-effective green manufacturing*". This centre comprises a number of university and industry partners and will receive funding of ~ $6M over the next five years. Secondly, Veena was one of only 16 people across the country to be awarded an ARC Laureate Fellowship – the "Georgina Sweet Australian Laureate Fellowship". This prestigious award recognises Veena as one of Australia's research leaders. The fellowship provides her with funds to continue, and expand, her role as an outstanding mentor for female scientists, especially through the creation of '50/50' scholarships to encourage female students to study science-based disciplines at UNSW.

In addition to Veena's success, the School performed outstandingly well in attracting research funding. Staff in the School won 6 Discovery Project grants, 4 Linkage Project grants, 2 LIEF grants, 2 Future Fellowships and 2 DECRA fellowships. In total $11.9m of funding. Given that for most of these schemes the success rate is well below 20%, this is a remarkable achievement. Our two new Future Fellows are Dr Dewei Chu and Dr Claudio Cazorla. Dewei has been in the School for a number of years developing functional materials with Professor Sean Li. Claudio comes to us from Spain where he has worked for some years in computational modelling of electronic materials. Both have now taken up these positions are establishing their research groups.

Professor Nagy Valanoor won directly, or indirectly, a number of awards in 2014. He was awarded the Young Alumnus of the year award from his alma mater, the University of Maryland, and the IEEE Young Investigator of the Year award. His former student, Rama Vasudevan was awarded the 2014 Faculty of Science Award for Excellence in PhD Research and Julian Walker, co-supervised by Nagy and Chris Sorell was awarded the Excellence Award for Best Oral Presentation by a Young Scientist at the PFM2014 Conference. These collective achievements recognise Nagy's outstanding research leadership in functional materials.

There have been a number of changes in the School's academic staff profile. Associate Professor Xuchuan Jiang and Dr Zongyan Zhou left UNSW to move to Monash University. Moreover, Associate Professor Sri Bandyopadhyay decided to retire. Bando has been on the academic staff of the School for 23 years and has been much loved by generations of students. He maintains an association with the School through a visiting appointment and continues to supervise a number of research students. The School welcomed a new lecturer, Dr Rakesh Joshi, in January. Rakesh is an expert in graphene and is seeking to develop graphene-based materials in collaboration with Veena's efforts in material recycling. In 2015 two new lecturers will commence duty. Dr Damia Mawad is an expert in biopolymers and currently works at Imperial College in London. Dr Sophie Primig is a physical metallurgist with an interest in structure property relationships. She currently holds a position as University of Leoben in Austria. We are looking forward to all three academics furthering and expanding their careers at UNSW.

The School began its relocation into its new building in March 2015. Staff and students relocated over a single weekend with minimal loss of items and sanity. Laboratory equipment was relocated on a floor-by-floor basis and that process is now nearing completion. Staff and students now enjoy abundant natural light and an array of collaborative and social spaces, all of which were sadly lacking in the old building. This exciting new building provides the School with contemporary laboratories and desperately needed expansion space.

Early in 2015, Professor Ian Jacobs took up the position as President and Vice-Chancellor at UNSW. He and his team have already visited the School (in its new building), to learn of our work and aspirations. The University is currently busy establishing a new strategic plan to take the institution to 2025 and we expect the School to play a significant role in the University's new direction. This new plan will continue to be developed through the remainder of 2015.

The School's achievements over the past year are detailed throughout this report and I am delighted to present this overview of our recent work.

Professor Paul Munroe
Head of School

Financial Report 2014

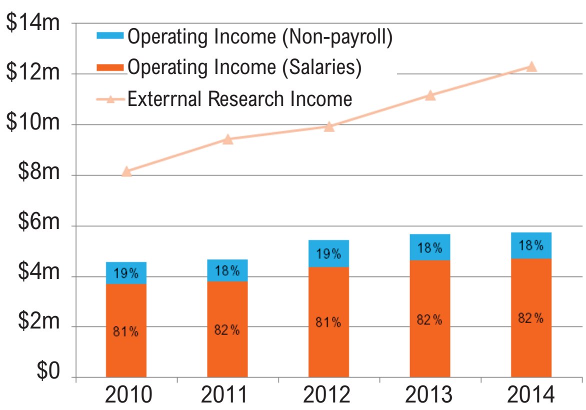
Overall the School is currently in a very strong and robust financial position. Its operating income has grown from a large deficit situation in earlier years to a strong position, which has enabled growth in academic staff. This growth is primarily due to an increase in the number of undergraduate and postgraduate research students.

INCOME

The School receives its income from three primary sources:

Operating income consists of allocations from the University, via the Faculty, to fund the day to day running of the School. Income is linked to a series of drivers around the level of undergraduate teaching load and research training, grants and outputs. Allocation is based on undergraduate and postgraduate teaching loads. *Research income* comes from research grants obtained from bodies outside the University. *Strategic allocations* are made by the University to the School for specific purposes. Trends in the School's operating and research income are shown in Figure 1.

Figure 1: Trends in School's Operating & Research Income



Operating Income

The majority of our operating income is allocated to salaries for teaching and research academics, technical, professional and casual staff. A number of the School's academic staff hold externally-funded research fellowships, however, shortfalls in these fellowships are paid out of the School's operating income, via a capped allocation that is specified by the University.

Other major expenditure items include support of teaching laboratories, administration, marketing and outreach, undergraduate recruitment scholarships, and allocations to staff based on research supervision and publications.

Table 1 below shows the breakdown of School operating income in 2014. During the year one Future Fellow and one Federation Fellow finished their fellowships and returned to School's teaching salary payroll. Previous Federation Fellow, Aibing Yu, moved to Monash University in April. This unexpectedly freed up salary, which had been budgeted for his salary and several research staff who followed him to Monash. Our final position showed a deficit, due to unbudgeted costs associated with preparation for relocation to the new Materials Science and Engineering building.

Table 1: Breakdown of School's Operating Income

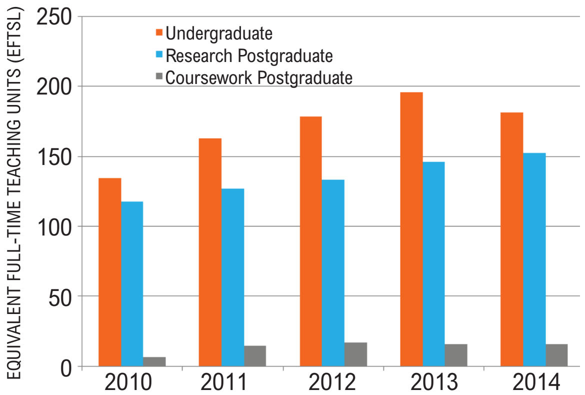
INCOME		
University:		
Teaching	$9,669,384	
Other	$3,000	$9,672,384
Allocation to School:		
Teaching and Research	$5,730,878	
Fellowship salary shortfalls	$170,572	
Capital equipment funding	$120,000	$6,021,450
EXPENDITURE		
Salaries	$4,925,972	
Non-salary	$1,059,178	
Capital expenses	$134,247	$6119,397
Variance		($97,947)

Apart from some essential laboratory equipment replacement, the School Research Committee also assessed applications for the School Infrastructure expenditure. The following bids were successful:

EQUIPMENT	RESPONSIBLE FOR ORDERING	ALLOCATION ($)
IR Gas Analyser	Narendra Saha Chaudhury	$22,500
Instron Extensometer	William Joe	$5,000
Residual Gas Analyser	Nagarajan Valanoor	$22,500
Desktop Scanning Tunnelling Microscope	Jan Seidel	$17,683
Ion Sputtering Gun	Sean Li	$15,000
UV-Vis-NIR spectrometer (specifically to upgrade existing spectrometry facilities)	Xuchuan Jiang	$10,000

The primary driver for operating income at the School level is undergraduate and postgraduate teaching load. The strong growth the School has seen in these areas in recent years is shown in Figure 2. We can see a slight dip in 2014 because the strong Australian dollar was a deterrent to international students.

Figure 2:



External Research Income

External research income comprises the largest fraction of the overall income of the School. It is the funding provided by external bodies to the School's staff to undertake specific research projects. The School is a very high performing research unit within the University. Figure 1 shows trends in internal research income. Despite Aibing Yu's departure, and the School's growth in teaching-load driven operating income, research income continues to grow at a steady rate.

UNSW Strategic Funding

The University provides central funding for a range of strategic research purposes including infrastructure, support of national initiatives and projects for early career researchers. In 2014, these included:

PROJECT NAME	PROJECT MANAGER	($)
Area of Research Strength & Internal Centres	Aibing,Yu	25,000
Federation and Laureate Fellowships	Aibing Yu	301,848
AINSE Fellowships	John Daniels	40,000
APF/ARF - 50:50	Nagarajan Valanoor	83,126
VC Postdoctoral Fellowships - Research Support	Guozhong Xing	10,000
Co-Operative Research Centres	Michael Ferry	33,333
Research Support: Mark Hoffman	Michael Ferry	135,000
Strategic hire SPF03	Judy Hart	135,990
ECR Development of novel sol	KaiWei Chu	4,927
ECR Use of charcoal in iron mark	Yansong Shen	4,927
ECR Unravelling force character	Qinfu Hou	4,927
ECR Towards fundamentals under	Shibo Kuang	4,927
2014 Goldstar_Michael Ferry	Michael Ferry	40,000
2014 Goldstar_Mark Hoffman	Mark Hoffman	40,000
Total:		824,005

Major Research Equipment and Infrastructure Initiative (MREII) Grants

The University receives an Research Infrastructure Block Grant, from which it funds the Major Research Equipment and Infrastructure scheme, designed to provide UNSW with a world-class research environment to attract and retain a critical mass of research excellence. In 2014, the School was awarded the following major equipment

LEAD CHIEF INVESTIGATOR	PROJECT TITLE	GRANT ($)
Michael Ferry	Laboratory-scale hot and cold rolling mill for metallurgical processing of sheet metal products	120,000
Sean Li	Professional Officer Level 8 Step 1 to commission, customize and operate a fabrication facility	114,825
Jan Seidel	Photo electrochemical nanomaterials workstation	99,850
Nagarajan Valanoor	Stainless Steel Pulsed Laser Deposition (PLD) Chamber	65,000

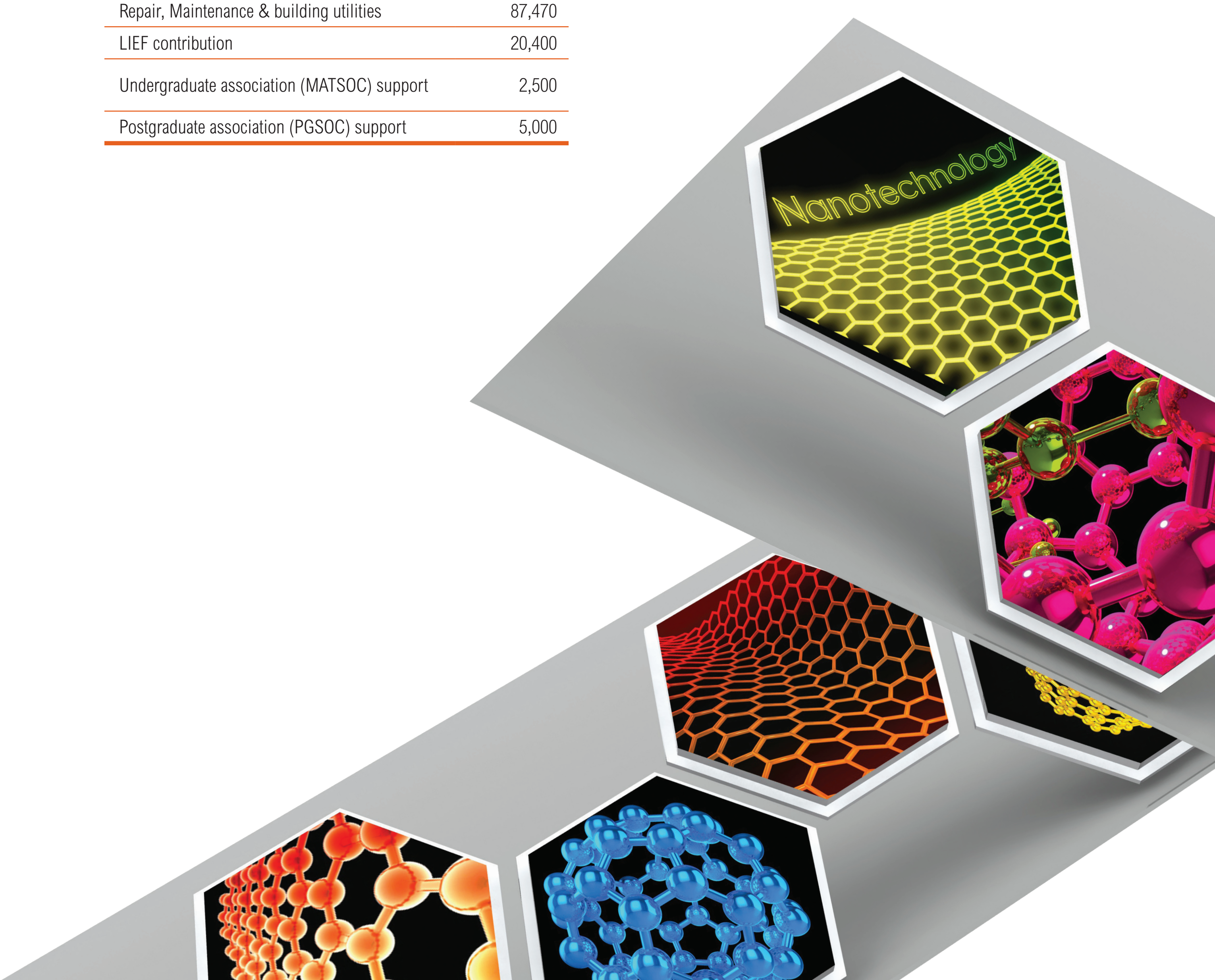
EXPENDITURE

In 2014 salaries comprised approximately 80% of the School's total non-capital operating expenditure. This is in line with the majority of schools across the campus. Despite the strong rise in salary costs, our income has grown at a faster rate, providing greater flexibility in strategic directions. The School's main expenditure items in 2014 were:

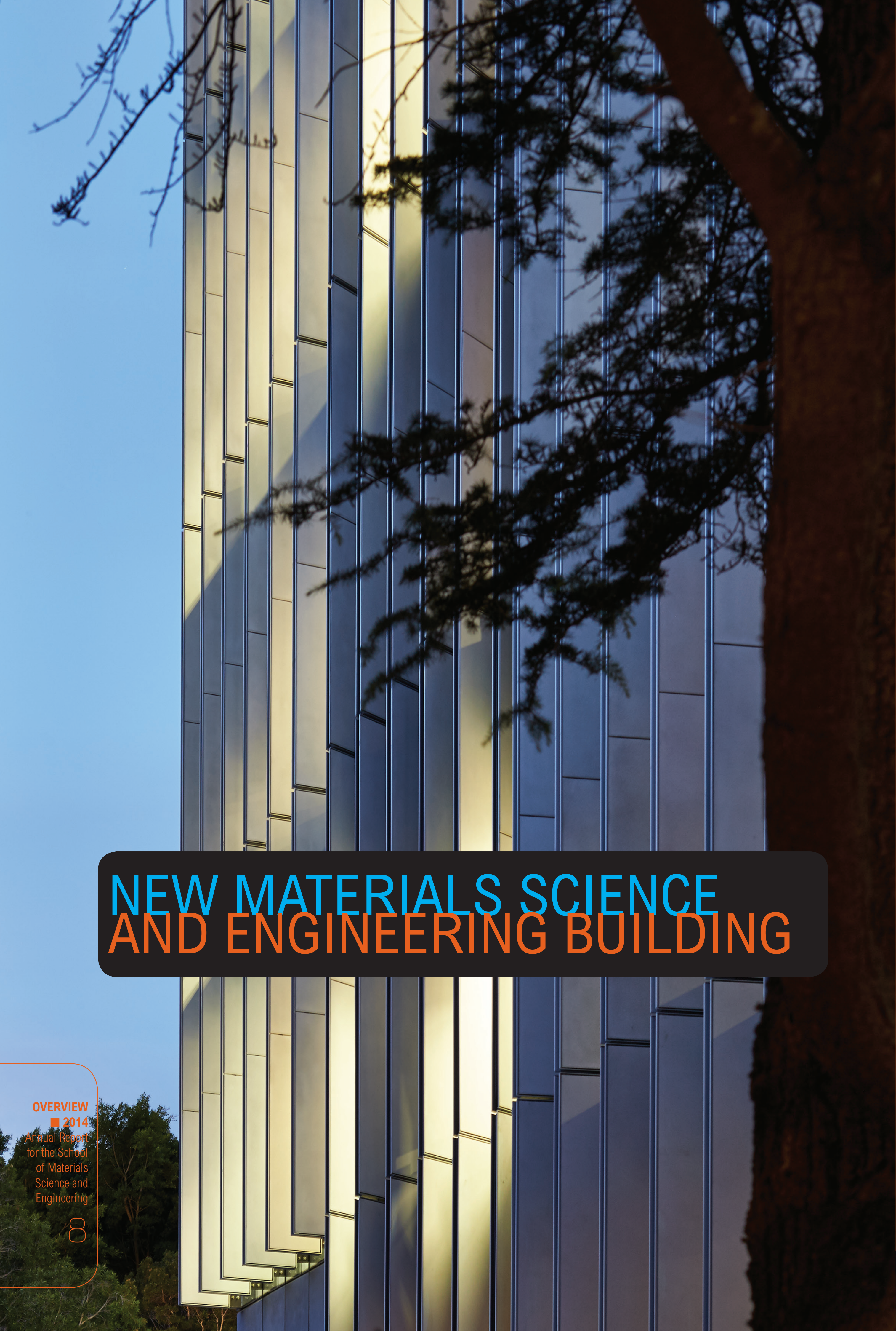
ITEM	AMOUNT ($)
Faculty Research Grants	40,000
Student Research Allocations	150,000
Undergraduate scholarships	90,000
Computer technical support	40,000
Publications allocation	150,000
Teaching laboratories	58,426
Safety	12,000
School Office	35,000
Staff Start Up	130,000
Marketing	35,000
Repair, Maintenance & building utilities	87,470
LIEF contribution	20,400
Undergraduate association (MATSOC) support	2,500
Postgraduate association (PGSOC) support	5,000

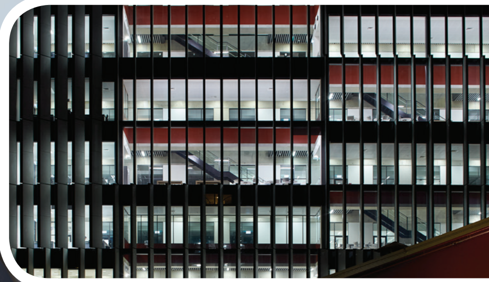
Faculty Research Grants are funds for small research projects, which are allocated from the School's operating budget. When allocating these grants, the School preferences junior staff who have not had the opportunity to build up significant external research funding. In 2014, the recipients were:

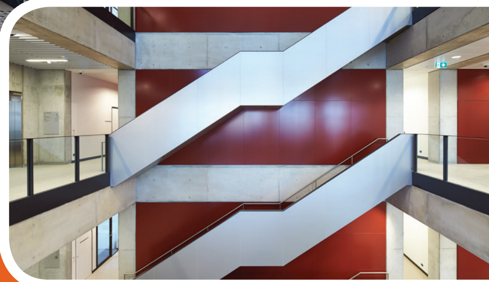
CHIEF INVESTIGATOR	PROJECT TITLE	GRANT ($)
Kejun Dong	A numerical study on the effect of shape on the self-assembly of colloidal particles	10,000
Judy Hart	Design and development of new semiconductors for cheap and efficient renewable energy	14,000
Danyang Wang	Micromechanical modelling and analysis of hydraulic transport of solids in pipelines	8,000
Zongyan Zhou	Micromechanical modelling and analysis of hydraulic transport of solids in pipelines	8,000



NEW MATERIALS SCIENCE AND ENGINEERING BUILDING







Staff and students moved into the stunning new Materials Science and Engineering building in March 2015. The relocation of the School's laboratories has been an extraordinary feat of logistics over several months, however, as this report goes to print, almost all equipment has been recommissioned and our gleaming new, state-of-the-art laboratories are open to staff and students for research and teaching.

This contemporary, purpose-built facility was designed by Grimshaw Partners, Architects, with significant input from HDR, who were contracted to facilitate the design of laboratory spaces. Planning meetings were held between the architects, HDR and stakeholders from the School to develop detailed designs for the parts of the building dedicated to experimental research and teaching. The building construction contract was won by Brookfield Multiplex. Capital Insight, who project-managed the build, have worked closely with all stakeholders to facilitate a (largely) smooth process.

A key feature of the new building design is the flexibility of modular spaces that allows laboratories to be adapted to changing research and teaching paradigms. There are also several open, and highly flexible, areas located throughout the building to serve as, for example, collaborative spaces for teaching and learning, an exhibition space for students to present their research findings or areas for networking during research conferences and similar activities. The glass walls of the building also ensure a remarkable amount of natural light can enter the building. Our School occupies the basement, much of the ground floor and Levels 1 to 4 of the building. Currently, the top three floors remain empty to be fitted out once an appropriate tenant is identified.

At a cost to the University of $143 million, this exciting new space will take the School well into the future and is a clear sign of the commitment of UNSW Australia to the future growth of Materials Science and Engineering.

The less tangible value of the University's investment can perhaps be summed up in the words of our undergraduate students, who are thrilled to be studying in this vibrant new learning space:

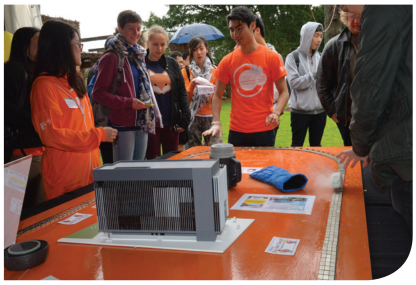
"The opening of the doors to the new MSE building signifies the opening of the doors to a plethora of new opportunities for the students. With the state-of-the-art facilities, the possibilities of what can be achieved are stacked as high as (if not higher) than the building itself." Gagan Jalandhra, 2nd year Mats/BioMed

"I think that the number of students enrolling into materials increases every year, so with the arrival of the new building, it accommodates this growing faculty and it gives an exciting new space for students to interact more and to build up a stronger student community." Jacqueline Mach, 5th year Mats/BioMed

"This is not only a new chapter for our School of Material Science and Engineering, but also a new chapter in my education. Moving into the new, state-of-the-art building will be opening doors to a flourishing, elevated future in my degree." Lara Nouri, 2nd year Mats/BioMed

Marketing and Outreach Activities 2014






The School's marketing strategy aims to create awareness and to communicate the interdisciplinary nature of the Materials Science and Engineering programs as well as to convey the collegial and vibrant nature of our community to prospective students considering a career in advanced science and/or engineering. Several marketing activities were implemented during this year to achieve these goals.

Despite extreme weather conditions, including flash flooding, **Open Day 2014** attracted record number of prospective high school students, parents and other visitors to the School's exhibitions. The impact achieved by the new MSE orange onesies, t-shirts and a myriad of oranges freebies was significant as it attracted a constant stream of curious visitors during the course of the day.

In addition to the demonstrations, the School ran two competitions: "Win a set of Dr Dre studio headphones" and the "mseselfie" photo competition. These competitions aimed to increase the number of survey/mailing list registrations and online engagement among prospective high school students, both during and after the event. From 552 survey respondents on the day, 57% (312) were year 12 students. Over 60% of high school visitors claimed to have a better understanding of materials science and engineering after visiting the tent and 61% said they were considering a career in science.

A **Digital Media Content Strategy** was launched one month prior to the release of the ATAR results - a crucial period to generate awareness among school leavers. This strategy included producing and posting informative content about our School (achievements, opportunities, alumni stories etc.) and about the field of materials science (with the "Materials that changed History" campaign) over an eight week period, to generate awareness and increase traffic from the Facebook page to the School's website. The posts with the highest number of engagements included: "*Materials that changed history: Silicon*" (17,476 reach and 76 engagement), the "Materials that changed history" campaign launch post (12,968 and 34 engagement) and the "*SCAA Scholarship*" (reach 9524 reach with 41 actions)

Below is an excerpt from "Materials that Changes history: Silicon":

"The 20th Century proved that #materialsmatter! You may not realise it but a tiny collection of materials called the Silicon chip is the brain that runs our modern world. Silicon is a semiconductor, which means that it conducts electricity, but not very well. This sounds like a problem, but it is exactly what you want if you are trying to create a computer out of a single material because you need some parts to conduct electricity and others not to conduct at all."

The **School's Newsletter**, "Material News" was also revamped to coincide with the launch of the School website. The new design is reader friendly, accessible and fresh. Whilst the main target audience is still Alumni, it also incorporates an undergraduate section to highlight student achievements and promote their engagement with the rest of the MSE community.

On February 26, 2014 the School hosted the "**O-week welcome**" for new undergraduate students. Professor Paul Munroe, Head of School, opened the celebration by welcoming the new cohort and introducing them to academic, technical and administrative staff. The official part of the event was followed by a tour of the facilities and by a brunch were students had the opportunity to meet their academic and peer mentors for the year.

The School ran two interactive lectures during July and November as part of **Science Info Day 2014**. This event is run by the Faculty of Science with the aim of giving high School students a taste of university life as a UNSW Science student. Professor Alan Crosky presented the July session and Dr Judy Hart presented the November session. These interactive sessions were followed by Q&A and an opportunity for the high school students to meet and engage with current undergraduate students and lecturers, to gain a better understanding of Materials Science and Engineering.

Website

In late 2013 we embarked on a project to redesign the School's somewhat tired website, giving it a bright, fresh look and developing new and relevant content. The revamped website (www.materials.unsw.edu.au) was launched on 13 May 2014.

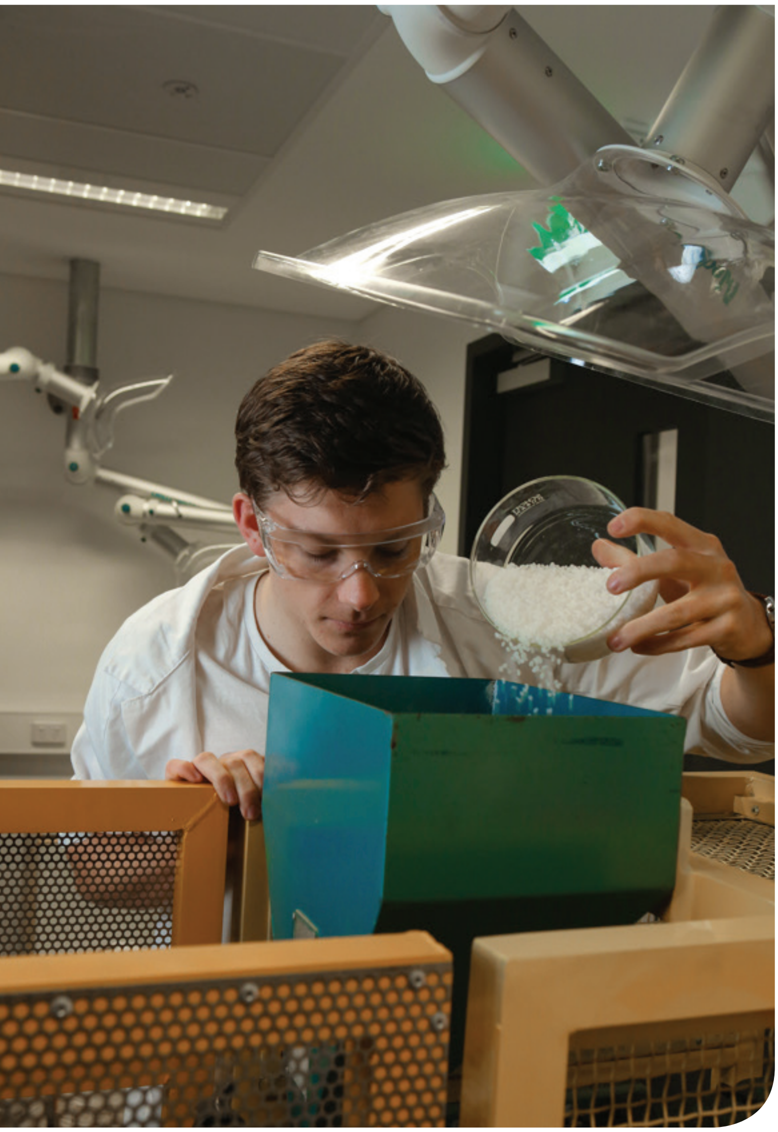
Our primary target audience is high school students, particularly those in Year 11 and 12, who are working towards university admission. We have endeavoured to encourage a better understanding of what the study of materials science and engineering involves, while creating interest in the various possibilities that a degree in materials offers. Information has been laid out in easy, uncomplicated language with, as much as possible, a one-click format.

We have also developed new content to encourage international students, both undergraduate and post-graduate.

The website is constantly evolving as we try to stay ahead of the curve by showcasing what's going on in the School, events for prospective students, staff and student achievements, as well as creating interest with stories ranging from study abroad experiences to the latest developments in materials around the world. We also advertise regular seminars to promote academic excellence.

Beyond recruitment, the website is a tool for current students, alumni, research and industry partners. It is closely aligned with our highly successful Facebook site in encouraging a strong and inclusive School community.

Work Health And Safety (WHS)



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

In 2014, the School WHS Committee consisted of Owen Standard (chairperson and academic representative), Anthony Zhang (School Safety Officer), Rahmat Kartono (administrative and technical staff representative), Ruiping Zou (research-only staff representative), and Paul Munroe (management representative). The Committee met quarterly to discuss, monitor, and implement WHS policy and procedures, to investigate hazards and incidents, and to consult with staff and students.

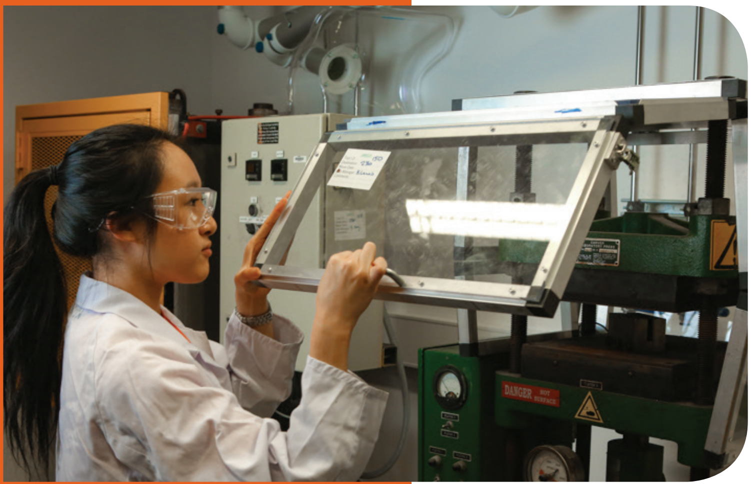
WHS activities in the School during 2014 included: continued update of WHS documentation and policies to comply with the updated documentation introduced by the UNSW HS Unit; electrical tagging and testing of equipment and appliances; mandatory School WHS information session (held in both semesters) for all new research staff, new postgraduate students, and Honours students; gas training session provided by the company Air Liquide; various laboratory training courses over the year; evacuation drill for the School in each session; laboratory safety audits conducted bimonthly; inspection and audit check of all offices and laboratories by the School WHS Committee.

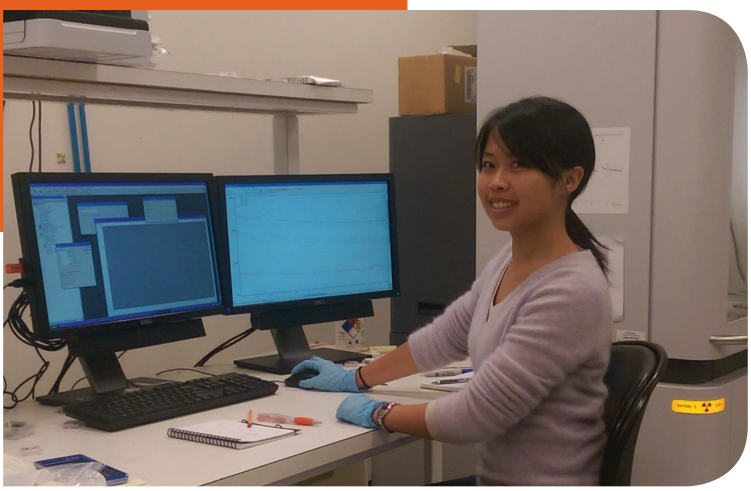
Over the course of the year, laboratory supervisors and laboratory managers provided extensive input into laboratory design and associated health and safety systems for the School's new building.

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

Dr Owen Standard
WHS Chairperson

Women in Materials





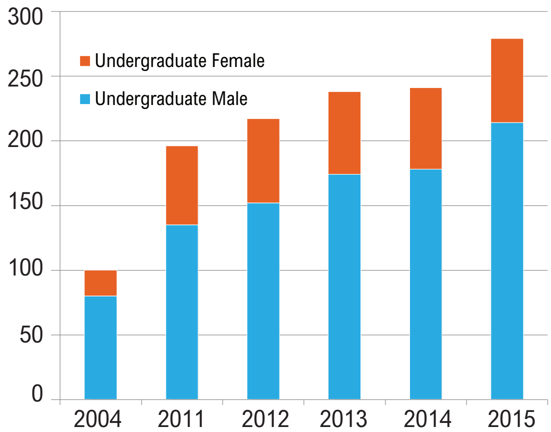
In 2014, we established a "Women in Materials" group and held several events to provide support and development for our female students. The aim of these events is to give our students opportunities to discuss and prepare for some of the challenges they may face during their careers in a male-dominated work place.

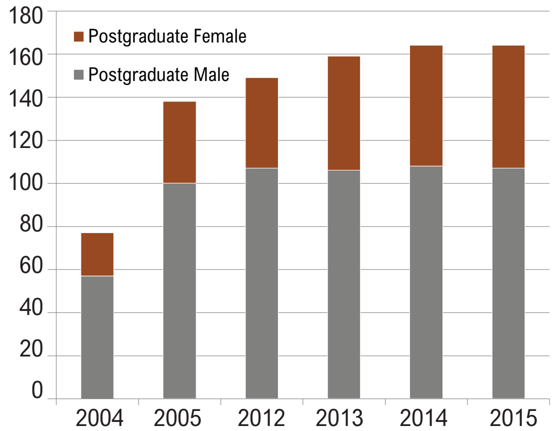
Events in 2014 included two careers seminars, where women working in different professions came to UNSW to share their own career experiences. These seminars provided insights into life working in policy development with the NSW government and running a small company; both were very positively received by the students.

We also held some networking lunches, to allow students to get to know each other and share their own experiences in an informal setting. The "Women in Materials" group also has a Facebook page and wiki page for sharing useful resources.

Currently in the School of Materials Science and Engineering, around 30% of our students are female and the number of female postgraduate students has been steadily increasing over the past five years.

Over that same period, however, the proportion of female undergraduates has decreased. The advent of the Science 50:50 program is aimed squarely at resolving this anomaly.





Scientia Professor VEENA SAHAJWALLA

Australian Research Council Laureate Fellow & Director, SMaRT Centre School of Materials Science and Engineering UNSW Australia

Professor Veena Sahajwalla FTSE FIEAust directs the **Centre for Sustainable Materials Research and Technology (SMaRT)** at UNSW, delivering scientific and engineering advances in sustainability of materials in close collaboration with industry partners. In 2014, Professor Sahajwalla was awarded a prestigious **Australian Research Council Laureate Fellowship** that brings with it $2.37 million for research into micro-recycling of e-waste; she received a **Georgina Sweet Fellowship** which has laid the foundations for '**Science 50:50**', a wide-reaching program designed to inspire women to pursue careers in science and engineering; and the SMaRT Centre was awarded $2.2 million by the **Australian Research Council (ARC)**, with funding and in-kind contributions from industry to a total of $8.8 million, to create an Industrial **Transformation Research Hub** for transforming waste directly in cost-effective green manufacturing - a first for UNSW Australia.

2014 Australian Research Council Laureate Fellows Announcement.
Photography - Russell Millard

AWARDS:

• Winner, Sydney Engineers Excellence Awards, 'Green Materials: Novel processes to transform automotive glass and plastic waste into value-added materials'. Category: Research & Development, Recipient: SMaRT Centre

AWARDS JUDGING:

- The Australian: Innovation Challenge, August/ September 2014
- Free fall Experience, ABC TV, August 2014

INVITED PANEL MEMBER:

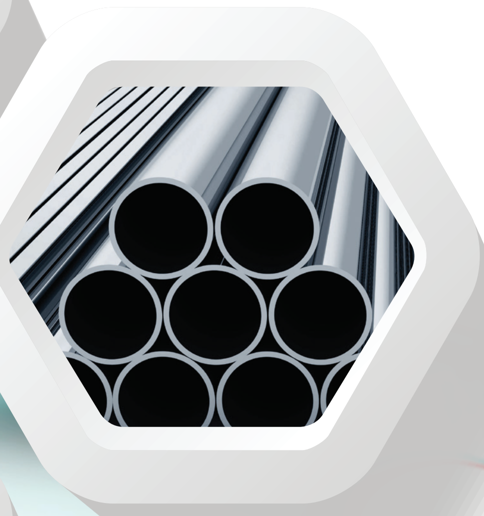
- Invitation from Ian Chubb, Chief Scientist for Australia, to join Strategic Priority Workshop.

In 2014 Professor Sahajwalla was invited by Chief Scientist for Australia, Ian Chubb, to join an academic workshop promoting productive industry-research collaborations. Her role was to discuss industry research collaboration and green materials from the perspective of the SMaRT Centre at UNSW Australia.

PROJECTS & PROGRAMS IN DETAIL:

ARC Industrial Transformation Research Hub - transforming waste directly in cost-effective green manufacturing

Awarded by the ARC in 2014 and commencing in 2015, the Industrial Transformation 'green manufacturing' Research Hub will create a unique opportunity for various industries to come together, with a common goal of creating value from mixed plastic and glass waste in manufacturing. The ITRH will develop scientifically-based solutions to some of the most challenging waste burdens within a framework particularly applicable to the Australian context. Building on the SMaRT Centre's international successes in 'green' steel manufacturing, the research hub will undertake world-leading research into the high temperature transformation of glass and plastic-rich waste streams into value-added manufacturing intermediates and novel products. The new hub is housed at the School of Materials Science and Engineering and will help Australian manufacturers develop ground-breaking processes and product innovations. Preparation for the program commenced in 2014 with the announcement of the research hub and the engagement of industry and local government through industry networking, conferences, workshops and the development of the 2015 International Sustainability Symposium in partnership with the World Resources Forum.



Australian Research Council Laureate Fellowship - e-waste research into high-value products

The prestigious Australian Research Council Laureate Fellowship received by Professor Sahajwalla in 2014 will provide the scientific foundation for a novel concept - the environmentally and economically sustainable micro-recycling of e-waste. The 5-year program will open advanced 'niche' markets for value-added metals and alloys derived from the untapped potential of 30-50 million tonnes of hazardous e-waste generated annually worldwide. The possible global economic, environmental and human benefits of cost-effective, safe, micro-recycling solutions that can be deployed locally are immense. Preparation for the program commenced in 2014 with the engagement of industry partners through new industry partnerships and collaborations and activities to develop relationships between industry and the SMaRT Centre.

Georgina Sweet Fellowship - Science 50:50 program

The Georgina Sweet Australian Laureate Fellowship for science and technology was awarded to Professor Sahajwalla in 2014 for her outstanding achievements in the field. The funding received has enabled her to establish 'Science 50:50', an outreach program to promote women in science and technology. The Science 50:50 program has been designed to support, mentor and inspire Australian girls and young women into careers in science and technology and to help them to succeed in an innovation-driven future. Science 50:50 provides scholarships, mentoring, industry immersion and networking opportunities in partnership with schools, the UNSW Science Faculty, academics and industry. Planning for the 2015 launch at the Australian National Maritime Museum (ANMM) commenced in 2014. It involved the participation of leading female scientists and industry representatives to share their career stories with more than 200 school students at the inaugural Women in Science Symposium. Co-hosted by UNSW Science and the ANMM, Science 50:50 was officially launched by UNSW President and Vice-Chancellor Professor Ian Jacobs.

Polymer Injection Technology - international commercialisation

Building on the SMaRT Centre's international reputation for leading innovations, the centre continues its ongoing collaboration with industry partner OneSteel, and UNSW Innovations, to support new Polymer Injection Technology ('green' steel) commercialisation agreements around the world. Adding to agreements currently in place with companies in Thailand and South Korea, in 2014 a new agreement was signed in the United Kingdom.

PART TWO:

PEOPLE

SCHOOL ADMINISTRATION

Head of School
Paul Munroe

School Manager
Lucy Zhang

Executive Assistant to HoS
Joanne Hallis

Outreach and Student Liaison Officer
Juanita Vargas

Student Services Officer
Laura McNally

Administrative Officers
Anne Aylmer
Alan Chow
Qing Xia

Industry Relations & Communications Manager
Uttra Benton

Committees

School

School Advisory Committee
Paul Munroe (Chair)
Owen Standard
Dewei Chu
Pramod Koshy
Laura McNally
Lucy Zhang

Research Committee
Nagy Valanoor (Chair)
Paul Munroe
Veena Sahajwalla
Sean Li

Teaching and Learning Committee
Sammy Lap Ip Chan (Chair)
Alan Crosky
Owen Standard
Danyang Wang
Judy Hart
Paul Munroe

OHS Committee
Owen Standard (Chair)
Anthony Zhang
Paul Munroe
Ruiping Zou
Rahmat Kartono

Marketing and Recruitment Committee (Operational)
Paul Munroe (Chair)
Juanita Vargas
Lucy Zhang
Joanne Hallis

Marketing and Recruitment Committee (Strategic)
Chris Sorrell (Chair)
John Daniels
Juanita Vargas
Alan Crosky

Space Committee
Michael Ferry (Chair)
Lucy Zhang
Rahmat Kartono

New Building Committee
Michael Ferry (Chair)
Paul Munroe
Lucy Zhang
Owen Standard
Joanne Hallis

Masters Coursework Review Committee
Chris Sorrell (Chair)
Runyu Yang
Nagarajan Valanoor

School Scholarship Committee
Veena Sahajwalla (Chair)
Owen Standard

Postgrad Coordinator
John Daniels

Honours Project Coordinator
Jianqiang Zhang

Undergraduate Program Coordinator
Owen Standard

Masters Coursework Coordinator
Runyu Yang

Misconduct and Grievance Officer
Owen Standard

PGSOC Staff Representative
Jan Seidel

MATSOC Staff Representative
Jiabao Yi

Nanotechnology Degree Coordinator
Danyang Wang

Overseas Degree Programs / Asia Engagement
Sammy Lap Ip Chan

Women in MS&E
Judy Hart

Visiting

Roger Leigh (Chair)
Senior Project Manager, Cochlear Limited

Adam Berkovich
Manager – Carbon, Pacific Technology Centre, Pacific Aluminium

Lyndon Edward
Head, Institute of Materials Engineering, ANSTO

Robert Every AO
Chairman of Board – Boral & Wesfarmers

Catherine Foley
Chief – Division of Materials Science & Engineering, CSIRO

Michiel Freislich
Director, Energy and Environment, Iron and Steel, HATCH

Edward Humphries
Pump Technology Centre Manager, Weir Minerals

Cathy Inglis
Group Technical, Research and Engineering Manager, Brickworks Building Products

George Melhem
Managing Director, Perfect Engineering Pty Ltd

Daniel Miles
Business Development Manager, OneSteel Limited

Chris Mouatt
National Research & Development Manager, Boral Bricks

Paul Zulli
Manager Iron and Steel Making Research, BlueScope Steel

UNSW AUSTRALIA

Merlin Crossley
Dean, Faculty of Science

Shane Griffin
Director, Student Recruitment & Scholarships

Paul Munroe
Head, School of Materials Science & Engineering

Owen Standard
Deputy Head of School, Materials Science & Engineering

Lucy Zhang
School Manager, Materials Science & Engineering

The School extends thanks to outgoing committee members, **Fred Bradner** of Weir Minerals and **David Varcoe** of Bluescope Steel Research for their service to the School. Fred has served on the Committee since 2008 and David since 2010.

Thank you also to retiring Chair, **Leo Selleck** from Arrium Mining & Materials, for his outstanding contribution to the Visiting Committee from 2007 to 2014 (Chair since 2009).

Our Academic Staff

ARC Future Fellow
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.

Associate Professor
Sammy Lap Ip Chan

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

ARC Future Fellow
Dr Dewei Chu

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

Professor
Alan Crosky

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

Senior Lecturer
Dr 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.

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 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 extensive mechanical property. His research covers fracture mechanics, fatigue and wear and tribology from the macro- to nano-scale.

Lecturer
Dr Rakesh Joshi

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

Professor
Sean Li

Sean's research is mainly focused on the interface engineering of heterostructural complex oxides and advanced multifunctional materials, including magnetic, thermoelectric and ferroelectric materials. In addition, his research examines the theoretical constructs underpinning the behaviour of these materials.

Head of School
Professor
Paul Munroe

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

Emeritus
Professor
Oleg Ostrovski

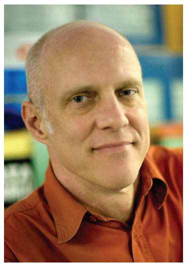
Oleg's major contributions are in the field of pyrometallurgical technologies for minerals processing, iron-, steel- and ferroalloy-making. Areas of research include thermodynamics, kinetics and mechanisms of metallurgical reactions, properties of molten metals and slags, reduction, smelting and refining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

ARC Laureate Fellow, Scientia Professor, Veena Sahajwalla

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

Associate
Professor
Jan Seidel

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



Professor
Chris Sorrell

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

Deputy Head of School, Senior Lecturer, Dr Owen Standard

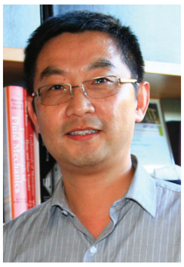
Owen's research is in the processing/microstructure/property relationship of advanced ceramics for functional applications including colloidal processing of electroceramics, compositional and microstructural modification of bioactive and bionert ceramics, sol-gel deposition of functional ceramic coatings,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

Professor
Nagarajan
Valanoor

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

Lecturer
Dr Danyang Wang

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



Associate Professor Runyu Yang

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

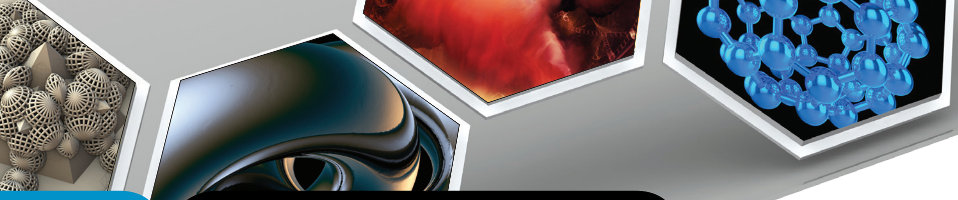
Emeritus Professor David Young

David's most significant contributions are in the field of high temperature alloy-gas interactions. Particular emphasis is placed on the diffusion and phase transformation processes which support these reactions. Current work includes fundamental studies of corrosion by Co_2, metal dusting reactions and water vapour effects on oxidation.

Senior Lecturer
Dr Jiabao Yi

Jiabao's most significant contributions are in the field of diluted magnetic semiconductors, based on oxide semiconductors, matnetic materials, nonstructural, oxide electronics and spintronics materials.

More detailed information about our Academic Staff can be found on the School website:
materials.unsw.edu.au



STAFF 2014

RESEARCH STAFF

Joseph ARSECULARATNE
Postdoctoral Fellow

KaiWei (Kevin) CHU
Senior Research Associate

Irene EMMANUELAWATI
Research Assistant

Muhammad IKRAM-UL-HAQ
Research Associate

Baoyu GUO
Lecturer

Sushil GUPTA
Senior Research Fellow

Manuel HINTERSTEIN
DECRA Fellow

Qinfu (Quentin) HOU
Postdoctoral Fellow

Reza KABIR
Research Assistant

Yusef KANETI
Postdoctoral Fellow

Rita KHANNA
Associate Professor

Pramod KOSHY
Senior Research Associate

Shibo KUANG
Senior Research Associate

Kevin LAWS
Senior Lecturer

Reza MAHJOUB
Research Associate

Thuan Dinh NGUYEN
Postdoctoral Fellow

Farshid PAHLEVANI
Senior Research Associate

Anh PHAM
Research Associate

Ravindra RAJARAO
Research Associate

Yasushi SASAKI
Professor

Pankaj SHARMA
Research Associate

Thiam Teck (TT) TAN
Postdoctoral Fellow

Chunguang TANG
DECRA Fellow

Tania VODENITCHAROVA
Postdoctoral Fellow

Zhiyang WANG
Postdoctoral Fellow

Xing XING
Postdoctoral Fellow

Wanqiang (Martin) XU
Lecturer

Adnan YOUNIS
Postdoctoral Fellow

Rong ZENG
Senior Research Fellow

Qi (Peggy) ZHANG
Postdoctoral Fellow /
Technical Officer

Qijun ZHENG
Postdoctoral Fellow

Ruiping ZOU
Senior Lecturer

TECHNICAL STAFF

Soo Woon CHONG
Technical Officer

Jane GAO
ITC Support Manager

Bulent GUN
Technical Officer

William (Bill) JOE
Research Support Engineer

Rahmat KARTONO
Technical Officer

Danny KIM
ITC Support Officer

Irshadahmed MANSURI
Technical Officer

John SHARP
Research Assistant

George YANG
Technical Officer

Anthony ZHANG
Safety Officer

NEW STAFF

ARC Future Fellow
Dr Claudio Cazorla

In late 2014 we welcomed Dr Claudio Cazorla to the School as a new Senior Lecturer under the Australian Research Council Future Fellow scheme.

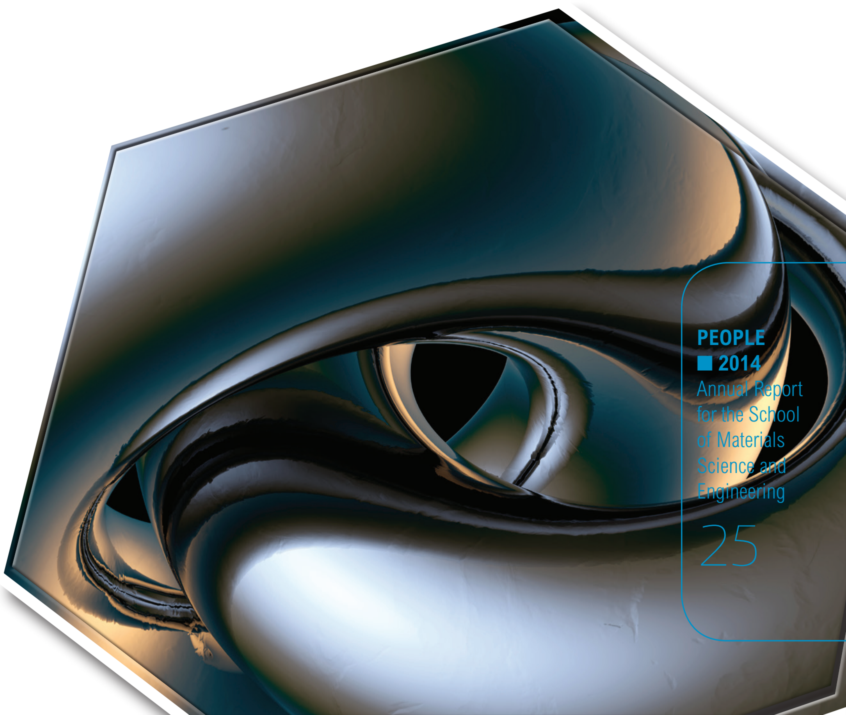
Claudio completed his graduate and postgraduate work in the School of Physics at the University of Barcelona, Spain. His PhD was supervised by Professor Jordi Boronat, investigating extreme quantum condensed matter at ultra-low temperatures by means of advanced computer simulation techniques. Prior to his UNSW appointment, Claudio has held a number of research fellowships in University College London and the Institute of Materials Science of Barcelona.

ARC Future Fellow
Dr Dewei Chu

Dr Dewei Chu joined the School of Materials Science and Engineering, UNSW as an Australian Postdoctoral Fellow (APD) and in July 2014 he was awarded an ARC Future Fellowship. Dewei received a PhD in Materials Science from the Chinese Academy of Science in July 2008. He joined the National Institute of Advanced Industrial Science and Technology (AIST), in Japan, from July 2008 to October 2010. In November 2010, Dewei received a Japan Society for the Promotion of Science (JSPS) Fellowship. In April 2011, Currently Dewei directs a research group focusing on ionic conductive oxide based nanomaterials for energy efficient nanodevices applications and he has published over 50 papers as first/corresponding author in this area.

Lecturer
Dr Rakesh Joshi

Dr Rakesh Joshi joined the School as a lecturer in January 2015. He completed his PhD from the Indian Institute of Technology Delhi in the area of functional nanomaterials. Prior to joining UNSW he was a Marie Curie International Fellow with Nobel Laureate Prof Andre Geim at the University of Manchester. He has held research positions in South Florida, the Toyota Institute Japan and Duisburg Germany and has worked on various forms of carbon and advanced semiconductor materials. Rakesh is in the editorial board of many journals and he is a RACI Chartered Chemist. He is currently a member of SMaRT@UNSW and is developing methods to convert low-valued waste into extremely high-valued carbon materials.



DEPARTING STAFF

After 22 years at UNSW, **Professor Aibing Yu** left the School to take up a position with Monash University as Pro-Vice Chancellor and President of the Southeast University Joint Research Institute.

From 1992 to 2014 Aibing was active in the School of Materials Science and Engineering at UNSW. He founded the Australia-China Joint Research Centre for Minerals, Metallurgy and Materials (3-M Centre) and the Centre for Simulation and Modelling of Particulate Systems (SIMPAS). He was promoted to Professor in 2001, became a Scientia Professor in 2007 and was a ARC Federation Fellow from 2008 to 2013.

Aibing is a world-leading scientist in particle/powder technology and process engineering. Since 1993 he has held approximately 50 grants from the Australian Research Council and has collaborated with many industrial organisations, including BlueScope Steel, BHP-Billiton, Alcoa, Rio Tinto, Kawasaki Steel (Japan), China Steel (Taiwan) and Posco (South Korea). In 2010 he was named NSW Scientist of the Year in the category of Engineering, Mathematics and Computer Sciences, and in 2014 became a Fellow the Royal Society of New South Wales. He has been a fellow of the Australian Academy of Science since 2011.

Aibing is Editor of both 'Powder Technology' and 'The Journal of Energy Chemistry' and serves on several editorial boards. He continues his association with the School as a visiting professor.

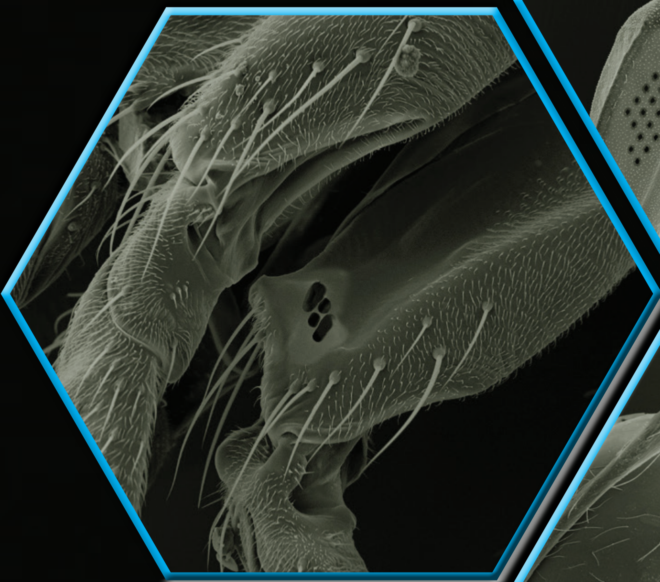
Associate Professor **Sri Bandyopadhyay** retired in mid-2014, after 23 years at UNSW Australia.

Bando (as he is affectionately known in the School), has held a number of significant grants over the course of his career. In 2009 Bando was the lead CI on the $1.55m AISRF Targeted Allocation "Nano-composites in Clean Energy" project. The project's focus was the recycling of fly ash, a freely available by-product from coal-fired power stations. Bando and his research team developed a technique to turn the powdery material from black to near white, making it a more attractive product for use in strengthening commercial polymers, such as plastics, ceramics, cement and even white paints. He has also chaired the ACUN series of International Composites Conferences.

Bando is well known for his penchant for poetry and song and can regularly be relied upon to liven up School functions with his unique vocal talents.

Over the years, Bando has taught countless undergraduate students of Materials Science and Engineering, primarily in polymer engineering, fracture mechanics and nanotechnology. He continues to supervise PhD students and currently holds a visiting appointment in the School.

farewell and good luck!



"Closer"

by Stephanie Valentin

with expertise from Paul Munroe

Professor Paul Munroe used his expertise in Focused Ion Beam Microscope Technology to manipulate specimens for Stephanie Valentin's 'Closer' exhibition.

This is their third collaboration as part of the 'Adaptations' series, which explores an ongoing interest in the human relationship to the natural world and the ecological effects of climate change.

Blurring the realms of reality and fantasy, Valentin has drawn on Paul's scientific expertise in ion-beam technology, to create microscopic sculptural interventions on the physical forms of dead insects. The specialised electron microscope was employed to etch with gallium ions, sculpting patterns and perforations on the insects' bodies.

These speculative adaptations respond to a very real ecological dilemma: the limited ability of many species to move habitat or evolve quickly enough to survive a rapidly changing climate. Imagine insect eyes with a physically enhanced structure, or additional breathing holes, multiplied in hexagonal formation. "Closer" provokes the viewer and invites empathy for an otherwise invisible subject.

STAFF AWARDS AND ACHIEVEMENTS

Associate Professor Sammy Chan was announced as a recipient of the 2014 Vice Chancellor's Award for Teaching Excellence. Sam's success follows a long tradition of teaching staff in the School winning this award. It is a highly prestigious and highly regarded award, which is presented to the most outstanding teachers in the University. Sam has a long track record in the School as a gifted and dedicated teaching and this award is testimony to his efforts in this area.

Dr Pramod Koshy was honoured with the 2014 Faculty of Science Award for Teaching Excellence. Koshy has provided outstanding teaching for the School over the past couple of years. Our students strongly value and appreciate the high quality of his teaching and this award is very well deserved.

In 2014 Dr Koshy was one of three School staff promoted to Level B Lecturer. Also promoted were **Dr Shibo Kuang** and **Dr KaiWei Chu**, both of whom are specialist researchers in the Laboratory for Simulation and Modelling of Particulate Systems (SIMPAS), and have achieved considerable success in research outcomes at the beginning of their careers.

We were also pleased to confirm the promotion of **Jan Seidel** to Associate Professor. Since Jan joined the School in early 2012 he has been outstandingly successful in attracting research funding from a wide range of sources, authoring papers in the highest calibre journals and rapidly building a very visible international profile in his field. His performance in the School has been quite remarkable.

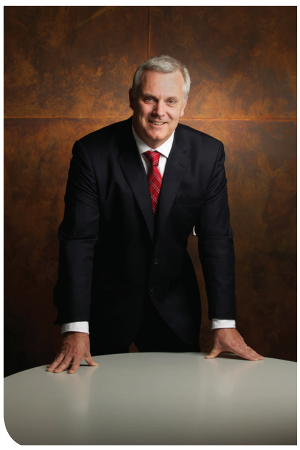
The University of Maryland awarded the inaugural Early Career Award from the A. James Clark School of Engineering to **Professor Nagarajan Valanoor**, in recognition of his significant professional achievements and exceptional contributions to the advancement of technology. The award honours those individuals who have made meritorious, rapid achievements in the early stages of their career.

This year Professor Valanoor was also awarded the UFFC Ferroelectrics Young Investigator Award. This award recognises "the achievements of the University, Industrial or Laboratory researchers in the area of ferroelectric materials and applications" and is awarded by the US Institute of Electrical and Electronics Engineers (IEEE).

Scientia Professor Veena Sahajwalla has been awarded the Australian Research Council's most prestigious fellowship - a Georgina Sweet Australian Laureate Fellowship.

Veena is the Director of the Centre for Sustainable Materials Research and Technology (SMaRT) and is a current ARC Future Fellow. Her Fellowship will allow her to work on transforming toxic electronic waste (e-waste) into value-added metals and alloys - simulataneously segregating hazardous constituents and preventing the generation of harmful emissions during processing.

This is an exceptionally prestigious award, with only 16 awarded across Australia and just 2 of those to UNSW. We congratulate Veena on a truly outstanding achievement.



Professor Mark Hoffman was announced as the new Dean of Engineering. Despite his onerous new role, Mark maintains a strong affiliation with the School as a member of our academic staff, supervising a team of postdoctoral researchers and postgraduate students.

International Microscopy Conference 2018 Sydney, Australia

Professor Paul Munroe

In early 2007, Professors Simon Ringer (USyd) and Paul Munroe were invited by 'Business Events Sydney' to bid for the 18th International Microscopy Conference to be held in 2014. Ever willing to take up a challenge, not matter how stupid, we accepted this invitation and pulled together a bid team to make the case to the world microscopy community to bring IMC18 to Sydney. The bid, made in Rio in 2010, was, unfortunately, unsuccessful as the compelling sentiment was for the conference to be held in Prague.

Disappointed, but undaunted, we resolved to try again. So in 2012 we, in the immortal words of Jake and Elwood, 'put the band back together' and established a bid team including AMMS president, Martin Saunders, Rhiannon Kuchel from UNSW, Deirdre Molloy, Miles Apperley and Ellie Kable from the University of Sydney. Together with Suzanna Rickard and her team from Business Events, this group set about planning our campaign to bring IMC19 to Australia, with a view to presenting our bid at the Prague conference in 2014.

Our strategy had many facets, not least being to build momentum through a presence at several microscopy events held in the year or so before Prague. To that end, we had exhibition booths at several meetings where we inundated attendees with clip-on koalas and conveyed the message that it was time for IMC to return to Australia.

Finally, the bid team converged on Prague in what was, frankly, a do or die attempt to bring the conference home; our bid competing against Beijing, China and Busan, South Korea. With our team supported by over 50 other Australian attendees, we 'Koala-ed for Australia', carpeting bombing the conference with 4,000 of the little critters, complemented by the bid team's own collective weight in Tim-Tams to harden the arteries of conference attendees. Throughout the week we built a compelling case for IMC19 to come to Sydney, with these activities being supplemented by formal bid presentations from Simon and myself.

On the last evening of the conference, the vote was held at the IFSM General Assembly and to our delight, and utter relief, we won the bid to hold IMC19 in September 2018.

Elation was soon tempered by the sober reality of what lay ahead. This is a significant conference (well over 3,000 attended IMC18) together with a major trade exhibition. Our bid team has now morphed into a 'conference organization committee'. Over the coming months and years, it will likely grow as others in the Australian microscopy community join us to build a capable and committed team determined to create a dynamic, exciting meeting at Sydney's spectacular new conference centre.

PART THREE:

STUDENTS

Undergraduate Study Programs

BACHELOR OF ENGINEERING (MATERIALS SCIENCE AND ENGINEERING)

The first year of the program lays a strong foundation in mathematics, chemistry and physics. Second year moves deeper into materials science through courses in fundamental properties and structures of materials, as well as aspects of engineering design, application and selection of materials. In third and fourth year, the study of materials properties and practical evaluation allows greater specialisation through technical and professional electives. Electives vary with the selected study plan and include Ceramics, Materials, Physical Metallurgy or Process Metallurgy. Fourth year students have the opportunity to concentrate on a research project sharpening experimental and analytical skills. The program includes lectures, practical hands-on laboratory work and research and design projects. It also includes components of professional communication, management aspects of business and industrial training.

BACHELOR OF ENGINEERING (MATERIALS SCIENCE AND ENGINEERING) / MASTER OF BIOMEDICAL ENGINEERING

This degree includes a four year Bachelor of Engineering in Materials Science and a fifth year Master of Biomedical Engineering. It is specifically designed for students who want to pursue a career in biomedical engineering through the technical base of materials science and engineering.

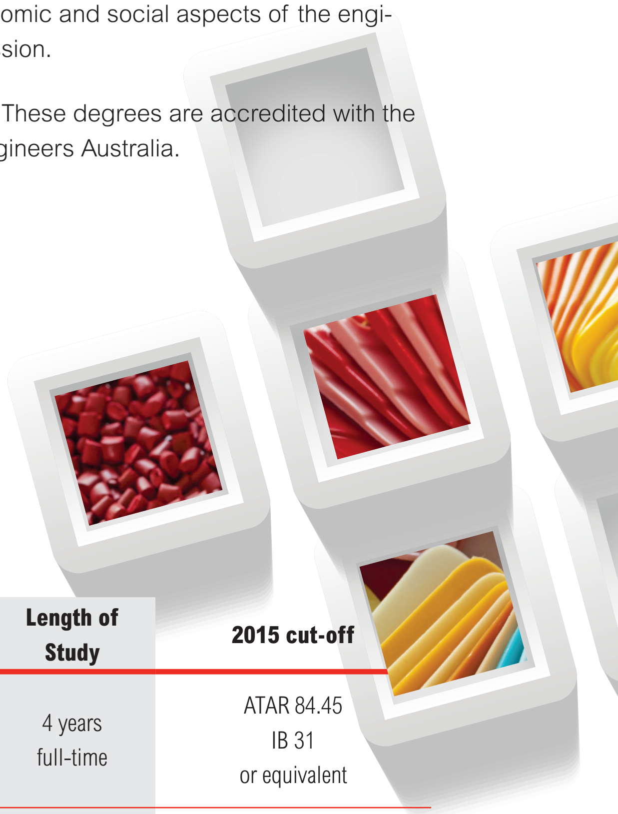
BACHELOR OF ENGINEERING (MATERIALS SCIENCE AND ENGINEERING) / CHEMICAL ENGINEERING

This degree is specifically for students wishing to pursue a career in the related disciplines of materials engineering and chemical engineering, with professional accreditation in both disciplines. It is a new and unique combination of professional qualifications that no other Australian institution currently offers.

BACHELOR OF ENGINEERING (MATERIALS SCIENCE AND ENGINEERING) / COMMERCE

This degree is for potential engineers in the fields of physical metallurgy, materials engineering, ceramic engineering or process metallurgy who want to become skilled in technical management and more aware of economic and social aspects of the engineering profession.

Accreditation: These degrees are accredited with the Institute of Engineers Australia.

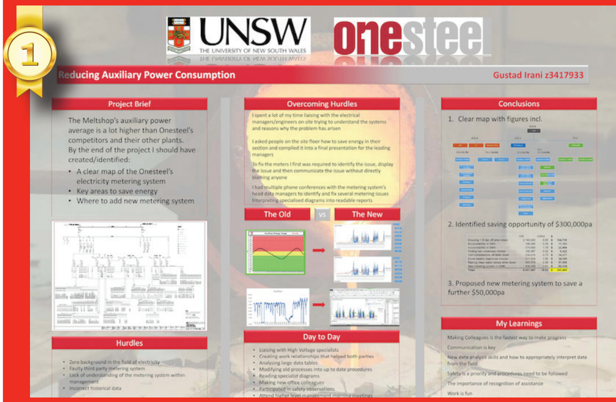


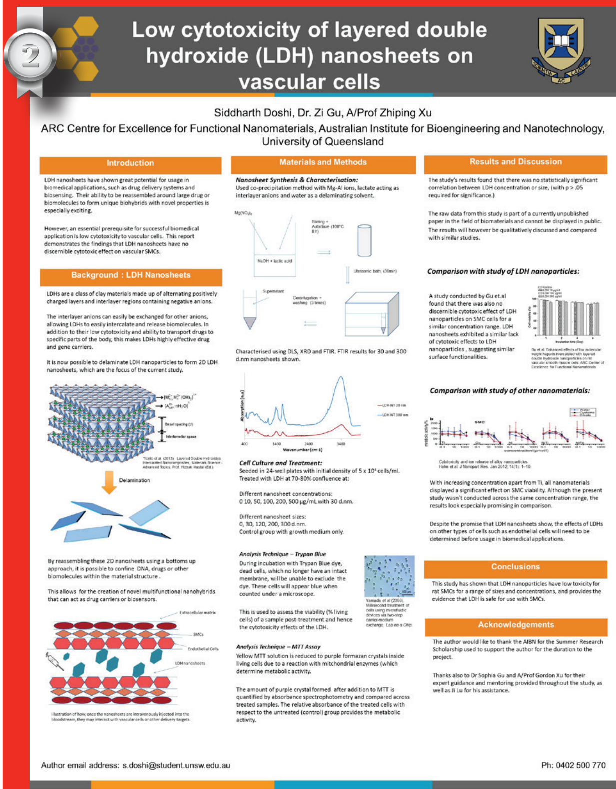
Program	UAC Code	UNSW Program Code	Length of Study	2015 cut-off
Bachelor of Materials Science and Engineering	429600	3135	4 years full-time	ATAR 84.45 IB 31 or equivalent
Materials Science Engineering / Biomedical Engineering	429630	3138	5 years full-time	ATAR 91.00 IB 34 or equivalent
Materials Science Engineering / Chemical Engineering	429620	3137	5 years full-time	ATAR 91.00 IB 34 or equivalent
Materials Science Engineering / Commerce	429610	3136	5.5 years full-time	ATAR 96.30 IB 38 or equivalent

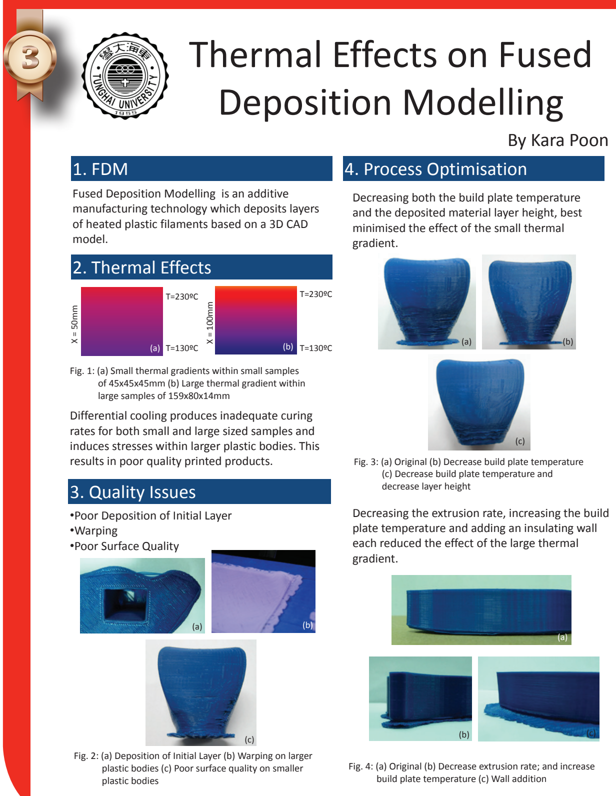
Undergraduate Industrial Training Poster Presentation

On Tuesday 25 March 2014 the School held its annual Industrial Training Poster Presentations evening. Around 40 undergraduate students presented posters and a brief oral summary outlining their experiences during the industrial training component of their course. A large number of industry visitors also attended the event. The winners for the best presentations were:

First place: Gustad Irani
Second place: Siddharth Doshi
Third place: Kara Poon







MATSOC Report

The Materials Science and Engineering Society (MATSOC) had a highly successful 2014, with active members upholding the aims to encourage School spirit, inter and intra-School engagement and interaction. Not only were old initiatives maintained, such as First Year Camp and BBQs, but new initiatives were implemented for the greater enjoyment of undergraduate students at the School of Materials Science and Engineering.

The Executive Committee for 2014 were elected by their peers at the AGM in November 2013. They were elected on the grounds of their prior experience and also their vision for the society. The aim of all new members was to engage the Materials Science students in more MATSOC events and to help students of all degree levels to engage more with each other. The First Year Representatives were elected in 2014 at the annual First Year Camp. The full team comprised 18 members as follows:

- *President:* Kara Poon
- *Vice Presidents:* Deep Kochar and Gavin Chan
- *Treasurer:* Jonathan Lee
- *Secretary:* Amanda Lai
- *ARC Delegate:* Nadia Funayama
- *Social Director:* Nadia Funayama
- *Industrial Liaison:* Sarah Pearn
- *Fourth Year Representatives:* Jacqueline Mach and Kenneth Tam
- *Third Year Representatives:* Amanda Lai and Richard Chu
- *Second Year Representatives:* Andrew Trimmer and Scarlet Kong
- *First Year Representatives:* Kevin Pei and Saba Payrovi
- *Post-Graduate Representatives:* Neil Lazo and Amanda Wang

The Executives coordinated a number of BBQs on campus to aid in funding and to encourage networking between students and staff. The BBQs were held every 2-4 weeks and included the Welcome Back BBQ in Semester 1 to welcome new students, current undergrad and postgrad students and staff. The BBQs were coordinated by approximately four students who set-up the BBQ and grilled and caramelised the delicious sausages and onions. Each BBQ raised up to $150 and this money was used to fund other events hosted by the MATSOC team.

MATSOC held a joint First Year Camp with CEUS (the Chemical Engineering Student Society) in early April. The students were put through their paces via a number of team building projects, including races to build the tallest newspaper towers and furthest-flying plastic bottle rockets. Around ten MSE first year students joined the Camp and it was a great opportunity for our new students to meet each other and to form new friendships. We were all fortunate to hear some motivational words from Prof. Alan Crosky on the field of Materials Science and Engineering.

A charitable initiative that had started the year before was continued in 2014 – the Red-Cross Blood Drive. MATSOC aimed to raise awareness of the importance of the cause throughout the School. Once again, the Materials Science students came forward and proved how kind their hearts are through blood and plasma donations and moral support for their peers.

A highly anticipated initiative of the year was the MATSOC Hoodies project. A lot of research was required by the team to determine the best company and hoodie design that would fit the student's fervour for their School. The design was a great success and we received around 50 orders from undergraduates, postgraduates and staff. Some people even purchased extra hoodies as gifts for friends! We received really warm and positive feedback and we were still receiving extra requests long after the final hoodie was delivered to its owner.

After a very enthusiastic suggestion by one of our Vice Presidents, it was decided that MATSOC should hold a Paintball event in July for the Materials students. Both postgraduates and undergraduates combined to form two strong teams who battled over a number of paintball fields during the day. The day was a great success and although slightly bruised and battered, all students went home with big smiles.

MATSOC also held its annual Bowling and Laser Tag evening at Strike Bowling Bar at Moore Park. About 20 students attended the evening in August and it was an occasion for students to interact in a casual and relaxed environment.

In August, MATSOC aimed to encourage the sporty side of the School by sending a team of Materials students to represent the School at the Annual Engineering Sports Day. The day included several games of Touch Footy between all the Engineering Schools at UNSW. Our students played hard and admirably. Furthermore, it was a great opportunity to make ourselves known amongst the Engineering Schools at UNSW.

With the approach of exams, MATSOC organised several study sessions to help motivate students. These sessions were organised for the week prior exams in Semester 1 and 2 and were designed to help students of all levels to gain some helpful information. MATSOC also booked rooms within the University to allow Honours students to practice their presentations. The rooms were fully equipped with projectors and screens and, most importantly, a band of supportive peers who were only too willing to provide constructive feedback.

Our final event of the year was the Extraordinary General Meeting, when our new members were elected by their peers. In order to help the new Executive to hold more successful events and initiatives, the 2014 Executives passed invaluable information and insight to the new 2015 Executives on this occasion.

If you would like to support MATSOC in its events and initiatives, please join the Facebook group: (https://www.facebook.com/groups/UNSWMaterials/).

MATSOC has continually improved and this has been evident in the time I've been involved with the Society. The team has been continually active in its pursuit of their common aim to engage all undergraduate and postgraduate students and staff. MATSOC 2014 had a truly successful year that was only possible due to a great team and I am proud to say that I was able to be a part of it.

Kara Poon, President, MATSOC 2014

VALE GAVIN KA WING CHAN

23 January 1992 - 12 May 2014

The School mourned the passing of one of our undergraduate students this year. Fellow student and Gavin's close friend, Amanda Wang, shares her thoughts:

Gavin Ka Wing Chan was undeniably a true friend – loyal to the core with the most generous heart and patient ear. He always had funny stories to share and would go out of his way to cheer his mates with a mixture of quirky jokes and ridiculous actions – including being mesmerised by his bicep while rotating his forearm and actively encouraging friends to smell his Lion Dancing training sash. He was a diligent, honest and thriving Honours student, who was determined to persevere through difficult challenges independently, even if it meant being penalised for submitting assignments late.

As the Master of Silly Faces and an avid Doctor Who fan, Gavin made his mark as the Vice President of MATSOC 2014 and an even bigger footprint in the lives of everyone who knew him. Deep in our hearts, you will always be *Present Gavin*.

WELL DONE!

Student Awards

The **Hugh Muir Prize** for the final year student who, in the opinion of the Head of School, has contributed most to the corporate life of the School, was awarded to Bhrat Deep Kochar.

The **ANSTO Prize** for the best performance in MATS3006 – Computational Modelling was awarded to Catherine Isaac.

The **Max Hatherly Prize** for the best performance in Crystallography and x-ray diffraction components of MATS2003 – Materials Characterisation, was awarded to Eric Foley.

We apologise for omitting to announce in our 2013 annual report that two of our final year undergraduate students were honoured with prestigious **University Medals**:

Holstein Wong received the University Medal in Ceramic Engineering.

JJ Black received the University Medal in Nanotechnology.

Congratulations to both for this fine achievement.

The **Wallarah Minerals Prize** for the best honours thesis in the Bachelor of Engineering in Ceramic Engineering program was awarded to Jacqueline Mach.

Recent postgraduate student, Rama Vasudevan, has been awarded the 2014 **Faculty of Science Award for Excellence in PhD Research**. This is awarded to the doctoral student in Science who is judged to have produced the best PhD thesis in a calendar year. Rama originally did an undergraduate Nanotechnology degree at UNSW and completed his PhD under the supervision of Professor Nagy Valanoor. As part of his thesis work, Rama produced a series of 16 first authored publications in very highly regarded journals (including Nature, Applied Physics Letters, Advanced Functional Materials, Nano Letters, Scientific Reports et al) that have already attracted a large number of citations. Following the completion of his PhD, Rama took up a position at Oak Ridge National Laboratories.

At our end of year party, the **School of Materials Science and Engineering Award for Teaching Excellence in Laboratory Class Teaching** was awarded to postgraduate students Neil Lazo and Qian Ru (Ruby) Lin. Neil, who was supervised by Professor Mark Hoffman, has recently submitted his PhD thesis. Ruby is studying her PhD under the supervision of Professor Sean Li.

Julian Walker, who last year finished his PhD under the supervision of Professors Nagy Valanoor and Chris Sorrell, recently presented some of the work he performed as part of postgraduate studies at the "PFM-2014" Conference in Ekaterinburg in the Russian Federation.

His presentation ˝Electrical, Electromechanical Properties and Domain Structure of Sm-modified-$BiFeO_3$ Ceramics Prepared by Mechanochemical Activation˝ was awarded one of three prizes for ˝**Excellence Award for the Best Oral Presentation of Young Scientist**˝.

Postgraduate Degree Programs

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

MATERIALS TECHNOLOGY – MASTERS DEGREE (COURSEWORK)

Commencing Semester 2, 2015

The Masters of Materials Technology program consists of 2 years of full-time or equivalent study comprising coursework in materials processing, materials design, materials technology and materials industry management. It is designed for graduates wishing to acquire expertise in the design, selection, use and performance of modern materials. It also includes a component of experimental and/or design project work, and an original research project is also undertaken in a chosen area.

MATERIALS SCIENCE AND ENGINEERING – MASTERS OF ENGINEERING (RESEARCH)

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

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

MATERIALS SCIENCE AND ENGINEERING – PHD

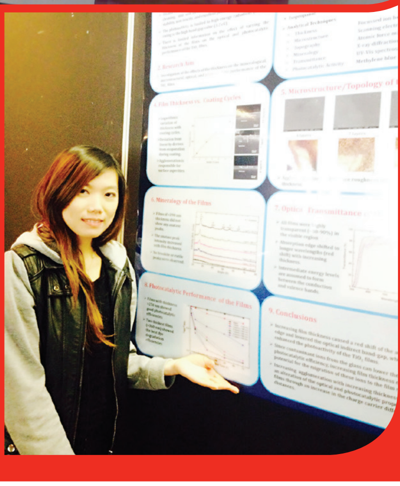
A PhD degree requires completion of a piece of research that demands a significant and original contribution to knowledge in the field of study. Candidates acquire advanced specialist research training and produce a thesis that summarises the research and provides evidence for independent thought and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

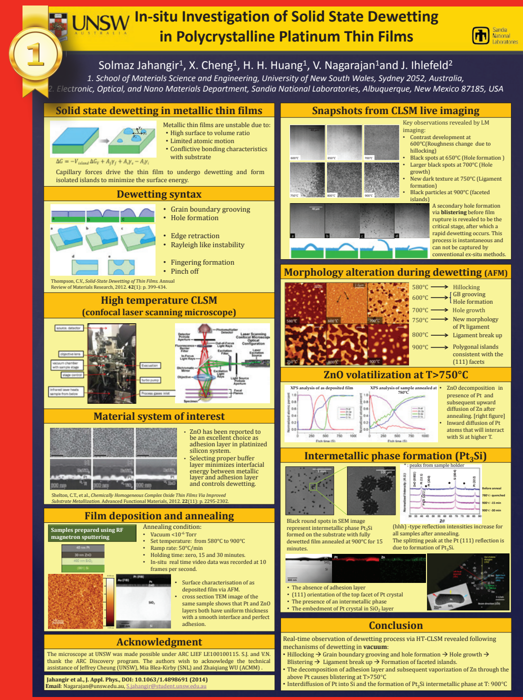
PROGRAM	MODE	UNSW PROGRAM CODE	LENGTH OF STUDY	MINIMUM UNITS OF CREDIT
Materials Technology - Masters Degree (Coursework)	Campus, Online, Directed Research, Independent Research	8717	2 years full-time	96
Materials Science Engineering - Masters Degree (Research)	Directed Research, Independent Research	2055	2 years full-time	96
Materials Science Engineering - Masters of Engineering (Research)	Directed Research, Independent Research	2175	2 years full-time	96
Materials Science and Engineering - PhD	Directed Research, Independent Research	1045	3-4 years full-time	144

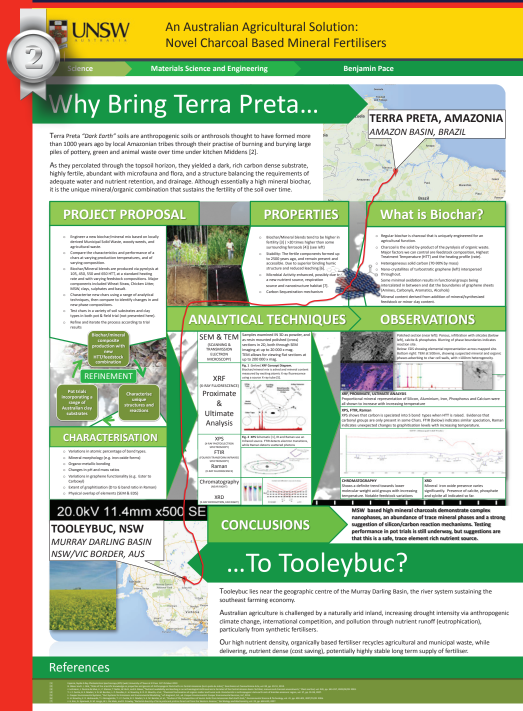
PGSOC Poster Competition 2014

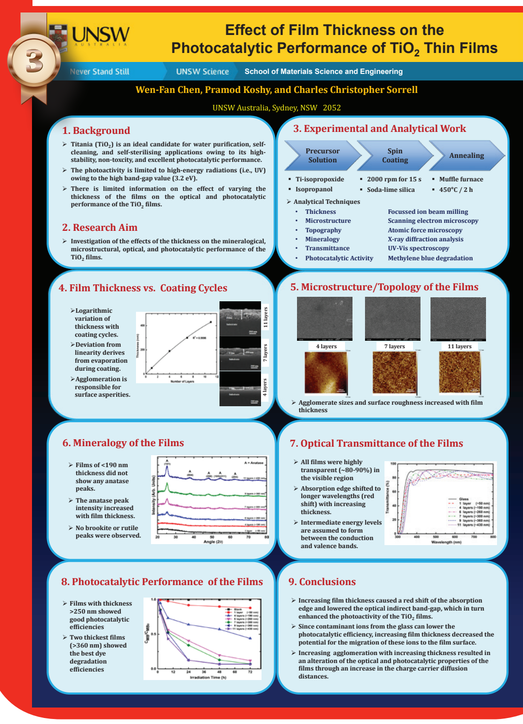
On Tuesday 14 October the Materials Postgraduate Society (PGSOC) held its annual poster competition. The judges (Faculty and School staff) were impressed by the quality of the posters, with prizes awarded to:

- Solmaz Jahangir – supervised by Nagy Valanoor
- Ben Pace – supervised by Paul Munroe
- Wen Fan Chan – supervised by Chris Sorrell









The Materials Postgraduate Society (PGSOC)

The Materials Postgraduate Society (PGSOC) is the social organisation for all postgraduate students of the school. Having been around for five years, the Society provides an outlet for students away from their ever-important research projects. An active academic life should be a balance of work and fun. This makes for a conducive and invigorating student atmosphere. The Society aims to address this by conducting activities that cater to student interest and holistically address student needs.

In 2014 the MSE PGSOC became a full-fledged ARC-affiliated society. This was done with the full support of the PG students and the School academics and staff. During the annual general meeting the students elected a full complement of executive officers and ratified a constitution. These executives were then tasked with the conceptualisation and organisation of events for the students as well as dealing with pressing PG issues.

Throughout the year the society hosted a number of exciting new events for the School. The Annual General Meeting also doubled as a Movie Night for the students with food and drinks for all. The Bowling Night was held at the Entertainment Quarter near Moore Park, where the PGs had a great time outdoing each other on pin-tipping, colloquially known as bowling, as well as discovering who had good combat and survival skills via laser-tag. The much-anticipated Materials Breakfast saw nearly the entire school gather for morning waffles, fruits, bread, and coffee and tea, with all gold coin proceeds donated to OzHarvest. The event saw members from all research groups in the School enjoy freshly-made waffles by the executives and volunteers and take some extras to their desks after. Before the Christmas break the PGs had a lunch party and beach outing to celebrate, once again flowing with food and drinks, which has quickly become a common theme for these events.

A highlight of the year was the Postgraduate Poster Competition. Here the PG students are given the opportunity to showcase their research work by making conference-style posters and presenting them to the public. This aimed to introduce the MSE PG students to each other's work and establish potential networks and collaborations. The exhibit was attended by both students and staff. The event saw a showcase of the undergoing state-of-the-art research advances happening in the school and with the student researchers themselves elaborating to the interested audience. Ultimately, Solmaz Jahangir, with her poster entitled, "In-Situ Investigation of Solid State Dewetting in Polycrystalline Platinum Thin Films", won the grand prize. The runner-ups include Benjamin Pace and Wen-Fan Chen, each receiving hefty prizes.

Several small initiatives were also begun in the year, such as informal Friday social get-togethers, and a growing degree of collaboration with the Materials Engineering Student Society (MATSOC) for undergraduates. Certain issues, such as mentoring for first-year PGs are now being addressed through additional activities.

The society would like to thank the members who have contributed greatly in the previous years, such as Ronald Maran, Neil Lazo, and Hsin-Hui Huang and wish them the best in their forthcoming venture into their careers.

2015 promises to be an even bigger year for PGSOC, as we aim for more events to encourage student participation and initiative, with the overwhelming support of the school staff and student body. The move to a new, bigger, and better MSE address opens a whole new avenue of opportunities and events of the society for the greater student body.

Materials PGSOC Executive Committee of 2014:

- Neil Lazo – President
- Akhila Mukkavilli – Vice President
- Yanyu "Maggie" Zhou – Treasurer
- Hsin-Hui "Sonia" Huang – Secretary
- Zain Zaidi – ARC Delegate
- Benjamin Pace – Media and Marketing Officer
- Aurelien Prillieux – Social Officer
- Amanda Wang – Women's Representative
- Lance Tang
- Scott Gleason
- Cindy Wang
- Caitlin Healy
- Mahsa Hosseini
- Fred Marlton
- Patrick Conway

ALUMNI PROFILE

Holstein Wong

In 2013 Holstein Wong graduated from the School with 1st Class Honours and was awarded the University Medal in BEng Materials Science and Engineering. She is now a Graduate Processing Engineer at BHP Billiton Mitsubishi Alliance. Here, she talks about her journey:

I studied a Bachelor of Engineering (Materials Science & Engineering), majoring in Ceramic Engineering.

I was drawn to the interdisciplinary possibilities of Materials Science. Bridging science and engineering, the subject matter had a good coverage of both the theory of why and how materials have the properties they do, and practical applications in industry.

Being both a scientist and engineer meant working with a diverse group of students and academics, so I had a fantastic time at university! Many people still ask what we do, and are surprised at how relevant our field is to many others; it's a great conversation-starter. In the later years, the close-knit community in MSE really shone through, especially the support we gave each other during our Honours thesis research projects.

I've moved to sunny Central Queensland to work at Peak Downs, a mine at BHP Billiton Mitsubishi Alliance that produces metallurgical coal. My role is Graduate Engineer - Production Processing.

I work in the Coal Preparation Plant (CPP) where we upgrade the run-of-mine material and reduce the ash content to meet the specifications of our international customers. As a Graduate Processing Engineer, I support the plant operations to optimise the recovery of product and reagents. Various responsibilities include analysing and benchmarking production performance and quality, trialling equipment and processing initiatives to produce more tonnes for less unit cost, and much more.

This is my first role since graduating in November 2013. The great thing about most graduate programs is that you get tangible development opportunities, such as rotating across different sites. I've started my career in mining, the most upstream point of the materials processing spectrum, and it truly is a great foundation for a career in materials.

Materials Science is a pathway into an exciting domain of inquiry. Even if you don't end up working in the field, knowledge about materials is relevant to every aspect of the world around us, which is why I find it fascinating.

I have so many great memories of my time at UNSW, there are too many to recount! O-Week, Matsoc BBQs and merchandise, the special space that is the G10 Computer Lab, being mentored by senior students and in turn mentoring the next intake of materials scientists (usually in the aforementioned Computer Lab), sharing stories from exchange are just some of the memories from my time at MSE.

ALUMNI PROFILE AND VALE

Dallis Ann Hardwick

26 June 1950 – 5 January 2014

ONE OF THE FIRST FEMALE STUDENTS IN THE SCHOOL OF METALLURGY AT THE UNIVERSITY OF NEW SOUTH WALES

By Pat Martin

Australia

Dallis was born in Sydney to Francis John and June Hardwick on 26 June 1950. She attended Matraville Public School where in 1961 she was awarded the Soldiers' Memorial Prize for Dux of the School. She continued her education at Sydney Girls High School (SGHS).

Dallis started her undergraduate studies in the School of Metallurgy at the University of New South Wales (UNSW), the first woman to do so. She applied her interest in physics to the study of Physical Metallurgy and completed her Bachelor Degree with Honours in April 1972. A Commonwealth Scholarship allowed her to continue directly to the PhD program at UNSW and she earned that degree in July 1977. Dallis was one of the first females to complete the PhD program in the School of Metallurgy. Her dissertation research on the oxidation/corrosion properties of iron-aluminum-carbon alloys set the direction for her technical career.

Canada

Being a lifelong learner, Dallis decided to continue her education through post-doctoral studies. She had choices in the United Kingdom but, instead, accepted a Fellowship at McGill University in Montreal, Quebec. This work was in the area of archeo-metallurgy and she dabbled in teaching, which convinced her that she preferred research over instruction. The decision to concentrate on research meant that another post-doctoral position was needed.

While a resident in Canada Dallis continued to play squash, learned to bicycle and became an active Nordic (cross-country) skier.

United States of America

Pennsylvania:

At the Gordon Research Conference on Corrosion/Hydrogen Embrittlement held in New Hampshire in the summer of 1979, she met Professors Melvin Bernstein and Anthony Thompson from Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania. They offered her a Fellowship to study the interaction of hydrogen in high strength aluminum alloys used in the aerospace industry. She started this work in September 1979 and those studies continued until August 1981. The research led to several journal publications and multiple conference presentations.

In addition to her research in Pittsburgh, Dallis made many friendships that would last for the remainder of her life. She led a group of friends back to Canada to participate in the Canadian Ski Marathon in February 1980. It is an annual three-day ski tour with thousands of participants; it covers up to 160 km from Montreal to Ottawa. Done in stages, with the ability to stop the tour at any check-point, Dallis was very satisfied to complete over 80 km of the course. She also participated in several squash competitions in Cleveland and Dayton, Ohio.

Maryland:

As the two-year Fellowship was coming to an end at CMU, she interviewed with several corporate research laboratories and in September 1981 accepted a position at the Martin-Marietta Research Laborato, located in suburban Baltimore, Maryland. She worked on the surface properties of aluminum alloys used in the U.S. Space Shuttle external tank. The adhesive bond between the metal and the external insulation was critical to the successful operation of the system.

Dallis continued to visit her friends in Pittsburgh becoming very familiar with the highways that cross Pennsylvania. In August 1982, Dallis married Pat Martin who was just completing his PhD dissertation at CMU.

New Mexico:

In November of 1982, Dallis and Pat moved to Los Alamos, New Mexico. Both became Members of Technical Staff at the Los Alamos National Laboratory (LANL). They were proud of this title as it harkened back to the Manhattan Project where Robert Oppenheimer eschewed gradations among the scientists in his organization. Dallis began studies on hydrogen interactions with stainless steels, however, it was not until she became a US citizen and obtained a security clearance in 1985, that she was able to appreciate the relevance of her work in understanding how nuclear weapons degrade in storage. She trained herself in the fields of ion beam analysis and surface modification. Dallis also began to volunteer her time in various capacities within The Minerals, Metal and Materials Society (TMS).

After living in Los Alamos for 3 years, Dallis and Pat designed and built a home on five acres just north of Santa Fe, New Mexico. The access to the cultural opportunities made the daily 45-minute commute easy to justify. Dallis continued to look forward to Nordic skiing but also revisited alpine skiing. In the summers, she enjoyed backpacking and hiking along the mesas and pre-Spanish Pueblo Indian sites surrounding Los Alamos.

California:

As the Berlin Wall was falling, the main mission of LANL (nuclear weapon design) seemed less significant. At the same time, the Martin-Hardwick team was recruited to join the Rockwell Science Center (RSC) in Thousand Oaks, California. This was the corporate laboratory for the Rockwell International conglomerate that included: North American Aircraft, Rocketdyne, Space Division (i.e. Apollo Program and Space Shuttle), Goss Printing Presses, Allen-Bradley Automation, Collins Avionics, Reliance Electric, as well as several solid state electronics and automotive component divisions. They moved to Thousand Oaks (mid-way between Los Angeles and Santa Barbara) in February 1990 and Dallis began working on high temperature, high conductivity and light-weight alloys for the aerospace divisions with a foray into lead-free solder for the electrical products divisions of the company.

Dallis began a very successful project to understand how metals burn in high-pressure oxygen environments. The Rocketdyne Division was, and still is, the largest liquid rocket engine manufacturer in the United States. The turbo pumps that move the fuel and liquid oxygen into the combustion chamber are extremely complex devices. There are only a handful of materials that will not burn when heated in very high-pressure oxygen environments inside these turbo pumps. Dallis devised an algorithm to define the optimum alloy composition to both maximize the strength and the burn resistance of alloys for use in these pumps. The next generation of liquid rocket engines to be made in the western world (by Rocketdyne) will have one or both of the alloys defined by Dallis. Her long-time collaborator on this project was a younger engineer, Monica Jacinto. The alloys that they jointly developed are named Mondaloy (Mon + Dal) in honor of their close collaboration.

During these years, Dallis made significant contributions to TMS. She became Chair of the Programming Committee responsible for the organization of the semi-annual technical gatherings that attract four to five thousand scientists and engineers. Her guidelines for how to organize these technical sessions are still in use by TMS. She also served as Chair of the Publications Committee. Each of these positions made her a member of the TMS Board of Directors.

Washington:

The Boeing Company purchased all of the aerospace operations from Rockwell in 1996. RSC remained a part of the parent company and Boeing committed to funding research within RSC for several years. As Dallis and Pat had been primarily supporting those divisions purchased by Boeing, it made sense to accept the opportunity to 'transfer' to Boeing during the transition of Rockwell's assets to Boeing. In May 1998, they moved to Seattle, Washington and began working in the Manufacturing Research and Development organization within the Boeing Commercial Airplane Group. Dallis worked in the Machining Group and was responsible for friction stir welding (in its early days) and novel tools for high speed machining of titanium alloys. Dallis was elected to the position of Chair of the Structural Materials Division of TMS, 1997-1999.


School of Metallurgy around 1964

As such, she was on the TMS Board of Directors for a third time.

Dallis and Pat had planned to make this their last move, but it was not to be. The Boeing Company continued to expand. When it absorbed the McDonnell-Douglas Corporation, the turmoil resulted in morale declines and eventually to an engineers' strike in 2000.

Ohio:

They were again recruited to move during the strike at Boeing. The Air Force Research Laboratories (AFRL), Materials and Manufacturing Directorate at Wright-Patterson Air Force Base was seeking senior engineers with knowledge of both rocket and gas turbine engines. In August 2000, they moved to Dayton, Ohio; the fourth move as 'a team'. Dallis became involved with all of the technologies being developed for advanced rocket propulsion. This placed her back into the Mondaloy effort – this time as the government sponsor/program manager instead of engineer.

Dallis was nominated to become President of TMS in 2002. While another female engineer, a close friend of Dallis, was selected to become President of the society, Dallis represented TMS on the Board of Governors for Acta Materialia; one of the most prestigious peer-reviewed technical journals in the field of Materials Science.

In 2005, Dallis was given the responsibility for coordinating all materials research in the Department of Defense (DoD) aimed at advanced gas turbine engines for aircraft. She reported status and plans in Washington DC at semi-annual reviews for senior administrators at DoD. She included complementary work done by NASA and the Department of Energy to avoid redundancy. In addition, she managed the Propulsion Portfolio (rocket and turbine) for the Materials Directorate of AFRL. For these contributions, she was awarded the Meritorious Civilian Service Medal in 2010. Dallis was appointed as the U.S. Air Force representative on the five country cooperative panel coordinating Materials Technology (USA, Canada, United Kingdom, Australia and New Zealand). This allowed her to travel widely and to add to her international network. She gave invited talks in North America, Europe, India and Australia.

A 'routine' mammogram in the summer of 2009 detected a small growth. It was eventually determined to be Stage 4 metastatic breast cancer. There were no symptoms of the liver and bone involvement at the time of diagnosis. She began a very aggressive clinical trial chemotherapy in September. The infusions were scheduled on Thursday afternoons. She felt fine on Friday and then used the weekend to recover; but she never stopped working. The first chemo treatment was successful in that the soft tissue tumors were eliminated and the bone lesions 'lessened' by April 2010. In all, Dallis participated in three clinical trials of experimental chemotherapies.

Dallis decided to retire from Civil Service in April 2012. She retained an office at the laboratory in the Emeritus Program so that she could continue to mentor and guide the younger engineers. She also moved full time into her crafts: sewing, bead jewelry, enameling and weaving. Dallis was chair of the local chapter of the American Sewing Guild for two years. She was also an avid cook with a special interest in French gastronomy and wine following multiple holidays 'barging through' France (1995 and 2005, most notably).

The breast cancer finally crossed to her central nervous system with noticeable weakness and confusion in late November 2013. She died on January 5 2014. She never had any pain. She was smiling and telling her visitors that she 'felt fine' to the last.

She was, and continues to be, inspirational to those who knew her.

International Exchange

The School collaborates with universities around the world to provide valuable exchange and internship experiences for our undergraduate students.

Articulation Program with Tunghai University, Taiwan

Tunghai University (TU) in central Taiwan has long been a close collaborator with the School of Materials Science and Engineering (SMSE). Through an articulation program between TU and UNSW, the top students from TU, after their first two years of undergraduate studies, will be able to join UNSW as articulated students in the Materials Science undergraduate program. After 2.5 years of study here and passing all the designated courses, these students will be able to graduate from UNSW. Some may also choose to spend just one semester in our School as Study Abroad students. So far 23 students have successfully completed the Articulation or Study abroad programs, with 6 of continuing at UNSW for their postgraduate studies.

AsiaBound Program

In 2013, the Australian Government announced the $37 million AsiaBound Study Grants Program, in support of the 'Australia in the Asian Century' White Paper, to encourage tertiary students to consider an exchange experience in Asia as part of their study. Under this program our School received a mobility grant to support 10 students for work placements in Taiwan. In 2014 three students, Adrian Greksa, Jeff Huang and Jackson Wong, went to Tunghai University, Taiwan for their internship.

Our students shared rooms with local students in the TU dormitories, encouraging them to mingle and giving them ample chances to learn the languages and the culture of Taiwan.

TU also arranged internships for them to either work in the materials industry or in its own materials labs. Adrian and Jeff interned at a company, Yung Sheng Optical. Yung Sheng Optical researches, designs and develops contact lens and their brand "Hydron" is currently regarded as one of the most popular contact lens brands in Asia. Under the supervision of materials engineers, the students were assigned to research prospective avenues of improving the biocompatibility of contact lenses using a chemical called chitosan. Jeff also ran experiments to examine the relationship between differing concentrations of monomer constituents in contact lens hydrogel formulations and the physical characteristics of the completed contact lens. By the end of the internship the students were able to design their own hydrogel formulations to synthesise a biocompatible contact lens for short term application.

Jackson, on the other hand, chose to join the Nanotechnology Lab in the Department of Electrical Engineering at TU for his internship. Under the supervision of Prof Miao and Dr Liu, he was assigned a task to learn and produce photovoltaic cells and code a simulation counterpart. Apart from his main project, he was able to learn the production of paper made with carbon nanotubes and ultrathin PV cells.

Our students were also assigned a mission: to visit several famous Taiwan universities and to introduce UNSW and, in particular, our School to the academics and students there. This included National Tsing Hua University in Hsinchu, whose engineering facilities rival UNSW's.

The students have all benefited tremendously from the AsiaBound Program, as can be seen in the reports that they submitted:

"I feel this trip was a great experience in the sense that I not only got to travel but I also gained knowledge invaluable to my future as an engineer. My internship at Yung Sheng Optical provided me with experience in R&D and patent analysis as well as furthered my understanding of polymers and hydrogels. My weekend work in the university laboratories allowed me to learn about nanoparticles and conducting research at university and overall my interaction with Taiwanese people has improved my Mandarin reading and speaking abilities." – Jeff Huang

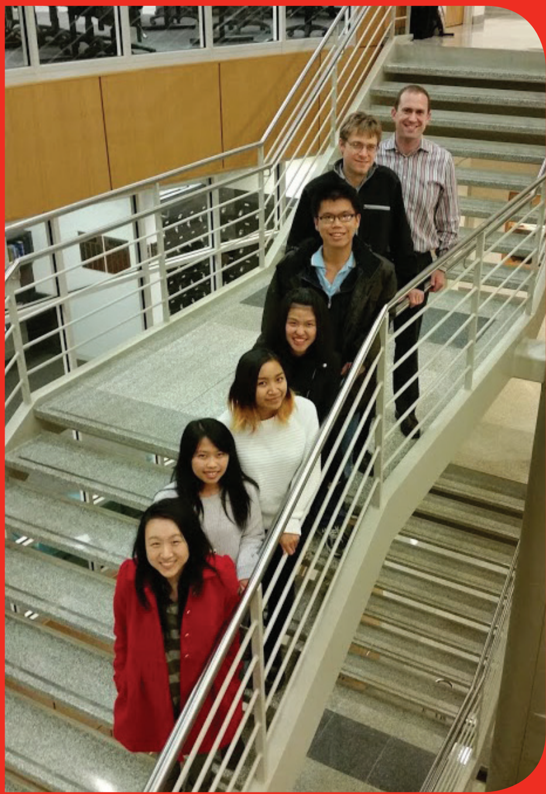
"Being given the opportunity to study, travel and learn has been a great privilege and journey. Although it was different to my major of Materials Science and Engineering at UNSW, I found the new perspective of Photovoltaic Engineering incredibly valuable. I was fortunate to entwine with the local students. English Corner is a student initiative to develop their English skills. Every Friday Adrian, Jeff and I would help to teach, discuss Australian culture and converse about daily Taiwanese life. It was a great experience as we were able to give back to the students for what they have given us." - Jackson Wong

Student Exchange Programs with United States Universities

Staff in the School of Materials Science and Engineering have also formed vibrant collaborations with two universities in the U.S.A. These have both garnered funding to allow student exchanges over, variously, the northern and southern hemisphere summers. Senior undergraduate students come to UNSW from June to December from Harvey Mudd College (HMC) in California and North Carolina State University (NCSU).

The interaction with HMC, funded by the National Science Foundation, has continued now for some years and research outputs generated have led to a prestigious award. A poster presented at this year's TMS conference in Orlando, entitled 'Microstructure, Phase Evolution and Properties of High Entropy Brasses and Bronzes' by Aarthi Sridhar, Cody Crosby, Kevin Laws and Lori Bassman was awarded both the Undergraduate Poster Prize for the Structural Materials Division and overall Undergraduate 'Best of Show' prize.

Over the southern hemisphere summer, the School sent 5 undergraduate students to the Department of Materials Science and Engineering at NCSU. Each of these students performed a research project in collaboration with an academics staff member on the Department. Over July-September 2015 the School will host groups from both HMC and NCSU.



North Carolina State University (NCSU) Exchange students

Real Aussie Family Experience

Winning a global competition to study in Australia was a passport to a brighter future for Indian student Uttam Kumar, who beat 37,000 other entries from 190 countries with his digital postcard design in the Austrade "Win Your Future Unlimited" competition. He has now received a prestigious PhD scholarship to continue his studies at UNSW.

Since arriving in Australia, Uttam has kept a blog describing his experience as an international student.

If you are an international student and want to have a real Aussie Experience while you live here, then make friends with the locals! This can be difficult sometimes because Sydney is a multicultural and cosmopolitan city, where a large number of students come from all over the world. As an international student many people in your circle are from overseas, just like you, staying in Australia for study or work, so it can be hard to make contact with many Australians.

I am doing masters in Material Science at UNSW. This is my first semester. I consider myself lucky and honoured to have been invited by an Australian family for dinner recently. The lady who invited me over for dinner, had read about me in the Sydney Morning Herald. As she was impressed by my academic journey, she contacted the journalist who wrote that article to get my contact details and then contacted me. Everybody in the family was so nice and welcoming. When I reached their home, I was welcomed by a very special member of their family: Max, a big, cute dog.

Then I met everybody else in their family. They were all so kind and curious to know about my Australian experiences so far. I won a study competition organised by the Australian Government last year. Everywhere I go, the first question people ask me is, "what was the competition all about and what did you do to win and all that". To my surprise, all of the family members already knew all about it and their first questions was, "How are you finding Australia? Do you like it?"

I told them about my experiences and the fun things I have done in Sydney and how living here and studying at UNSW is so much different than India. Considering the fact that I am from India, they had prepared Pani Poori, Namkeen with potato, and a strong chilli chutney, I guess basically to make me feel at home away from home. It was so good. In my wildest dream, I couldn't think that I would get to eat Pani Poori at an Australian dinner as a starter. ☺☺

When they discovered that I didn't know anything about rugby, the sport Australians love (it seems cricket is not the only game Australians love), they told me the name of the rugby team which I should tell people I support if they ask me about my favourite team. It was so much fun. Everybody in their family told me about their studies and work.

Looking at my research area (Waste Recycling), they offered to introduce me to some organisations in this area if I was interested. We discussed a lot of fun things as well. The Australian sense of humour is way too different and I couldn't understand most of their jokes no matter how hard they tried to make me understand. During dinner we had pasta and I got to taste a very, very nice sparkling red wine as well. After that we had fruits with ice-cream and later on we had a very delicious homemade coconut cake. Lastly, we all had sleepy tea.

I want to thank them with all my heart for giving me such a wonderful evening to remember and cherish. I hope to see them all again in the future. Moments like these play a huge role in the satisfaction level of international students and give them a chance to live a true Aussie experience. ☺☺

Jeff Huang – **AsiaBound** program to Taiwan

Asiabound members in Taiwan left to right Adrian, Jeff, Jackson

During the 2014-2015 summer uni break I embarked on the AsiaBound Program offered to me by the Department of Education and UNSW's School of Materials Science and Engineering. My destination was Tunghai University located in Taichung, Taiwan. My purpose for going was to complete the industrial training requirement for my degree.

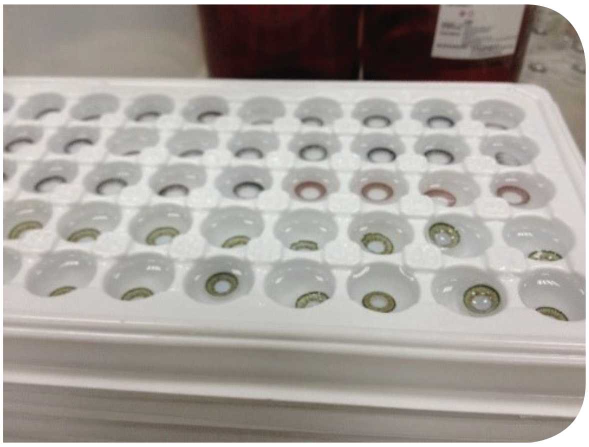
Yung Sheng Optical

While the other students had classes, I interned at a company called Yung Sheng Optical, a company that researches, designs and develops contact lenses. Their brand "Hydron" is one of the most popular contact lens brands in China. I worked in their Research and Development department with other chemical and materials engineers.

Taipei

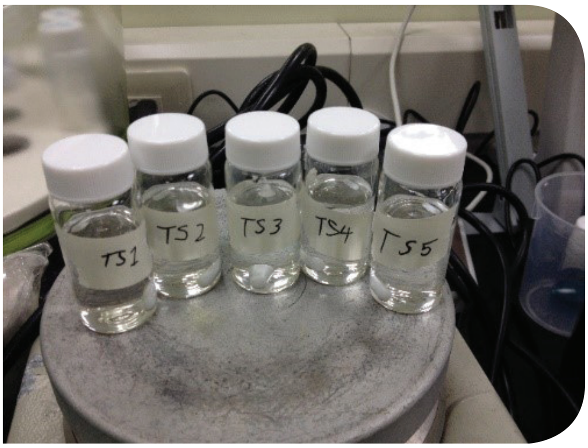
I was initially intimidated about applying as my Mandarin reading, writing and speaking ability was basic at best and this would be my first time living away from home in a country where I didn't speak the local dialect. Eventually, I realised that this program was a great opportunity to be independent and travel to a new country.

In Taiwan, I lived in the male student dormitory at THU, which was occupied by mainly first year students. I shared a room with 3 Taiwanese students and although we were not able to converse with each other very well, eventually, with them teaching me Mandarin and me teaching them English, we were able to communicate and develop friendships.



Hydration of contact lenses

At YSO I helped research prospective ways to improve the biocompatibility of contact lenses using a chemical called chitosan. I also ran experiments to examine the relationship between differing concentrations of monomer constituents in contact lens hydrogel formulations and the physical characteristics of the completed contact lens. By the end of my internship I was able to design my own hydrogel formulation to synthesise a biocompatible contact lens for short-term application. On those weekends when I didn't travel, I would go to the laboratory in the Department of Chemical and Materials Engineering in Tunghai to help a post-graduate conduct his study on gold nanoparticles applied to electrochemical dopamine sensors.



Hydrogel formulations

Most nights after work I would have dinner with my roommates and other friends in a shopping district about a 15-minute walk from our dormitory. I was always amazed by the multitude of cheap and delicious street food available, which ranged from hot pot to the internationally famous Taiwanese fried chicken.


Kaohsiung

I also visited some engineering institutions during my trip, including the Yung Sheng Optical factory where I toured the factory floor and saw their contact lens manufacturing process, from raw hydrogel formulations to a final packaged product. I also visited other Taiwanese universities to give presentations on Australian culture, student life and UNSW.

Night Market

Due to the relatively small size of Taiwan and the convenience of their transport system, travelling around was very easy. On weekends when I had more free time, a 20-minute bus ride from the university took me to FengJia night markets, which is one of the most popular night markets in Taiwan. A 3-hour bus ride allowed for a day trip to the beautiful Sun Moon Lake, located in Nantou County in the middle of Taiwan.

It wasn't only the buses that were impressive - the Taiwan train system made it especially convenient to travel up and down the island of Taiwan. On Boxing Day, I took a 3-hour train ride to scenic Kaohsiung, located in southern Taiwan. Then on New Year's Eve, I travelled to Taipei in northern Taiwan, to see the fireworks at Taipei 101. I then went on to Keelung, near the northern tip of Taiwan, to watch the first sunrise of 2015.


Engineering building in National Tsing Hua University

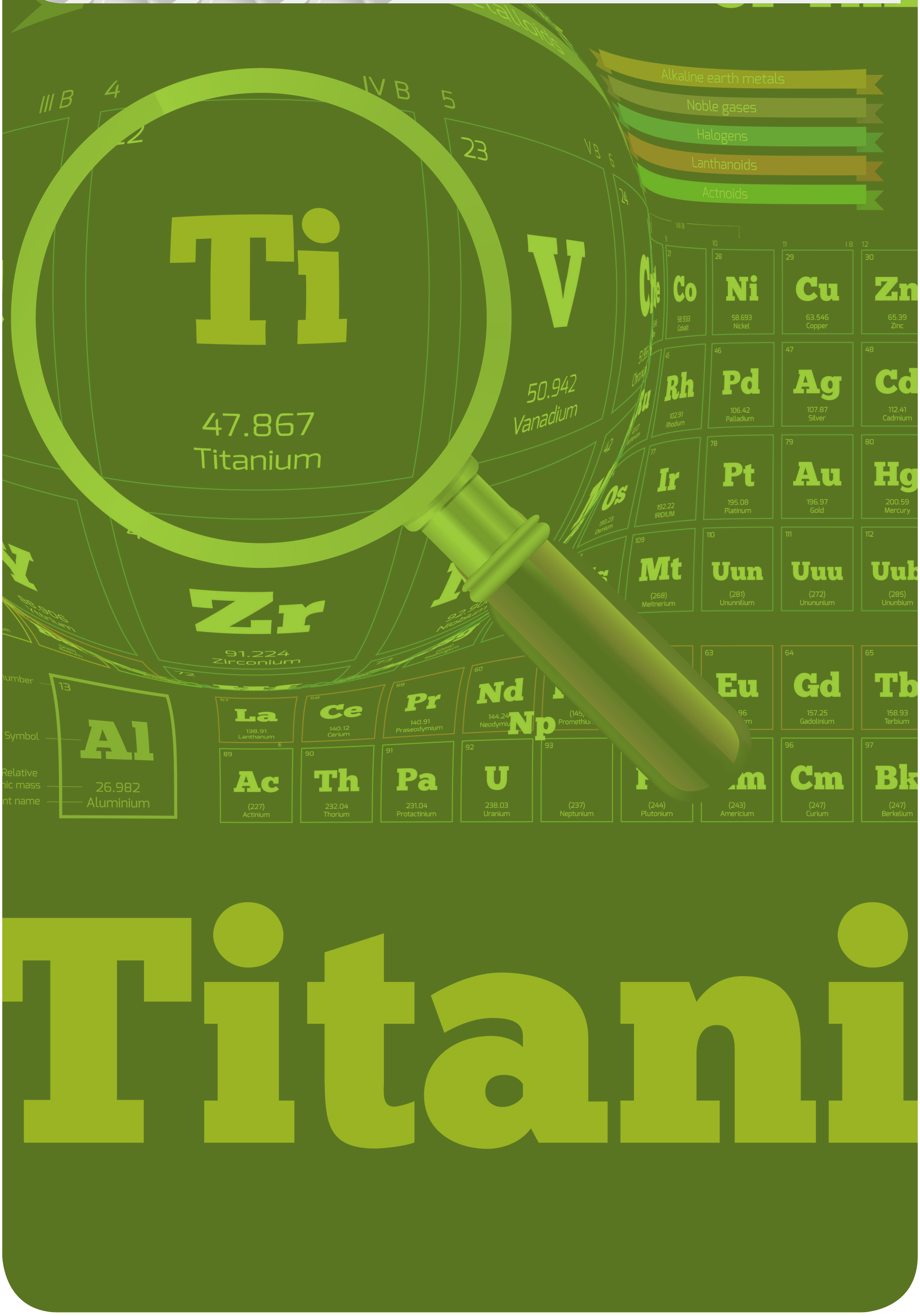
One of the most notable of these was at National Tsing Hua University in Hsinchu, whose engineering facilities rival those of UNSW.

This trip was a great experience in the sense that I not only got to travel, but I also gained knowledge invaluable to my future as an engineer. My internship at Yung Sheng Optical provided me with experience in R&D and patent analysis and furthered my understanding of polymers and hydrogels. My weekend work in the university laboratories allowed me to learn about nanoparticles and conducting research at university, and overall my interaction with Taiwanese people has improved my Mandarin reading and speaking abilities.

Any UNSW Material Science and Engineering students who are "on-the-fence" about applying to the AsiaBound Program should definitely do it. Not only is it a great way to do Industrial Training, but it is also a great opportunity to travel and have fun. I just have one piece of advice - bring mosquito repellent!

PART FOUR:

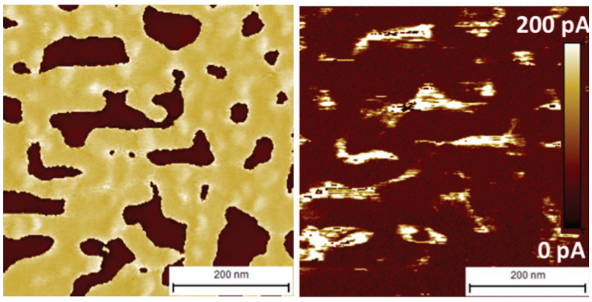
RESEARCH



Functional Materials

Professor Nagarajan Valanoor

Our research focuses on the synthesis and functional properties of interfaces and surfaces. For the majority of the research we study thin films, but we also investigate nanoscale islands and nanowires. Most of the group investigates a class of functional materials called ferroics. Ferroic materials possess naturally occurring interfaces such as domain walls, which separate local regions that possess the same order parameter known as domains (the "blobby" regions in Figure A-B). Traditionally, domain morphology (i.e.



size, shape, periodicity, etc.) and kinetics (i.e. mobility, pinning and propagation) was believed to fundamentally drive the performance of ferroic devices (ferroelectrics, ferromagnets and ferroelastics alike). On the other hand domain walls (the boundaries that separate domains) were never considered to play a significant role. Recently though, it is shown that given a sufficiently large volume density of such domain walls, the functional behaviour of a material can be dominated, not so much by the domains as by those of the domain walls themselves. This groundbreaking approach to designing new functionalities drives our research.

An alternate, but equally critical, driver is the chemical and mechanical stability of interfaces under a variety of both processing and service conditions. For this aspect we make use of sophisticated aberration corrected electron microscopes housed in leading dedicated microscopy labs across the world. We are interested in how defects at oxide interfaces control

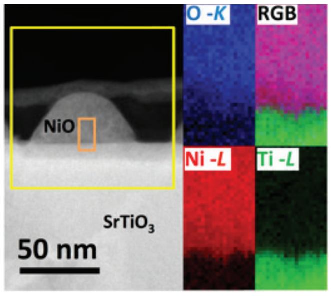
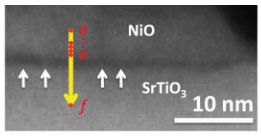


Figure C left
Figure D below



functional behaviour. Figure C-D show a panel of aberration corrected cross-section scanning transmission electron microscopy (Cs-STEM) images of a nanoscale nickel oxide island. It shows that there is an increase in the oxygen defect concentration at the interface between the island and the underlying substrate, which leads to fascinating functional behaviour. Similarly, we study the thermal stability of ultra-thin metallic films. Our laboratory houses a vacuum – confocal laser scanning microscope (Figure E), unique in the world, which is used to image thermal stability of interfaces across metal-metal oxide systems. Figure F is a typically dewetted nickel (Ni on magnesium oxide) substrate sample that shows fingering along the edges. How these fingers are formed are interesting, from both a fundamental surface science perspective as well as for understanding the stability of metallic coatings used in harsh climates.

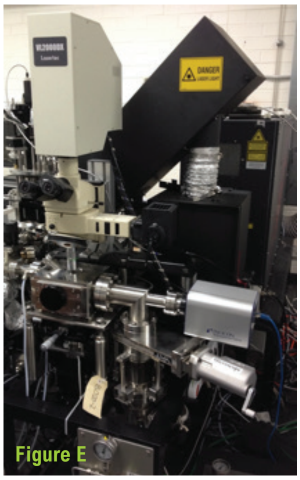


Figure E

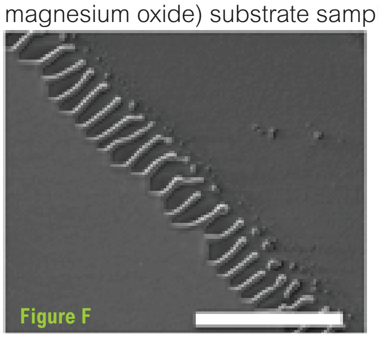


Figure F

Building Novel Solid State Electric Double Layer Transistors (FT140100032)

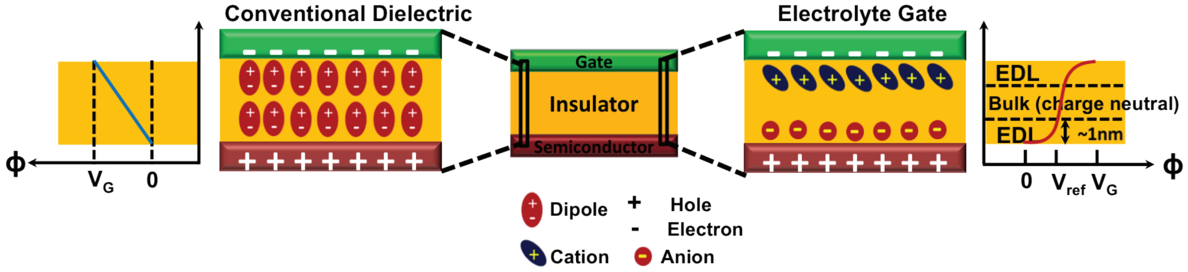
Dr Dewei Chu

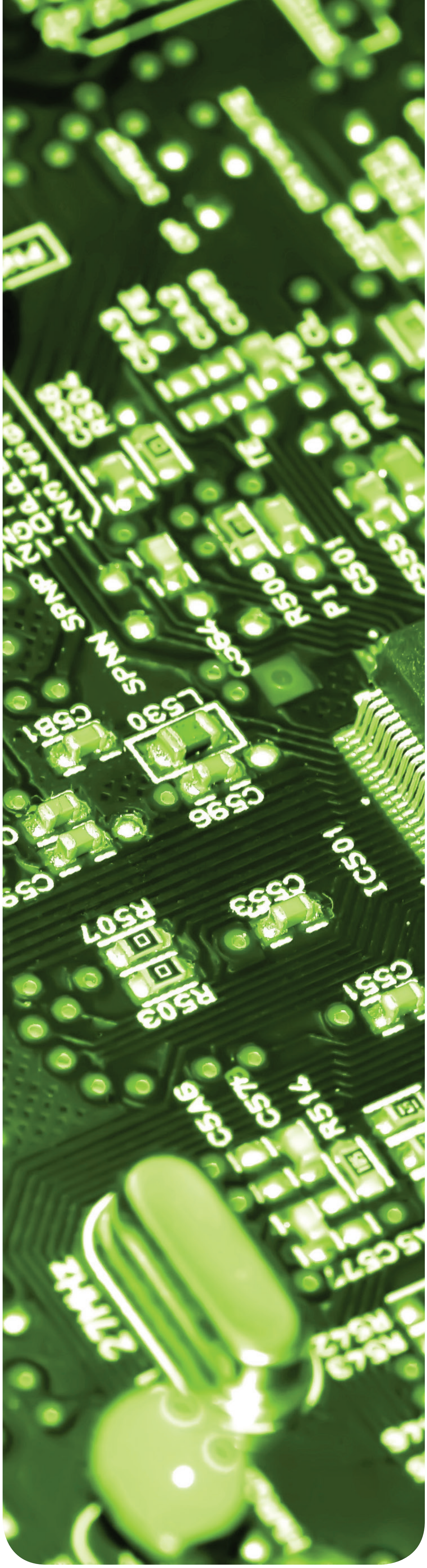
In modern electronic devices, transistors are fundamental building blocks for amplifying and processing the electronic signals. During the last three decades, transistors have been getting smaller, faster and cheaper with the development of semiconductor technology. In particular, field effect transistor (FET), which utilises electric field to control channel conductivity through charge carrier accumulation or depletion, has long been a key microelectronics technology. The attractiveness of such a transistor lies in the ability of easily controlling the charge carrier density by manipulating the bias voltage and in the freedom from the structural disorder inherent in conventional chemical doping approaches.

To induce the same amount of charge in the channel, one with higher carrier density would require a smaller voltage than what would be required classically. This means the operation voltage could be reduced below the classical limit. However, the maximum carrier density obtained from the existing gate dielectric material is smaller than 10^{13} cm^{-2} due to the difficulties of boosting gate dielectric capacitance and the problems of low voltage breakdown. Therefore, significant increase of the attainable carrier density in FET becomes of great importance and urgency to surmount the fundamental limit of current semiconductor technology, thus providing a solution for next generation microelectronic devices.

Recently, a new type of FET, namely electric double layer transistor (EDLT, Figure 1), has been developed for attaining much higher carrier density by using polymer electrolytes or ionic liquids as gate dielectrics, in which larger capacitances can be achieved in the electric double layer capacitors. Compared with the conventional FET, EDLT exhibits ultra-high carrier density and transconductance in a fast, reversible and reproducible manner. The electric field produced in EDLT can be on the order of $50 MVcm^{-1}$, allowing high-density charge accumulation reaching 10^{15} cm^{-2}, which is 1-2 orders of magnitude larger than that of the conventional FETs, thus having a breakthrough in the current best technology.

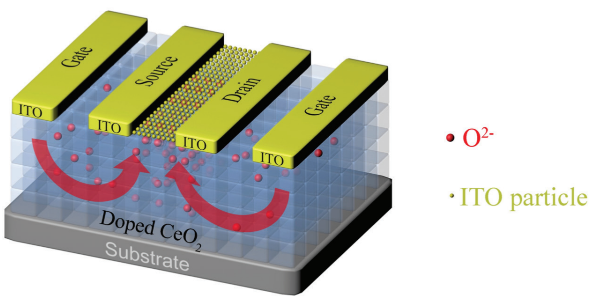
Figure 1 Crosss-sectional schematic of gate-insulator-semiconductor structure in FET geometry for conventional dielectrics and electrolyte gates.





To maximize the charge accumulation, it is essential to manipulate the interface interaction as well as the defect distribution in *three dimensions* with the atomic precision of the interfaces both vertically and laterally. The performance of an ionic conductive oxide based EDLT can be improved by controlling the ion migration, which determines the ionic conductivity. However, the inactiveness of ion migration at room temperature results in a very low ionic conductivity of bulk materials. A possibility to solve this problem is to reduce the grain size into nanometre scale to increase the faster ion diffusion pathways along the grain boundaries, thus enhancing the overall ionic conductivity and making the materials operable at ambient temperature. Therefore, it is essential to optimize the grain size and morphology of the ionic conductive materials. However, it is a great challenge to use the current thin film technology to create a three dimensional structure in an ultrathin ionic conductive layer with the control of nanocrystals size and morphology. To tackle this problem, we proposed a new concept, namely Ion Conductive Oxide Nanocubes Superlattices *(patent pending)*, to promote the strong interface interactions among colloidal oxide nanocrystals, as shown in Figure 2.

Figure 2 Schematic Illustration of CeO_2 nanocubes based electrical double layer transistor.



Unusual ferromagnetism through nonmagnetic element doping

Dr Jiabao Yi

Every electron spin has two states: spin up and spin down. In ferromagnetic materials, the spin can align in one direction and a small magnetic field can manipulate the spin state from up to down. These two states of "up" and "down" could be used as the logical "on" and "off' states, which is different from semiconductor devices using charge manipulation. Spin related devices (also called spintronics), such as spin-FET's, are faster, use lower power and do not release heat, as opposed to current semiconductor devices.

It is possible to dilute a magnetic semiconductor by adding magnetic dopants to non-magnetic semiconductors. Hence, the material possesses both semiconductor and magnetic behaviour, which is very promising for the development of spintronic devices.

ZnO is seen as a candidate material for the synthesis of diluted magnetic semiconductors. Indeed, many reports have shown that ZnO doped with magnetic elements demonstrates room temperature ferromagnetism. However, this is disputed as researchers have observed that pure ZnO also shows room temperature ferromagnetism. In our previous work, we have proposed the theory of defect-induced ferromagnetism and shown that non-magnetic elements, such as C or Li doped into ZnO leads to room temperature ferromagnetism [1,2]. In 2014, we used a simple hydrothermal method to fabricate Na-doped ZnO films. Experimental results indicate that the film is ferromagnetic at room temperature. First principle calculations indicate that the ferromagnetism is due to Z-site vacancies induced from Na doping. Most importantly, we have, for the first time, discovered positive magnetoresistance in this material without the presence of any magnetic elements. In addition, changes in doping concentration can manipulate positive magnetoresistance to negative magnetoresistance [3].

It is well known that α-MnO_2 is an anti-ferromagnetic material. Recently, we have incorporated alkaline element such as Li, Na and K into α-MnO_2. These three elements, when present as dopants, induce ferromagnetic behaviour in α-MnO_2. Detailed experimental and first principle calculations indicate that doping induced asymmetry of tunnels in α-MnO_2 attributed to ferromagnetic behaviour. The work not only clarifies the mechanisms of ferromagnetism in this compound, but also illuminates the doping dynamics of Li, Na and K in α-MnO_2, which may be useful for the future development of high performance batteries, since α-MnO_2 is one of the best anode materials for application in batteries [4].

Figure 1: a) R-T curve of Na-ZnO with a variety of doping concentrations; b) MR curve of Na-ZnO with a variety of doping concentrations at 5 K; Positive magnetoresistance is observed in 0.6 and 1% Na doped ZnO, while 0.2 and 1% Na-ZnO shows negative magnetoresistance; c) Temperature dependence of MR curve of 1% Na-ZnO, indicating negative to positive magnetoresistance transition with decreasing the temperature.

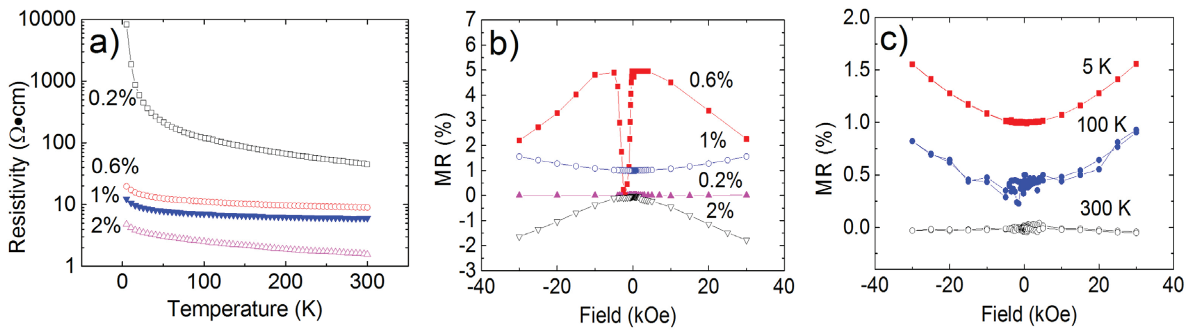
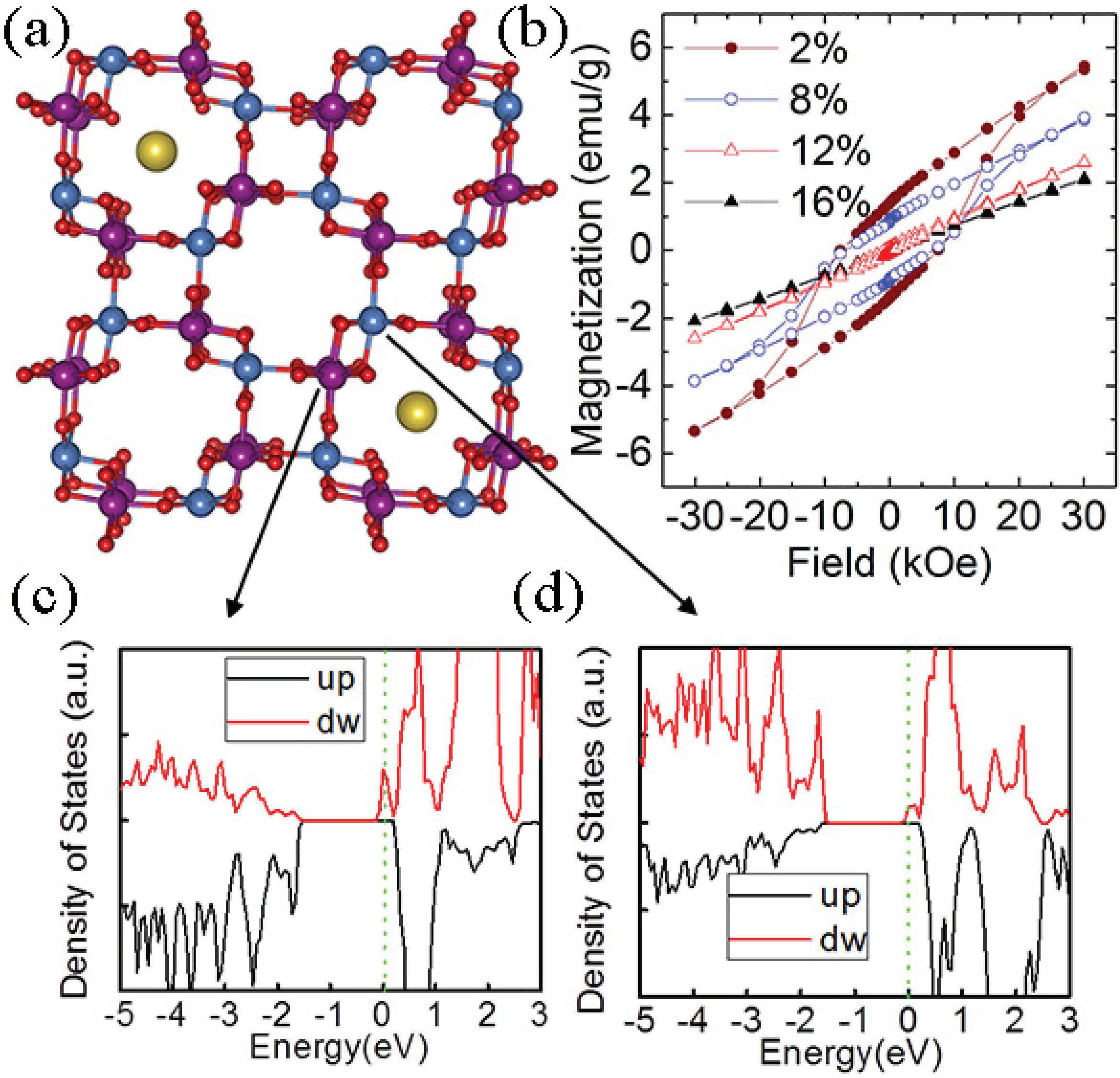


Figure 2: a) 2×2 tunnel structure of α-MnO_2 indicating the position of O and Mn. K doping has different effects on two Mn sites (blue and purple) bonded with apex site and plane site of octahedral O respectively; b) Hysteresis loops of K doped MnO_2 with a variety of dopig concentrations taken at 5 K. c) DOS of Mn bonded with apex site of O; d) DOS of Mn bonded with plane site of O. The differences of c) and d) induce ferromagnetic behaviour.



1. H. Pan et al. Phys. Rev. Lett, 99, 127201 (2007);
2. J.B, Yi et al. Phys., Rev. Lett. 104, 137201 (2010);
3. Y.R. Wang et al. Chem, Mater, 27, 1285 (2015).
4. L.T. Tseng et al. Sci. Rep. 5, 9094 (2015)

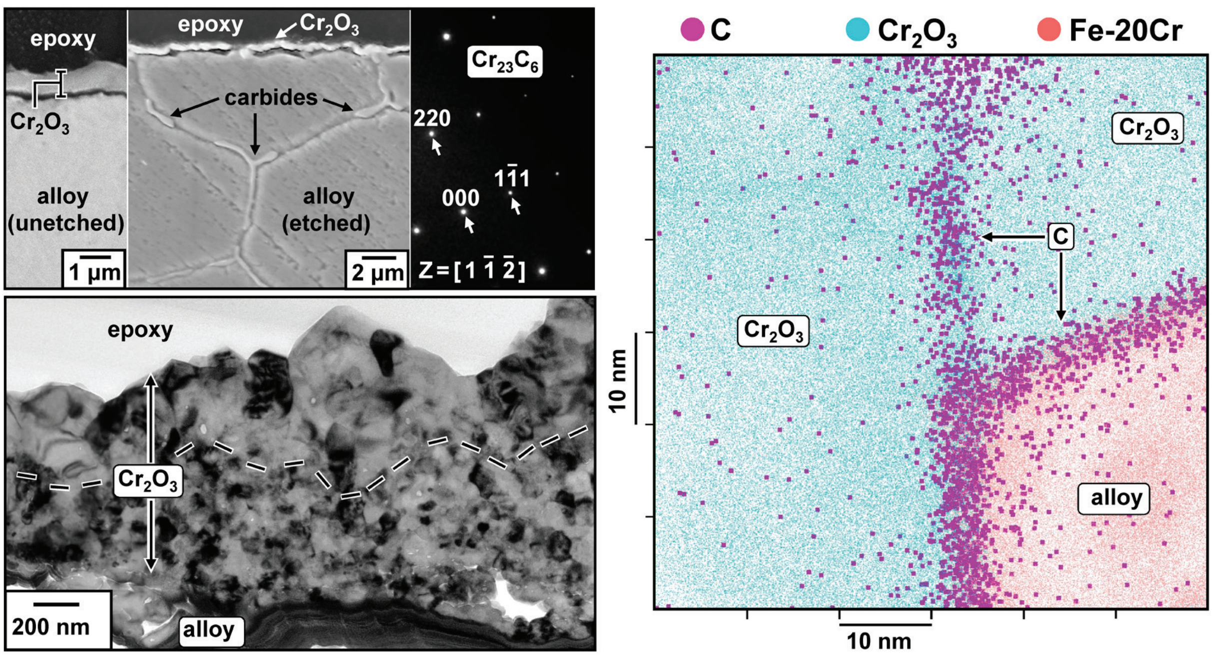
Research Highlights at High Temperature

(Dr Jianqiang Zhang, Emeritus Prof. David Young and their group)

High temperature corrosion of steel by CO_2-rich gases

This research addresses an important phenomenon in the handling of hot CO_2-rich gas corrosion in coal combustion for power generation. The oxyfuel process, where coal is burnt in O_2 rather than air, has been developed, making CO_2 capture feasible. Unfortunately, the flue gas, rich in CO_2 and H_2O is very corrosive to steels used for the boiler construction. Steels were able to survive in oxygen or air at high temperatures by forming a slow-growing oxide scale, usually Cr_2O_3, which protects the underlying metal, but not in CO_2 as it can interact with scales in damaging ways, resulting in a transition from slow "protective" scale growth to rapid "breakaway" corrosion. This project is to define corrosion kinetics in CO_2-H_2O gases, identify the mechanisms, and investigate ways of preventing attack by controlling gas composition and appropriate alloying. The carburisation observed under low carbon activity CO_2/H_2O gas has been successfully described by a local equilibrium model at the scale/alloy interface. Direct observation of enriched carbon at oxide grain boundaries has been achieved by using TEM and atom probe tomography, for understanding of how carbon penetrates via grain boundaries in the external oxide scale in CO_2 (Figure 1). This finding makes a possible approach to blocking carbon access by selective adsorption of sulphur on oxide grain boundaries. Minority alloy components of Si and Mn on CO_2-rich gas corrosion have also been investigated, showing strong effects on improving corrosion resistance of steels.

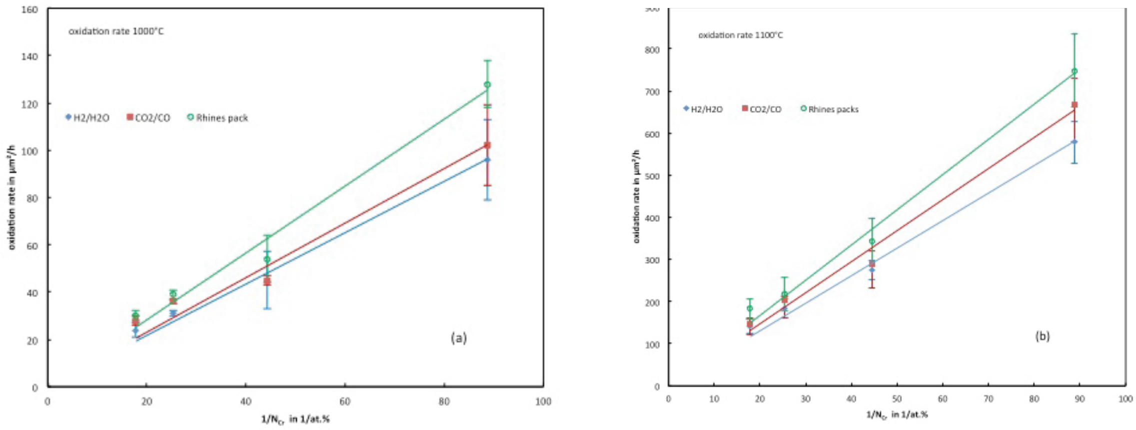
Figure 1. Left – SEM and TEM analyses of Cr_2O_3 and internal $Cr_{23}C_6$ in Fe-20Cr exposed at 650 °C to Ar-20O_2 for 24 h, and then to Ar-20CO_2 for 70 h; Right – Atom probe analysis of Fe-20Cr reacted with Ar-20CO_2 for 120 h at 650 °C, showing 10 nm thick slice from reconstructed atom distribution.



Determination of oxygen solubility and diffusivity for heat-resisting iron-nickel alloy design

Heat-resisting alloy design is based on forming a slow-growing protective oxide scale, usually Cr_2O_3 or Al_2O_3, which protects the underlying metal. To design (or select) such materials needs fundamental data of oxygen solubilities and diffusivities in these alloys, which are unknown. Also, it has been discovered recently that rates of internal oxidation in heat resisting alloys are accelerated in the presence of CO_2 and H_2O, a phenomenon not yet understood, but of critical importance to alloy design. This work used Rhines packs and gas mixtures of CO/CO_2 and H_2/H_2O with the same oxygen potential to measure oxygen solubility of Fe-Ni alloys at high temperatures. Oxygen permeability was also determined by carrying out internal oxidation experiments for Fe-Ni alloys doped with Cr. Preliminary results on pure nickel showed that oxygen permeability in nickel is not increased by the presence of hydrogen and/or carbon (Figure 2).

Figure 2. Oxidation rates of Ni-Cr alloys oxidized at (a) 1000°C and (b) 1100°C in different exposure conditions

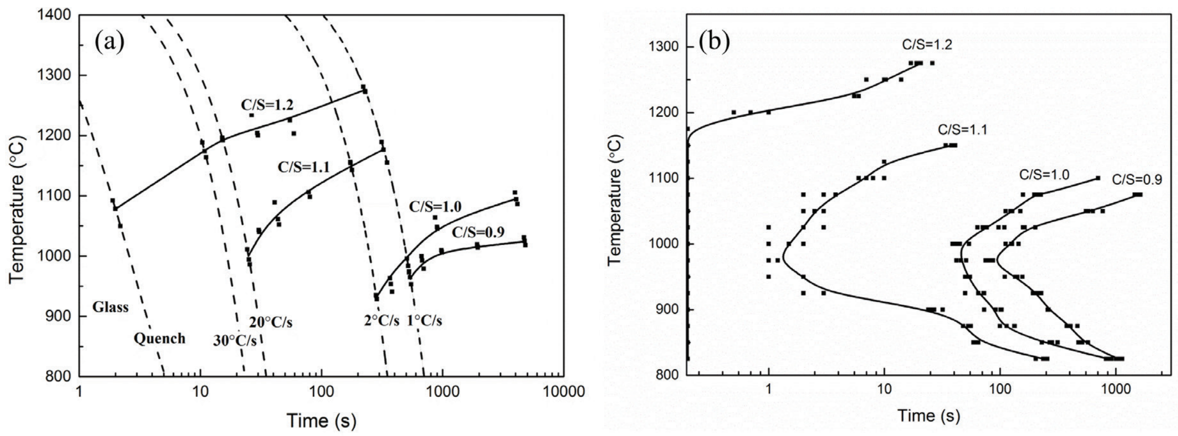


Fluoride-free mould flux for continuous casting (this project carried out together with Oleg's group)

In the continuous casting process, mould flux plays an important role in ensuring heat insulation, avoiding oxidation of steel, absorbing inclusions from liquid steel, controlling heat transfer, and lubricating shell and mould. Traditional mould fluxes contain fluorides, leading to environmental pollution, equipment corrosion and potential health and safety hazards. Thus, development of fluorine-free mould flux is essential to the continuous casting process.

In our work, several fluorine-free boracic mould fluxes were developed, and their melting properties and viscosities were measured. The crystallisation processes of these fluxes, which are correlated with flux heat transfer, were determined by using Hot Thermocouple Technique. Figure 3 shows the measured TTT and CCT diagrams of these mould fluxes as function of flux basicity.

Figure 3. (a) CCT diagrams and (b) TTT diagrams with varying CaO/SiO_2 ratio for boracic mould fluxes using Hot Thermocouple Technique.

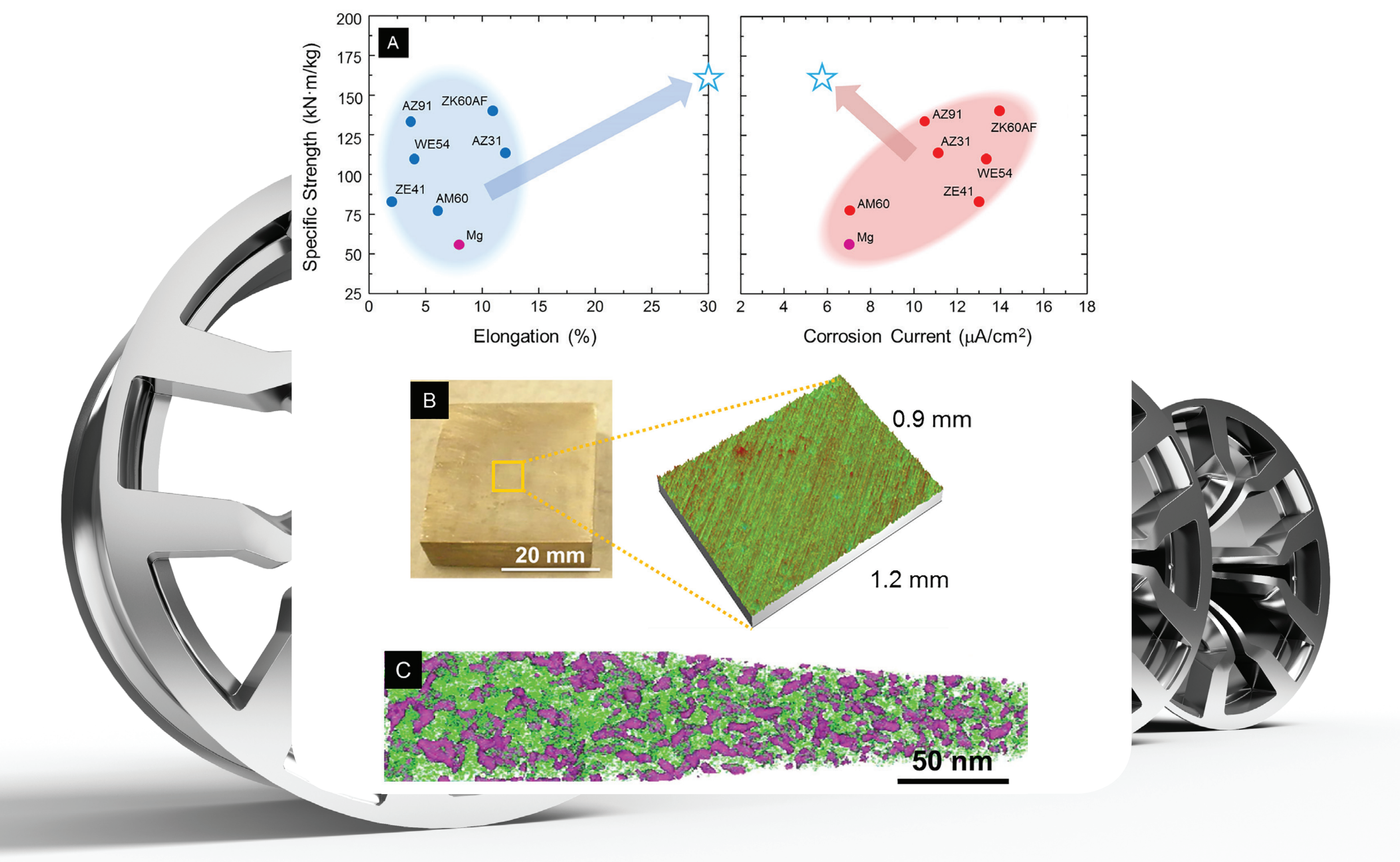


Designing novel high strength, ductile and corrosion resistant magnesium alloys

Michael Ferry and Wanqiang (Martin) Xu

It has long been sought to create ultra-lightweight alloys with high strength, ductility and corrosion resistance. *An inherent problem is the latter two properties are inversely correlated with strength.* For example, magnesium (Mg) alloys are the lightest (ρ ~1.74g/cm^3) of all structural materials, significantly lighter than steel, titanium and aluminum alloys. Whilst Mg alloys possess good strength-to-weight ratio (specific strength), two critical factors hindering their commercial use are: (1) limited cold workability/ductility, and (2) high susceptibility to corrosion. Point 1 is very difficult to overcome due to the crystal structure of magnesium and Point 2 is particularly critical because Mg alloys do not form a protective oxide film on their surface (as opposed to aluminum, stainless steel, titanium etc.). Moreover, Mg alloys have no effective sacrificial coatings similar to that of zinc used for steel surfaces.

An international research team led by Professor Ferry and Dr Xu have demonstrated that the aforementioned strength/ductility/corrosion paradox can be overcome via the design of an ultra-low density (1.4 gcm^3) Mg-Li-based alloy that is strong, ductile, and more corrosion resistant than any other Mg alloy (represented by the blue stars in the property space (Ashby) maps in A, and revealed in B by the pristine sample surface after extensive corrosion testing showing the original grinding marks). This novel property profile was achieved by engineering a novel solute-nanostructured matrix in the alloy (shown by the atom probe image in C). Corrosion resistant Mg-Li actually seems counterintuitive due to the chemical reactivity of Li in Mg, but our nanostructured alloy generates a highly protective surface film in a manner similar to stainless steel and aluminium. This has enabled us to create a *stainless* form of magnesium for potential use in diverse applications such as the automotive, aerospace, military, biomedical, sporting and electronic goods sectors.



Research Grants

GRANTS COMMENCING IN 2015

ARC Discovery Grants

- Koumoto, K., **Li, S**., *Beyond Phononic Crystals-Building New Concepts to Enhance Thermoelectricity*, 2015, $384,700
- Birbilis, N., **Laws, K.J., Ferry, M.**, *Ultra-lightweight alloys with unique multi-dimensional property profiles*, 2015 $355,100
- **Young, D.J., Zhang, J**., *Controlling nickel-base alloy high temperature corrosion in CO_2-rich gases*, 2015 $399,500
- Morozovska, A., **Munroe, P.R.,** Weyland, M., **Valanoor, N.,** *'Designer defects' - A new approach to functional oxide interfaces*, 2015 $473,900
- Xie, Z., Xu, J., **Munroe, P.R**., *Design of Tough, Durable and Corrosion-resistant Coating*s, 2015, $325,500
- **Hoffman, M.**, *Fatigue in lead-free piezoceramics*, 2015 $369,900

ARC DECRA Awards

- **Hinterstein, J.M**., *On the origin of high strain in lead-free piezoelectric materials*, 2015 $315,000
- **Tang, C**., *Materials Design for Self-toughening Bulk Metallic Glasses*, 2015 $368,000

ARC Future Fellowships

- **Cazorla, C.,** *Rational Design of Novel Multiferroic Materials for Energy Harvesting and Energy Efficiency*, 2015 $621,374

ARC LIEF Grants

- Hamilton, A.R, McKenzie, D.R., Micolich, A.P., Ulrich, C., **Valanoor, N**., **Seidel, J**., *Next-Generation Electronic and Magnetic Materials Characterisation Facility*, 2015 $760,000
- McCamey, D., Schmidt, T., Lakhwani, G., Gooding, J., D'Alessandro, D., and **Hart, J**., *Fabrication facility for oxygen-sensitive electronic materials*, 2015 $240,000

ARC Linkage Grants

- **Laws, K.J.,** Patel, Y., **Ferry, M**., *Reducing the environmental impact of passenger vehicles by the design of lightweight alloy components*, 2015 $420,000

GRANTS COMMENCING IN 2014

ARC Discovery Grants

- Morozovska, A., **Seidel, J., Valanoor, N.,** *Domain wall nanoelectronics: The wall is the device*, 2014 $330,000
- **Seidel, J.,** *Electronic charge separation at polar topological defects - photovoltaics beyond the conventional p-n junction*, 2014 $380,000
- **Yi, J.,** *Spin manipulation in oxide magnetic semiconductors towards spintronics applications*, 2014 $240,000
- **Sorrell, C.C.,** *X-Ray Activation of Photocatalytic Titania-Coated Biomedical Implants in Situ*, 2014 $365,000
- Ding, J., **Wang, D., Li, S.,** *Development of Novel Spin Caloritronic Materials and Devices for Heat Management in Nanoelectronic Systems*, 2014 $400,000

ARC Future Fellowships

- Chu, D., *Building Novel Solid State Electric Double Layer Transistors with Interface Engineering of Ionic Conductive Oxide Superlattices*, 2014 $735,144

ARC Linkage Grants

- **Yu, A-B., Jiang, X.,** *Development and Application of VO_2-based Advanced Nanomaterials for Smart Window Coatings*", 2014 $690,000
- **Yu, A-B.,** *Development and application of a virtue experimental blast furnace*, 2014 $440,000
- Saydam, S., **Crosky, A.G.,** Hagan, P.C., Hebblewhite, B.K., Timms, W.A., Craig, P.H., Sheffield, P.M., McCowan, B., Byrnes, R.P., Johnson, R., *Avoiding Catastrophic Failure of Cable Bolts in Underground Mines*, 2014 $210,000

GRANTS COMMENCING IN 2013

ARC Discovery Grants

- Hibbert, B., **Zhang, J., Young, D.J.,** *Heat-resisting iron-nickel base alloys in challenging* new applications - oxygen permeabilities and resistance to internal oxidation, 2013 $460,000

- **Glaum, J., Daniels, J.E.,** *Electro-mechanics of natural load-bearing materials: Understanding mechanisms of toughening, remodelling, and self-healing*, 2013 $360,000

ARC LIEF Grants

- Duty, T.L., Nowotny, M., **Sahajwalla, V.H.**, Sheppard, L., **Wang, D., Yu, A.B**., Li, S., *Spin-Polarized Scanning Tunneling Microscope: A Critical Instrument for Expanding the Functionality of State-of-the-Art Oxide MBE System*, 2013 $340,000
- Barnett, M., Bettles, C., Cairney, J., Davies, C., **Hoffman, M.J., Laws, K.J**., Ma, Q., **Munroe, P.R**., Quadir, Md. Z., Ringer, S.P., Stanford, N., Zhang, M-X., **Ferry, M.**, *Thermal and Mechanical Simulation Laboratory for Light Metals*, 2013 $390,000

ARC Linkage Grants

- Hockings, K., Zhang, G., Zulli, P., **Ostrovski, O.,** *Coke integrity in blast furnace ironmaking: Understanding and technology development*, 2013 $365,000
- Maric, M., Zhang, C., **Zhang, J., Ostrovski, O**., *Decrease of environmental impact of steelmaking: development of fluorine-free mould flux for steel continuous casting*, 2013 $250,000
- Fang, Y., Hodgson, P.D., **Laws, K.J.,** Quadir, Md. Z., Stanford, N., **Ferry, M.,** *Reducing the environmental impact of steel making through direct strip casting*, 2013 $210,000

GRANTS COMMENCING IN 2012

ARC Discovery Grants

- **Young, D.J., Zhang, J.,** *Role of oxide grain boundaries in controlling high temperature corrosion of steels by CO_2-rich gases*, 2012 425,000

ARC DECRA Awards

- **Glaum, J.,** *Fatigue degradation in lead-free piezoelectric ceramics: the key factor for successful industrial implementation*, 2012 $400,446

ARC Future Fellowships

- **Seidel, J.,** Nanoscale *Characterization And Manipulation of Complex Oxide Interfaces And Topological Boundaries*, 2012 $713,028

ARC Linkage Grants

- **Ostrovski, O.,** *The use of Australian magnetite ore in advanced ironmaking*, 2012 $220,000
- **Ostrovski, O.,** *The use of non-traditional materials in production of manganese alloys with economic and environmental benefits*, 2012 $227,516

GRANTS COMMENCING IN 2011

ARC Discovery Grants

- **Yi, J.,** *The Development of advanced diluted magnietic semiconductors through nonmagnetic element doping and defect engineering for spin transistors*, 2011 $139,620
- Chan, H. L-W., **Wang, D.,** *Development of high-performance lead-free piezoelectric superlattices for environmentally-friendly and biocompatible pMUTs applications*, 2011 $210,000
- **Yi, J.,** *QEII-The Development of advanced diluted magnietic semiconductors through nonmagnetic element doping and defect engineering for spin transistors*, 2011 $610,680

GRANTS COMMENCING IN 2010

ARC Discovery Grants

- **Valanoor, N., Munroe, P.R.,** *Elastically controlled magnetoelectric transduction in thin film multilayer*s, 2010 $251,415

SMART GRANTS

- Scientia Professor **Veena Harbhagwan Sahajwalla**, *Recycling lignocellulosic agricultural waste as an iron oxide reductant in ferrous processing*. ARC Linkage Project / Onesteel NSW / Microbiogen Pty Ltd. Start Date: 2012
- Scientia Professor **Veena Harbhagwan Sahajwalla**, *Transforming Waste Directly in Cost-effective Green Manufacturingm,* ARC / Industrial Transformation Research Hubs, 2013
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- Associate Professor **Rita Khanna**, *Direct reduction of mixed oxides at lower temperatures: A novel approach to produce lightweight ferrous alloys*, ARC, 2013

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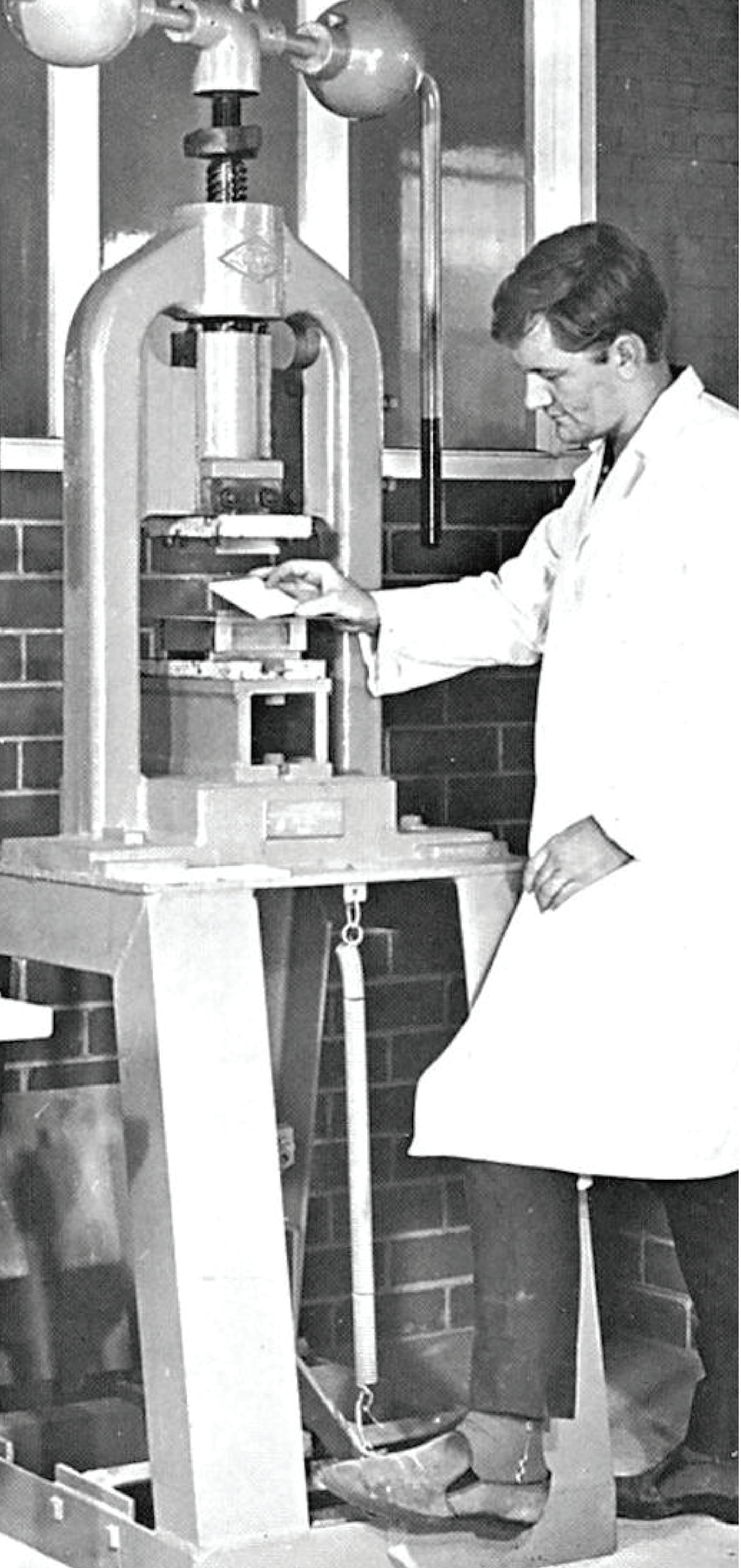

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