DEAKIN
UNIVERSITY AUSTRALIA

IFM
INSTITUTE FOR
FRONTIER MATERIALS

2014 ANNUAL REPORT

Geelong & Melbourne |
Victoria | Australia

THE YEAR AT A GLANCE

- Carbon Nexus, $35M carbon fibre research facility officially opened
- Five year, $2M collaborative research program on short nanofibres with partner HeiQ Pty Ltd
- 146 PhD students and 25 PhD completions
- 369 scientific journal papers and 40 conference papers published
- Member of new ARC Centre of Excellence for Electromaterials Science
- Hosted 14th International Symposium on Polymer Electrolytes
- Collaboration with more than 100 local and international industry partners
- Five new ARC Discovery projects
- Three new ARC Linkage projects
- One new ARC Discovery Early Career Researcher Award
- Two new ARC LIEF grants
- $510,000 funding from Australian Wool Innovation
- $1.1M funding from Cotton Research & Development Corporation

CONTENTS

IFM
INSTITUTE FOR FRONTIER MATERIALS

> Pictured above, Team IFM

FROM THE CHAIRPERSON

> Professor Lee Astheimer, Deputy Vice-Chancellor (Research), Chairperson IFM Board.

2014 was a landmark year for IFM, particularly in relation to a number of new ventures.

The highlight of the year was the official opening of our cutting-edge carbon fibre research facility, Carbon Nexus in May. This $34 million open access facility is an international centre of research and development, underpinned by strong local connections. Deakin now has a pilot carbon fibre manufacturing line embedded in the University, directly tied to research and ready to work with industry on projects that will help drive the jobs of the future. We also welcomed Derek Buckmaster as the new Director of Carbon Nexus. Our researchers are exploring the fundamental science for making industry-relevant breakthroughs in low-cost, high-performing composite materials.

Also related to IFM's fibre expertise, the short nanofibre research has resulted in a five-year, $2 million collaborative research program with industry partner HeiQ Australia, a joint venture with HeiQ Pty Ltd and Cytomatrix. The agreement will see world-leading short nanofibre commercial manufacturing at Deakin in Geelong, with the promise of jobs and new associated industries for the region. This new joint venture illustrates the importance Deakin places on partnerships and collaboration, from both a research and commercial perspective.

In March I was pleased to open the National Facility for Pipelines Coating Assessment with the CEO of Energy Pipelines CRC (EPCRC), Valerie Linton. This EPCRC supported facility is in demand by industry to test oil and gas pipeline coatings and will help to build Australia's capability to support pipeline coating selection and development through cutting edge research.

Another exciting development that is starting to take shape is the new Australian Centre for Infrastructure Durability (ACID). This virtual centre, led by IFM Deputy Director, Professor Maria Forsyth will build on our expertise in corrosion science and materials durability and aims to give Australian industry a national platform to connect with researchers in these areas critical for infrastructure sustainability.

Finally, I would like to recognise the enormous contributions made by former IFM director, Professor Peter Hodgson. Over just seven years as Foundation Director of IFM (ITRI), Peter had the vision and drive to build IFM into a leading Australian centre of materials science with a commitment to world-leading, industry-focused research. In his new role as PVC Strategic Partnerships, Peter will continue making important contributions through building new international collaborations and partnerships for Deakin and IFM.

Professor Lee Astheimer

Deputy Vice-Chancellor (Research), Chairperson IFM Board

FROM THE DIRECTOR

> Professor Xungai Wang, Alfred Deakin Professor, Director IFM.

Since the last IFM Annual Report, Professor Peter Hodgson has stepped down to take up a new leadership position in the University as Pro Vice-Chancellor (Strategic Partnerships) and I was appointed as Director in December 2014.

A review of IFM took place in October. The review panel delivered 13 recommendations, which will help IFM's future development as we enter a challenging time of reduced government funding for research. The panel acknowledged IFM's excellent research performance and innovation under Prof Hodgson's leadership as well as IFM's significant contribution to the University's reputation.

During the year, our strategic planning process has clearly identified six major areas for research focus and growth opportunities:

- Australian Centre for Infrastructure Durability (ACID)
- Carbon fibre and composite research (Carbon Nexus)
- Energy storage
- Future fibres
- Future metals manufacturing
- Nanofibres

The annual IFM conference once again showcased the work of our students through presentations and posters with the theme 'From Ideas to Impact' reflecting our increased focus on engaging with industry.

Congratulations to all the IFM staff who received promotions in 2014, including two new professors – Professors Bronwyn Fox and Tiffany Walsh.

I am pleased to report that we exceeded our research target of $7.9 million for the year. IFM achieved a good outcome in the ARC grants, especially in terms of the overall University performance.

We were awarded two Linkage grants, three Discovery grants, one Discovery Early Career Researcher Award and one Linkage Infrastructure, Equipment and Facilities grant as the lead institute and have CIs in several other successful ARC projects. As well, we have received some significant grants from industry, including $1.1 million from the Cotton Research and Development Corporation.

In summary, 2014 was a busy year and I am delighted with the achievements of IFM staff and students as detailed in the following pages.

Professor Xungai Wang

Alfred Deakin Professor,
Director, Institute for Frontier Materials

INTERNATIONALISATION

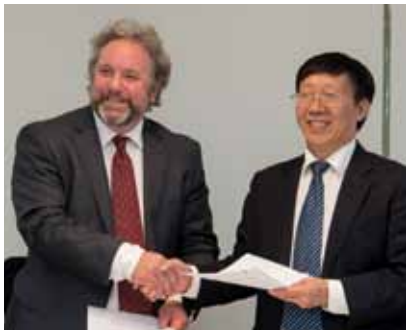
In 2014 we strengthened existing collaborations in India and China as well as identifying new links in Europe and North America.

> IFM, the University of Mumbai and Sankara Nethralaya Vision Research Foundation held a collaborative workshop on microelectromechanical systems (MEMS) and their applications in health care, supported by the Australia-India Strategic Research Foundation.

INDIA

In 2014, Prof Peter Hodgson and senior researchers (Prof Jeong Yoon, Prof Lingxue Kong, A/Prof Bernard Rolfe, Dr Daniel Fabijanic and Dr Matthias Weiss) visited Chennai (Madras) for discussions with local industry and IIT-Madras to identify future research projects as part of a new Centre of Excellence for Advanced Manufacturing and Materials. They identified a number of strategically aligned topics for PhD research and other areas of collaboration.

They also visited the large automotive manufacturer Mahindra & Mahindra Corporation which expressed interest in being part of the new centre and in IFM delivering high-level courses to its staff. The centre will be very industry focused as Chennai is a major manufacturing hub in India. It will initially support 10 PhD students, who will be co-supervised by the Deakin team and IIT-Madras. These students have all been selected through interviews by IFM and IIT-Madras and will commence before June 2015.



> Prof Peter Hodgson and Prof Maofa Jiang, Vice-President of Northeastern University, China signed a Memorandum of Understanding between the two universities.

CHINA

Our collaboration with Chinese institutions on both academic and research programs grew during the year and new initiatives have been developed.

Two major new projects began with Wuhan Iron and Steels (Group) Corporation (WISCO) to develop high-quality coated steel products and hot stamped automotive components. Four WISCO research engineers successfully completed their one year joint research at Deakin and we welcomed a new group of four research engineers in November 2014. The joint Deakin-WISCO annual forum on advanced high strength automotive steels was successfully held in Sydney in partnership with CAMS2014. More than 20 Chinese academics and research scientists participated in the forum.

All Deakin joint laboratories with WISCO, WUST, WTU, CISRI and CATAS have been progressing well including the joint publication of a number of high quality journal papers and joint supervision of research students. We also jointly held the 3rd Australia - China Forum on Multidisciplinary Environmental Science and Engineering Research with Chinese Academy of Sciences.

Dr Maryam Naebe was awarded an Australia-China Young Scientists travel grant and visited a number of leading Chinese textile universities and companies. (see page 12).

We welcomed our first joint PhD student from Northeastern University who has been supported by a prestigious China Scholarship Council fellowship.

EUROPE

Our collaboration with research institutes in the Basque region of Spain continues to grow, with research projects between Prof Maria Forsyth's group and the Tecnalia Corporation of San Sebastian in a number of areas, including corrosion, energy storage, point-of-care, ionic liquids and membranes.

We also have an off-campus PhD student, Laura Sanchez, between Deakin and Tecnalia, researching recovery of rare earth in ionic liquids and supervised by Prof Forsyth.

In 2015 Prof David Mecerreyes from the Polymat University of the Basque Country will visit Deakin for three months as a Thinker in Residence, which will lead to new collaborative research programs mainly in energy storage; however as an expert in polymer chemistry, his broad experience will be useful for other activities in IFM.

In the last two years we have hosted two PhD students from Prof Mecerreyes' group which has led to two peer-reviewed international publications. In the future we are looking to formalise the PhD student exchange between both groups.

NEW
Centre of Excellence for Advanced Manufacturing and Materials

OUR VISION AND MISSION

OUR VISION

To lead and inspire innovations in materials science and engineering that have a transformational benefit to society.

OUR MISSION

To foster innovation and excellence in materials science and engineering research with the aim of developing:

- Innovative manufacturing technologies
- Energy efficiency, resource and infrastructure sustainability.

We aspire to provide the highest quality research training and education to sustain the advancement of society.

BOARD MEMBERS 2014

The IFM Board is responsible for the governance and oversight of the research, development and commercialisation activities of IFM.

Top row (L-R):

PROFESSOR JANE DEN HOLLANDER
Vice-Chancellor, Deakin University

PROFESSOR LEE ASTHEIMER
Deputy Vice-Chancellor (Research), Deakin University, Chairperson, IFM Board

PROFESSOR PETER HODGSON
Australian Laureate Fellow and Director of the Institute for Frontier Materials (until 30 Nov 2014)

PROFESSOR BRENDAN CROTTY
Pro Vice-Chancellor Health, Deakin University

Bottom row (L-R):

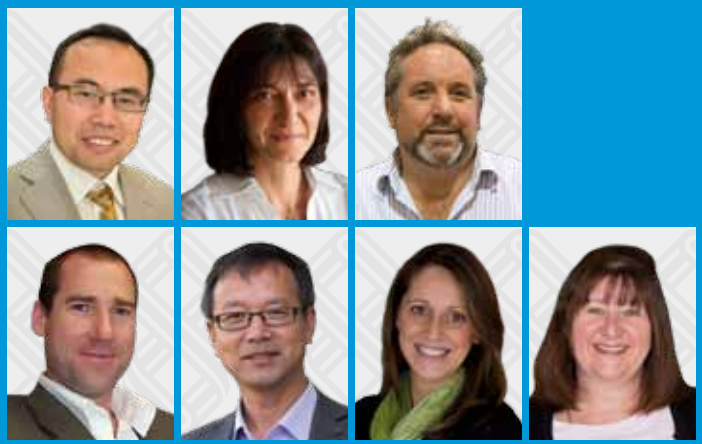
PROFESSOR TREVOR DAY
Pro Vice-Chancellor Science, Engineering & Built Environment, Deakin University

PROFESSOR GEOFF STEVENS
External Independent Director

PROFESSOR KEITH MCLEAN
External Independent Director

PROFESSOR GORDON WALLACE
External Independent Director

IFM EXECUTIVE TEAM



Top row (L-R):

PROFESSOR XUNGAI WANG
Alfred Deakin Professor, Director Institute for Frontier Materials

PROFESSOR MARIA FORSYTH
Australian Laureate Fellow, Deputy Director Institute for Frontier Materials

PROFESSOR PETER HODGSON
Australian Laureate Fellow and Pro Vice-Chancellor Strategic Partnerships

Bottom row (L-R):

PROFESSOR MATTHEW BARNETT
Alfred Deakin Professor and ARC Future Fellow

PROFESSOR LINGXUE KONG
Professor (Research)

MS VIRGINIE HOAREAU
General Manager, Institute for Frontier Materials

MRS DARLENE BARNETT
Senior Manager, Technical and Academic Support, Institute for Frontier Materials

KEY RESEARCH AREAS

- Australian Future Fibres Research and Innovation Centre (AFFRIC)
  - Carbon Fibres and Composites
  - Green Natural Fibres
  - Functional Fibrous Materials and Nanofibres
- Biomaterials
- Molecular Modelling and Simulation
- Numerical Modelling and Design of Materials for Lightweight Structures
- Corrosion Research Centre
- Electromaterials and Energy
- Nanotechnology and Energy Storage
- Metals
- Micro and Nano Systems
- Plasma Research
- Polymers

AFFRIC - CARBON FIBRES AND COMPOSITES

GROUP MEMBERS

STAFF: Prof Bronwyn Fox, Steve Atkiss, Derek Buckmaster, Dr Minoo Naebe, Dr Kevin Magniez, Dr Luke Henderson, Dr Claudia Creighton, Dr Hamid Khayyam, Dr Mandy de Souza, Dr Nishar Hameed, Dr Nisa Salim, Dr Steve Agius, Dr Tim de Souza, Josephine Posterino, Katrina Robertson, Pedro Sousa, Alex Borda Coca, Alexis Leblais, Madhu Suryanarayana, Tristan Alexander, Kieu Nguyen

STUDENTS: Peter Bruchmüller, Erwan Castanet, Thomas Chaffraix, Matthew Jennings, Quanxiang Li, Sahar Naghashian, Robert Nunn, Linden Servinis, Srinivas Nunna, Maxime Maghe, Racim Radjef, Khashayar Baddi, Gelayol Golkar, Deepa Ram, Omid Zabihi, Azam Oroumei, Sajjad Shafei, Jamie Gilbert

> Dr Nisa Salim has been awarded a highly prestigious Gold Medal from the Australian Institute of Nuclear Science and Engineering (AINSE).

The highlight of the year was the official opening of Carbon Nexus on 21 May. The Victorian Premier Denis Napthine officially opened the $34 million carbon fibre research facility.

A host of dignitaries and industry leaders were among the 300 guests at the event. Deakin University Vice-Chancellor, Professor Jane den Hollander said the new open access facility - owned and operated by Deakin University - was an international centre of research and development, underpinned by strong local connections.

Our group continues to build on its excellent reputation for conducting research in partnership with industry, responsive to industry needs. Our vision is to be a world leading centre of excellence in providing research solutions for industry focused on the science of the manufacture and use of carbon fibre.

The partnership between Deakin University, CSIRO and international collaborators gives us a unique capability to tailor the next generation of composite materials from their molecular components.

RESEARCH HIGHLIGHTS

Our long-term industry partner, Quickstep Holdings Ltd was awarded a $1.76 million Geelong Region Innovation and Investment Fund (GRIIF) grant to establish a dedicated automotive division to be located at Deakin University.

An ARC Discovery Grant of $345,500 was awarded to a University of Queensland and Deakin team, including Professor Bronwyn Fox for investigating ‘High performance sustainable carbon fibres from Australian spinifex grass’.

Our industry partner, Quickstep Holdings Ltd receives **$1.76M** grant to set up automotive division at Deakin

NEW PROJECTS

- High Curvature Armour Systems, DMTC/VCAMM
- Process Development of Lower Cost Automotive Grade PAN Based Carbon Fibres, Ford University Research Program (URP)
- High-volume process to manufacture carbon fibre composite parts for automotive applications, AutoCRC, Multimatic, VCAMM
- Fundamental Understanding of Carbon Fibre Properties: Towards Development of Low Cost Carbon Fibre for Transport Application, AutoCRC, VCAMM
- High Barrier and Strength Polyethylene Nano-Composites, Qenos.

EVENTS/CONFERENCES

Dr Luke Henderson gave two invited lectures at international conferences (RACI Congress and the Asia-Pacific Conference on Ionic Liquids).

Dr Minoo Naebe gave an invited talk on Next Generation Composite Armours at DMTC annual conference held in Canberra in March 2014.

STAFF AWARDS

Smart Geelong Awards

Professor Bronwyn Fox was named the 'Barwon Health Smart Geelong Network Researcher of the Year' and also received the Chamber of Commerce 'Award for Innovative and Sustainable Technology and Engineering'. Dr Luke Henderson received the runner-up Smart Geelong Network Highly Commended Award and the Viva Energy Australia 'Award for Innovation in Biomedicine and Biotechnology'.

Dr Nisa Salim was awarded the highly prestigious Gold Medal from the Australian Institute of Nuclear Science and Engineering (AINSE). Dr Salim also received an Endeavour Research Fellowship to work overseas for 4-6 months in 2015.

Professor Bronwyn Fox, Steve Atkiss and Ian Kett received the Vice-Chancellor's Award for Outstanding Contribution to Creating Innovative Environments.

One of our students, Linden Servinis, was a finalist in FameLab – the international science communication competition to find the best new voices of science, engineering and mathematics. Linden came second in the state final for her presentation *Chemistry and carbon fibre* and then competed in the national competition in Western Australia.

Tristan Alexander, one of our Armour Research Engineers won the Land Defence Australia Limited Young Innovator award for his work on Polymer Ceramic Composites which is a part of the DMTC High Curvature Armour Systems project.

> Below: The ballistics armour project team: Tristan Alexander, Madhu Suryanarayana and Dr Minoo Naebe.

CASE STUDY

RESEARCHERS CONQUER BALLISTICS ARMOUR

It is only nine years since the Defence Science and Technology Organisation (DSTO) put out a challenge to Australian scientists – find a way to put curves into ballistics materials. At the time, it seemed impossible. In ballistic fabrics alone, the stiffness of the fibres made it too difficult to bend without wrinkling the material.

But ballistics fabric experts at Deakin couldn't resist the challenge. They chose the most difficult shape they could think of – the combat helmet – which has the deepest draw and tightest radius of curvature of any ballistics equipment – and set their sights on solving the problem.

The results were outstanding. Now, the researchers have helped develop the capability to produce shapes that will enable the manufacture of non-spliced combat helmet shells that are lighter, stronger, better performing and cheaper to produce than previous designs.

Deakin chief investigator Dr Minoo Naebe and research engineer Mr Madhusudan Suryanarayana worked in collaboration with the Defence Materials Technology Centre (DMTC), the Victorian Centre for Advanced Materials Manufacturing (VCAMM), Pacific ESI, Ballistic and Mechanical Testing, DSTO and independent manufacturer Australian Defence Apparel (ADA).

The team developed a unique process – Double Diaphragm Deep Drawing (D4) – to curve and harden the Kevlar-style ballistic fibres into the correct shape. They designed a special plant that uses thermal (heat) forming to shear the fibres in ultra-high molecular weight ballistic fabric – and managed to achieve perfectly shaped shells that are 20-30 per cent lighter than current helmets. The technology will help Australian industry to deliver world class armour at lower cost to the Australian Defence Force, and allied military and paramilitary customers.

An important benefit of the D4 process is that it has eliminated the need to cut or splice the fibres, as in existing helmets, thus avoiding any compromise in strength – and improving the mechanical and ballistic performance. D4 is considered the world's fastest composite forming process, taking only 20 minutes to produce each shell, as opposed to the 45 minutes to one hour of current techniques.

The helmet shells meet the highest safety standards, including the requirements outlined in the US standard for Advanced Combat Helmets (ACH).

There are also numerous non-military and civilian potential applications which allows the technology to be used in areas as diverse as aerospace, automotive, shipping, construction, furniture, sports, or radomes (radar covers).

The technology is ready to go and the team is looking forward to exploring commercial ventures with industrial partners.

AFFRIC - GREEN NATURAL FIBRES

GROUP MEMBERS

STAFF: Professor Xungai Wang, Dr Nolene Byrne, Dr Bruce McGregor, Dr Jingliang Li, Dr Ben Allardyce, Dr Christopher Hurren, Dr Xin Liu, Dr Maryam Naebe, Dr Rangam Rajkhowa, Dr Lu Sun, Dr Jinfeng Wang, Dr Jin Zhang, Dr Jingyu Chen, Dr Donna Menzies, Mr Greame Keating, Dr Andreea Voda, Ms Christine Rimmer

STUDENTS: Genevieve Crowle, Saeed Dadvar, Chantal Denham, Rasike De Silva, Shan Du, Linpeng Fan, Xing Jin, Jasjeet Kaur, Mehdi Kazemimostaghim, Sepehr Moradi, Esfandiar Pakdel, Amol Janardan Patil, James Preston, Charanpreet Singh, Marinus van der Sluijs, Yao Yu, Mingwen Zhang, Licheng Zhu

> IFM Director Prof Xungai Wang and ACES Director, Prof Gordon Wallace at the Textile Institute World Conference.

ACHIEVEMENTS 2014

The green natural fibre area attracted more than $2 million in project grants from CRDC, AWI and ARC. All staff members in the area contributed to our ongoing success in securing external funding to support our research into a range of natural fibres, particularly cotton, wool and silk.

In October 2014, Professor Xungai Wang was elected President of the Fiber Society for 2015. He also chaired a very successful 89th Textile Institute World Conference in Wuhan, China in November. The conference was attended by more than 400 delegates from over 20 countries.

Over the five days the delegates heard more than 150 presentations and also visited the Hubei Fengshu Thread Manufacturing Company's huge spinning plant and technology centre.

Protective gear fails the test

Research by Dr Chris Hurren and engineering student Patrick Phillips, who was working with Dr Hurren on a summer scholarship project, has revealed the urgent need for standards for protective motorbike clothing in Australia.

Using IFM's belt abrasion tester (the only one in Australia) they tested 10 pairs of reinforced jeans marketed as protective motorcycle clothing. The results were quite a shock - only three pairs met the minimum requirements of the European standards for protective motorbike clothing, three were close to the standard, while the others were no more protective than ordinary (much cheaper) jeans.

The results have attracted interest from motorcycle magazines as well as road transport authorities in a number of states.

Novel approach improves stent mechanics

Dr Charanpreet Singh has developed an innovative knitted stent design with significantly better biomechanical properties than currently available products. Unlike conventional stents, which are usually constructed from metal alloys and have problems of limited flexibility and kink resistance, the new design has a knitted structure using polymer fibres, which gives much greater flexibility.

The novel design was inspired by observations of caterpillars and how their skin (cuticle) expands and contracts to help them move, providing a balance between structural support with elasticity and flexibility. Dr Singh and Prof Xungai Wang manufactured a segmented stent structure which shows improved flexibility and kink-free bending. Importantly, mechanical properties of the new design can be tailored for different applications. Dr Singh hopes to continue development of the novel stent.

> The segmented cuticle structure of the monarch caterpillar has provided inspiration for a novel stent design.

> The segmented stent shows improved flexibility and kink-free bending.

> Metal stents have problems of limited flexibility and kink resistance.

Young Scientists China Exchange

Dr Maryam Naebe *(pictured above)* visited China in November-December as part of the Australia China Young Scientists Exchange Programme. She visited five universities (Beijing Institute of Clothing and Technology, Tianjin Polytechnic University, Wuhan Textile University, Jiangnan University and Donghua University) where she met leading textile researchers, including the president of Wuhan Textile University and the Vice President of Tianjin Polytechnic University. During the visit Dr Naebe discussed possible research collaborations with a number of researchers and postgraduate students.

STAFF AWARDS

Mr Graeme Keating received a Vice-Chancellor's Professional Development Award to attend ITMA 2015 - the world's most significant textile and garment machinery exhibition, where he will inspect the lastest technology in both production and sampling machines as well as testing equipment, in Milan, Italy, November 2015.

CASE STUDY

> AFFRIC researchers Rasike De Silva and Dr Nolene Byrne have developed a way to separate blends of cotton-polyester material.

PROCESS TAKES TEXTILE RECYCLING TO A NEW LEVEL

Researchers at Deakin University have found a way to separate blends of cotton-polyester material, providing a major breakthrough for recycling textile and other waste.

Each year, masses of material from unwanted clothing and other textile sources are deposited in landfill. In Australia alone the figure is estimated to be one trillion tons of fibrous waste from the textile, clothing and footwear processing industries buried in landfills annually.

A significant hurdle to recycling waste clothing and other textiles back into their original fibres is that most of this material is composed of blended fibres – the most common being polyester/cotton blends. While it is easy to recycle cotton and polyester individually, separating the blend into its individual components is the difficult part. Mechanical separation is not possible due to how the fibres are blended and chemical solutions to date have involved the use of harsh solvents.

AFFRIC researchers, Dr Nolene Byrne and Rasike De Silva have developed a simple process using an ionic liquid as an environmentally friendly solvent to chemically separate polyester-cotton blends into their individual components.

After selectively dissolving the cotton component, the ionic liquid can be reused. The cotton can be regenerated into various forms, such as regenerated cellulose fibres like rayon and viscose or cellulose films like cellophane. The recovered polyester can also be recycled by melting and reshaping it into other forms, such as plastic bottles or fibres.

The researchers say the new process is not limited to textile recycling but can also be applied to recycling any type of bio-composite material, including those used in the automotive industry.

Mr De Silva carried out the project as part of his PhD research into separation and utilisation of polymer fibre blends using environmentally friendly approaches.

The process described here was published in the journal RSC Advances: *http://pubs.rsc.org/en/content/articlelanding/2014/ra/c4ra04306e#!divAbstract*

AFFRIC - FUNCTIONAL FIBROUS MATERIALS AND NANOFIBRES

GROUP MEMBERS

STAFF: Professor Tong Lin, Dr Hongxia Wang, Dr Yan Zhao, Dr Jian Fang, Dr Haitao Niu, Dr Hua Zhou, Dr Zhenyu Li, Dr Yong Du, Dr Chuanxiang, Mr Armstrong Xie

STUDENTS: Zengxiao Cai, Chao Zeng, Charanpreet Siangh, Esfandiar Pakdel, Hao Shao, Guilong Yan, Yang Zhou, Xueyang Liu, Nadeem Shuakat

> Prof Tong Lin with the new needleless electrospinning machine.

Functional fibres and fabrics have special properties to make them, for example, waterproof, conductive/resistant to heat, electrically conductive, or changing colour in response to an external stimulus.

RESEARCH HIGHLIGHTS

Dr Hongxia Wang and Dr Yan Zhao were awarded an ARC Discovery Grant ($236,700) for a project on 'Water-phase assembly of durable, superamphiphobic, self-cleaning surfaces.

This innovative project will investigate ways of creating durable, self-cleaning surfaces through water-phase assembly of super-liquid-repellent materials using dopamine, a marine-mussel-inspired underwater adhesive agent. These surfaces have wide applications in daily life, the health sector, environment and industry.

The group has recently designed and commissioned a large prototype electrospinning machine to produce nanofibre mats. The machine can be used to verify key parameters for large-scale production in industry, design production lines for nanofibre manufacture and produce commercial samples.

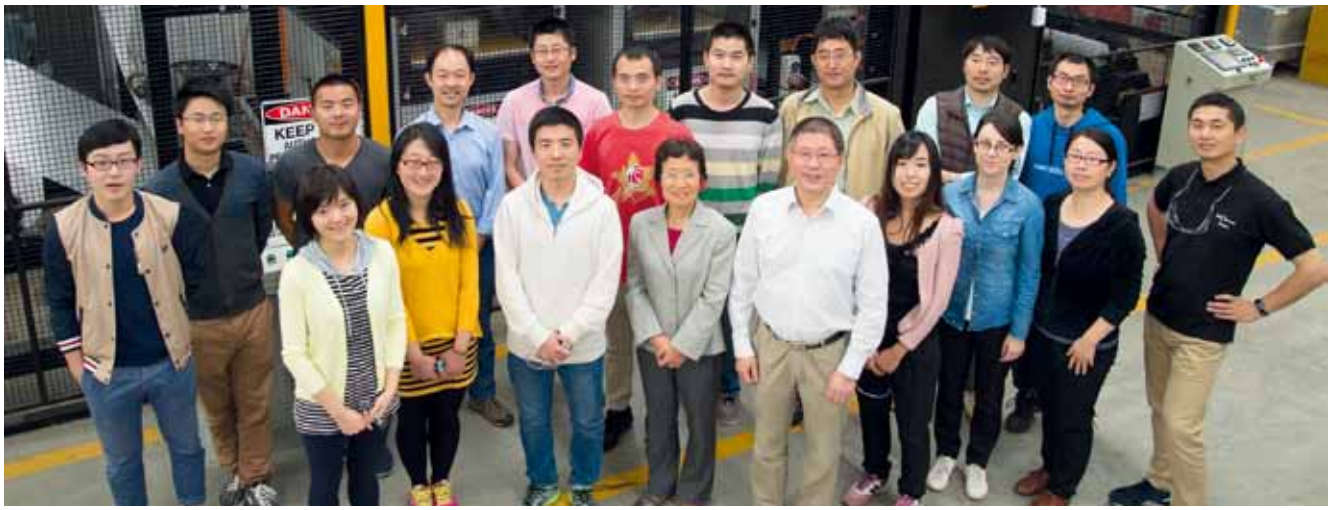
The group has now secured funding from US company, Donaldson Filtration Solutions to build a full-scale machine.

NEW PROJECTS

- Donaldson – Needleless electrospinning machine ($200,000)
- AWI – Cooling and thermal regulating wool fabrics: proof of concept.

TEXTILE JOURNAL AWARD

Professors Tong Lin and Xungai Wang, together with students Usman Ali and Yaqiong Zhou, received the prestigious Textile Institute Research Publication Award for their paper 'Direct electrospinning of highly twisted, continuous nanofiber yarns' which was published in the Textile Institute Journal.



> The functional fibres/nanofibres group: Front (L to R): Dr Hua Zhou, Zengxiao Cai, Dawei Li, Dr Hongxia Wang, Prof Tong Lin, Chenhong Lang, Emilija Zdraveva, Dr Yan Zhao, Armstrong Xie. Back (L to R): Long Tian, Yang Zhou, Guilong Yan, Dr Jian Fang, Dr Haitao Niu, Chao Zeng, Hao Shao, Dr Zhenyu Li, Dr Yong Du, Jie Cai.

BIOMATERIALS

GROUP **MEMBERS**

STAFF: A/Prof Mark Kirkland, Dr Cynthia Wong, Dr Alessandra Sutti, Dr Marzieh Parhizkar, Dr Julie Sharp, Mrs Christina Kirkland, Dr Teo Slezak

STUDENTS: Jacob Hanley, Magenta Perus, Keiran Pringle, Nishat Sharma

> Deputy Vice-Chancellor (Research) Professor Lee Astheimer, Dr Teo Slezak, Dr Paul Collins, Dr Alessandra Sutti and Associate Professor Mark Kirkland at the Victorian Engineering Excellence Awards.

Our research in the area of polymeric biomaterials focuses on two main areas: developing systems for the improved expansion of haematopoietic and mesenchymal stem cells and developing and establishing a new method for large-scale production of short nanofibres.

This research is carried out through a partnership with local biotechnology company Cytomatrix, the Advanced Manufacturing CRC and the Victorian Centre for Advanced Materials Manufacturing (VCAMM).

RESEARCH HIGHLIGHTS

Short nanofibre plant completed

The pilot-scale nanofibre plant constructed with the help of a $500,000 grant from the Victorian State Government (Skilling the Bay), and developed in collaboration with partners Cytomatrix and Austeng Engineering, is now built and being used to produce a range of short nanofibres from a range of materials. The new pilot facility will establish a platform technology for IFM with a plant that produces a range of short nanofibres for use in very diverse areas.

Initially the plant has enabled large-scale manufacturing of nanofibre-functionalised filters for air filtration. The nanofibre-production method at the core of the team's expertise has advantages of lower costs of production, greater flexibility and improved nanofibre properties over current methods used to produce these high-end filters.

The plant is the largest of a family of devices used to model and progressively scale-up the production of short nanofibres, while reducing scale-up costs.

The short nanofibre work has also attracted interest from Engineers Australia (Engineers without Borders) and the group is working on potential areas of collaborative research through student engagement.

The work will continue to develop new opportunities for industry engagement, in both enzyme biofuels and sensing technologies.

Scaffolds for stem cell research

The work in scaffolds for stem cell research with our partner Cytomatrix progressed rapidly in 2014, with two main systems being designed and tested. Protocols for stem cell expansion are being optimised so that when used in conjunction with the new cell culture device they will produce a cost-effective and scalable system for cell expansion.

This work and the very promising results have attracted international investment from GE and the Fred Hutchinson Research Centre.

> Short nanofibre experts, with the world-leading technology - (from left) Deakin researchers Dr Alessandra Sutti, Dr Paul Collins, Dr Teo Slezak and Dr Marzieh Parhizkar.

$2M
agreement with HeiQ Pty Ltd

ARC
Linkage project ($470,491)

NEW
pilot-scale nanofibre plant completed

HeiQ agreement

A major collaborative research program was entered into with partner HeiQ Pty Ltd, to begin in January 2015. This 5-year, $2 million program is based on the transfer of intellectual property and partial commercialisation rights to HeiQ and our commercial partner Cytomatrix. This work is expected to generate new commercial opportunities for short nanofibres and to continue to grow the short nanofibre technological platform.

Victorian Engineering Excellence Award

The short nanofibre multi-scale device platform was awarded the Victorian Engineering Excellence Award 2014 in the category 'Research and Development/Innovation', and was a finalist in the Australian Engineering Excellence Award 2014.

VC Award

Dr Sutti and Dr Paul Collins (SEBE) were awarded the Vice-Chancellor's Award for Industry Engagement in Research.

NEW PROJECTS

ARC Linkage project: Short silk nanofibre based 3D scaffolds with enhanced biomimicry. ($470,491)

MOLECULAR MODELLING AND SIMULATION

GROUP MEMBERS

STAFF: Prof Tiffany Walsh, Dr Pablo Palafox-Hernandez, Dr Zak Hughes

STUDENTS: Aaron Brown, Kurt Drew, Anas Sultan, Andrew Church, Thi Minh Chanh Le (Caroline), Baris Demir

> Anas Sultan and Baris Demir with their presentation and poster awards at the IFM Annual Conference.

Our research is all about prediction - we develop and apply advanced computer modelling at the molecular level, based on fundamental principles of chemistry, physics and mathematics, to predict properties and behaviours of anything that is composed of atoms and molecules.

Our predictions can provide strong guidance for industrially focused projects where questions of formulation and types/numbers of additives need to be addressed quickly and economically.

RESEARCH HIGHLIGHTS

Miami and Buffalo

Our collaborative project (Miami and Buffalo) funded by the Air Force Office for Scientific Research (AFOSR) goes from strength to strength.

This year we accomplished major goals in developing the fundamental understanding that allows us to design biomolecules that can recognize silver over gold and vice versa. This understanding is pivotal to exploiting these molecules in the fabrication of 3D nanoparticle assemblies with advanced photonic and plasmonic properties, for use in a range of defence applications. Our simulations in this project are truly ground-breaking and push the boundaries of what is possible using current molecular simulation approaches.

In the graphene space, in 2014 we released a novel, polarizable inter-atomic potential for graphene/biomolecule interactions. This potential is an essential component for advancing our own research activities and, in addition, is already being adopted by external laboratories for their own research.

We have another carbon-related project related to carbon fibre reinforced polymers, funded by our joint ARC Discovery Project award. In our part of the project, we are using molecular simulation to predict how the interface between the carbon fibre and epoxy polymers can be tailored, using a biomimetic strategy. We are making great progress, with the two PhD students on this project, Baris and Caroline, being recognized for their interesting findings generated thus far.

We also have had great success this year in using molecular simulation to show how biomolecules can selectively adsorb to one polymorph of chitin over another – a phenomenon that may be key to understanding the biomineralization process in mother-of-pearl at the molecular level.

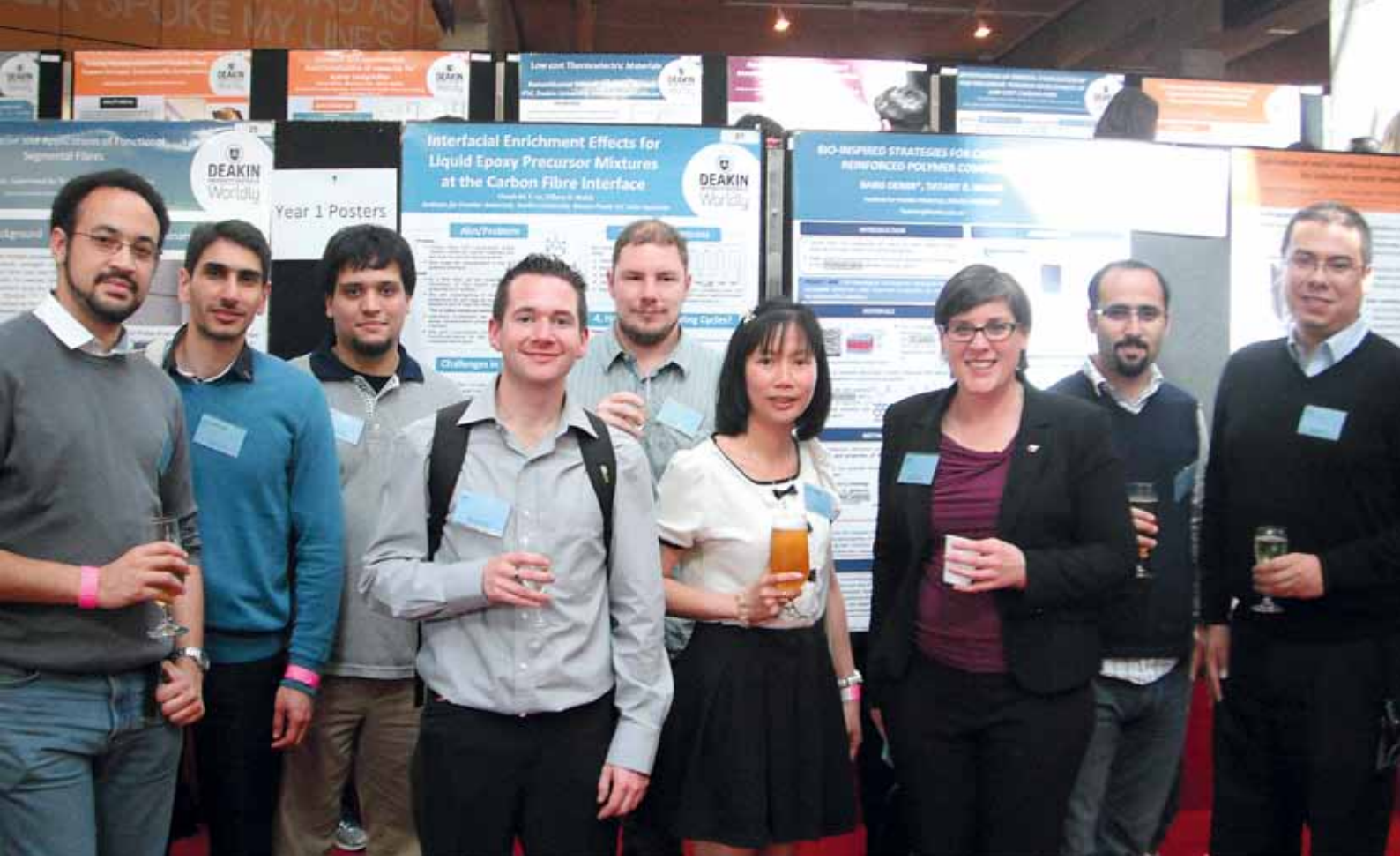
Additionally, our progress regarding the conformationally-switchable JAK1 peptide and its interaction with hydroxyapatite took a big step forward this year with our modification to the CHARMM parameter set; something that will enable advances in research by a wide range of scientists in the field of biomolecular modelling in general.

Finally, in the medical implant research area we are building on our successes in understanding how biomolecules interact with titania, and are developing the first credible models of biomolecular interaction with bio-compatible electroactive polymers, starting with PEDOT.

In February 2014 we also hosted a 1-month research visit from Professor Lucio Colombi Ciacchi from the University of Bremen, with whom we are initiating a new research collaboration.

NEW PROJECTS

- DNA sensor technology / University of Bremen
- DNA/RNA aptamer sensor technology / Air Force Research Labs (AFRL)
- DNA/RNA aptamer design for nanomedicine / Wei Duan, School of Medicine
- Catalytic peptide-capped metal nanoparticles / National Institute for Standards and Technology (NIST), AFRL, University of Miami
- Blood therapeutics design / CSL Ltd
- Barnacle adhesive peptides / Naval Research Labs (NRL).



> Members of the modelling group at IFM's annual conference: Aaron Brown, Anas Sultan, Andrew Church, Kurt Drew, Dr Zak Hughes, Thi Minh Chan Le (Caroline), Prof Tiffany Walsh, Baris Demir, Dr Pablo Palafox-Hernandez.

MEDIA

- ABC News TV interview on optical cloaking, aired Jan 6, 2014
- IT News article (www.itnews.com.au) Jan 7, 2014
- Article in Geelong Independent, week of Jan 12, 2014
- Article in The Conversation 'Invisibility cloaks closer thanks to digital metamaterials', Sept 2014
- Research Highlight featured on NCI front page website "Small particles, Big Impact" Oct 2014.

TV

Optical Cloaking featured on ABC News

EVENTS/CONFERENCES

Professor Walsh gave five invited conference talks:

- Invited speaker at CECAM conference, "The simulation of biomolecular interactions with inorganic and organic surfaces as a challenge for future nanotechnologies", Toulouse, France, March 2014
- Invited speaker at MM2014, Queensland, Australia, July/Aug 2014
- Invited speaker at M^4 2014, LaTrobe University, February 2014
- Invited speaker at NanoBio, Queensland, Australia July 2014
- Invited speaker CECAM conference "Molecular and coarse-grained modelling of interactions at bio-nano interface", Dublin, Ireland, September 2014.

Dr Zak Hughes, Kurt Drew and Aaron Brown all gave talks at the Materials Research Society Fall Meeting. Dr. Hughes and Anas Sultan presented posters at this conference.

Anas Sultan and Kurt Drew gave talks at the International Biophysics Conference (IUPAB) conference in Brisbane.

STAFF AWARDS

Anas Sultan won the prize for "Best presentation" at the IFM Annual conference, and Baris Demir won the "Best poster" prize at the same conference.

Both Kurt Drew and Anas Sultan won travel awards from the Australian Biophysical Society to attend the International Biophysics (IUPAB) Conference in Brisbane to present their findings.

PUBLICATION HIGHLIGHTS

J. P. Palafox-Hernandez, Z. Tang, Z. E. Hughes, Y. Li, M. T. Swihart, P. N. Prasad, T. R. Walsh, M. R. Knecht, Chem. Mater. 26, 4960-4969 (2014). [IF=8.5]

Comparative Study of Materials-Binding Peptide Interactions with Gold and Silver Surfaces and Nanostructures: A Thermodynamic Basis for Biological Selectivity of Inorganic Materials.

NUMERICAL MODELLING AND DESIGN OF MATERIALS FOR LIGHTWEIGHT STRUCTURES

GROUP MEMBERS

STAFF: Prof Jeong Yoon, A/Prof Bernard Rolfe, Dr Matthias Weiss, Dr Michael Pereira, Dr Tim de Souza, Dr Joseba Mendiguren, Dr Yanshan Lou, Dr Erik Pavlina, Dr Shunying Zhang, Gary Owen

STUDENTS: Ahmad Erfani Moghadam, Akbar Abvabi, Amir Abdollahpoor, Idalina Alcantara Pinto Martins, Jingsi Jiao, Klaus Fiedler, Mariana Paulino Santos, Ossama Badr, Paul Souza, Pushpakumar Sugirtharaj, James Raggatt, Akbar Mostaani, Robert Dick, Erwan Castanet, Hui Kong, Salah Khaleel

Using computer-aided engineering techniques to model materials, we can conduct very fast virtual prototyping to decrease design and physical testing times.

RESEARCH HIGHLIGHTS

A/Prof Bernard Rolfe gave a presentation on the group's condition monitoring tooling project to the Ford Review of University Research Projects at Shanghai Jiao Tong University, China. Next year Ford hopes to hold the annual review of its university projects at Deakin's Geelong Waurn Ponds Campus.

A/Prof Rolfe, Prof Peter Hodgson and Mr Gary Owen attended a review of their (with CSIRO and Monash) Science & Industry Endowment Fund (SIEF) project at Microturbo in Toulouse, France, where they demonstrated the micro-turbo 3D printed engine. The group's part in the project was to create a CAD design from the original engine. Our current role is to carry out the performance analysis of the printed engine.

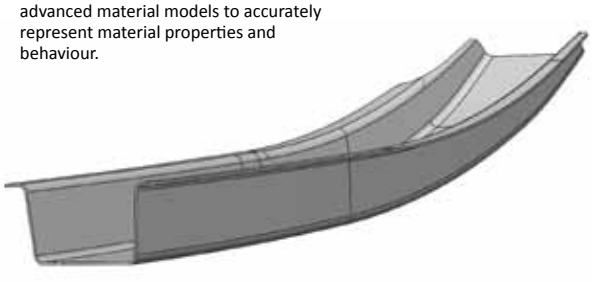
In April, Prof Jeong Yoon and A/Prof Rolfe attended a research collaboration meeting at IIT Madras, India. As a result of this new collaboration, we will have three new PhD students in the area of modelling of machining starting in 2015.

One of our students Ossama Badr returned from Postech Korea after a short secondment, working with Prof Fred Barlat to utilise specific cutting edge material characterisation equipment. This project resulted in a research paper submitted to the International Journal of Solids and Structures.

NEW PROJECTS

- WISCO - Modelling of hot stamping process
- WISCO - Simulation of flexible roll forming
- SAMMITR - Analysis of new lightweight canopy design
- Ford US - Novel forming of bipolar battery plates.

> The modelling group develops advanced material models to accurately represent material properties and behaviour.



EVENTS

3D sheet metal forming at Numisheet 2014

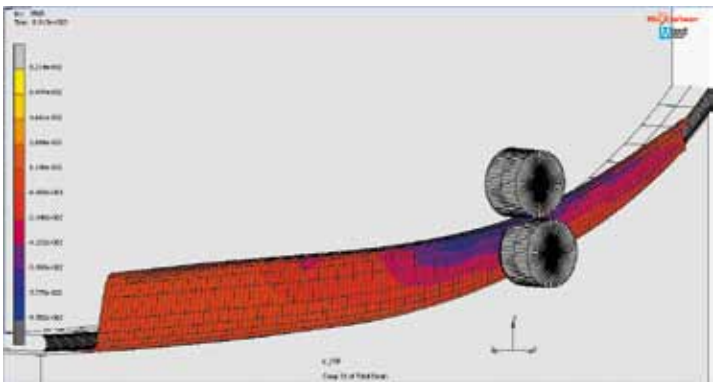
The modelling and design group played a key role in organising Numisheet 2014, the 9th International Conference and Workshop on Numerical Simulation 3D Sheet Metal Forming Processes. Held in Melbourne from 6-10 January, it was the first time the forum had been hosted in the southern hemisphere where it attracted about 300 delegates, almost 90 per cent from overseas.

Prof Yoon chaired the organising committee and Prof Hodgson was a co-chair. Professor Yoon said the conference aligned perfectly with IFM's research in metal forming and numerical modelling. The delegates explored challenges in sheet metal forming, including new manufacturing techniques, as well as issues related to prediction, limit states and failure and multiscale modelling.

On the final day, about 70 of the delegates visited the Geelong Technology Precinct where they toured IFM facilities.

Autoweek

A number of journalists representing Thai automotive media visited the Geelong Technology Precinct during Autoweek in March, sponsored by our industry partner SAMMITR. The visit resulted in a number of articles about R&D in the Thai press, connected with SAMMITR's new R&D facility in Melbourne.



AWARDS

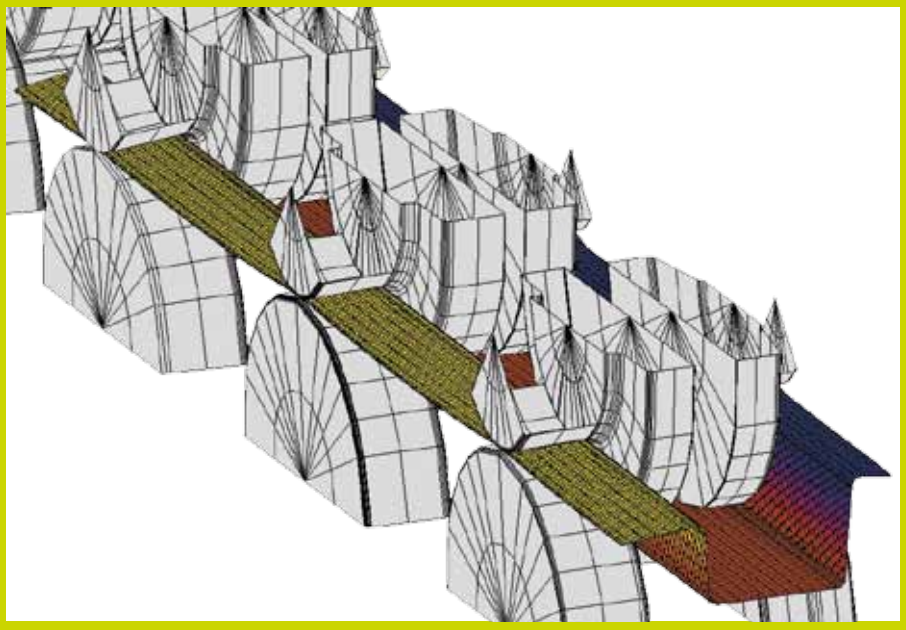
PhD student Akbar Mostaani received a student travel award for travel to the Netherlands in 2015 to work with Dr Matthijn de Rooij at the University of Twente for three months. Akbar will work on a project closely related to his PhD research on understanding and predicting galling wear in metal forming.

PUBLICATION HIGHLIGHTS

Prof Yoon co-edited a special edition of the *International Journal of Plasticity* in recognition of Prof Kwansoo Chung, a world renowned expert in plasticity theory.

Lou Y, Yoon, JW, Huh, H. Modeling of shear ductile fracture considering a changeable cut-off value for stress triaxiality; *International Journal of Plasticity* 54, 56-80. Cited 12 times.

Yoon, J.W., Lou, Y., Yoon, J., Glazoff, M.V. Asymmetric yield function based on the stress invariants for pressure sensitive metals. *International Journal of Plasticity* 56, 184-202. Cited 4 times.



> Formation of an automotive structural component using roll forming, simulation is used to validate the production process.

> The Numisheet 2014 organising committee at the MCG where the conference dinner was held: Professors John Benyon, University of Adelaide; John Wilson, Swinburne University; Jeong Yoon and Peter Hodgson, Deakin University.

CORROSION RESEARCH CENTRE

GROUP MEMBERS

STAFF: Prof Maria Forsyth, Prof Mike Yongjun Tan, Prof Bruce Hinton (Adjunct), Prof Tony Hughes (Adjunct), A/Prof Warren Green (Adjunct), A/Prof Frédéric Blin (Adjunct), Dr Patrick Howlett, Dr Daniel Fabijanic, Dr Jianyu Xiong, Dr Dang Nam Nguyen, Davi Abreu, Dr Rajeev Gupta, Dr Anthony Somers, Dr Timothy Khoo, Sara Abdi Kheibari, Lex Edmond

STUDENTS: Infant Gabriel Bosco, Peipei Huang, Rainier Catubig, Yafei Zhang, Facundo Varela, Ying Huo, Reza Parvizi, Faribra Mahdavi, Shyama Ranade, Phillip Wyld

FINAL YEAR PROJECT STUDENTS: Minto Porinchu, Aifang Wei, Nam Zheng, Quntao Fang, Mohamed Al Qubaisi, Tong Wang, Thomas Wilson, Minhas Umear, Brendon Gery, Thomas Hallifax-Ballinger, Hu Yang, He Rina, Yuhao Luo, Burak Cacan, Chao Zeng, Yunfei Ding, Dolly Mushahary, Douglas Feast

The Deakin Corrosion Research Centre's focus is on corrosion engineering and infrastructure durability studies.

Continued progress was made in 2014 in developing major research programs with particular emphasis on the reliability, durability and protection of critical industrial infrastructure, such as energy pipelines and desalination infrastructure. Major efforts were made in developing facilities for providing research and development support to Australian industries, supporting initiatives in the new Australian Centre for Infrastructure Durability (ACID), developing strategic industry and international collaborations, and in linking-up with undergraduate and postgraduate teaching programs.

> APA Group's Alan Bryson said the NFPCA would provide industry with the independent testing needed to support the commercial aspects of its work.

RESEARCH HIGHLIGHTS

- **Opening of the new National Facility for Pipelines Coating Assessment:** The National Facility for Pipelines Coating Assessment (NFPCA) was officially opened on March 5 by Energy Pipelines CRC Director, Prof Valerie Linton and Deakin Deputy Vice-Chancellor Research, Professor Lee Astheimer. The facility, which is located in the ni building at the Geelong Technology Precinct is an independent laboratory supported by the Energy Pipelines CRC. Its role is to provide a pipeline coating testing facility that meets the needs of the Australian energy pipeline sector. Services include testing to support pipeline coating selection and development, research into pipeline coatings and corrosion inhibitors and a range of standard tests. Since opening, the facility has performed about 10 contracted coating tests. The corrosion laboratory has been further enhanced by the acquisition of a multi-channel potentiostat for electrochemical and corrosion research supported by a Deakin RESS grant and EPCRC funding.

- **Significant progress was made on all EPCRC research projects** including: 'Energy pipeline health monitoring and life prediction', 'Evaluating and understanding coating failure due to cracking and disbondment', 'Transient loss of cathodic protection' and 'Building a National Facility for Pipeline Coating Assessment – Phase 2' (total cash funding of $1.23M over 3 years). Some 10 journal and major conference papers have been prepared based on these projects and eight were published in 2014.

  About 10 final year mechanical/civil engineering students successfully carried out their final year projects in the new NFPCA and corrosion laboratory. All the projects were directly linked with industry needs.

- **A project for the National Centre of Excellence in Desalination** produced some new findings:
  (i) Low grade stainless steels that were subjected to appropriate surface treatment could significantly improve their corrosion resistance in Australian seawater reverse osmosis desalination environments;
  (ii) Carbon fibre reinforced plastic can be a better choice than the currently used glass fibre reinforced plastic in terms of mechanical properties and durability;
  (iii) A safer alternative pickling solution has been found to restore the passivity of stainless steel weldments.

ACID UPDATE

The Australian Centre for Infrastructure Durability (ACID) began operation in 2014, building a number of collaborations with industry, particularly in the Geelong area. ACID appointed seven Industry Leads in 2014 and strengthened its industry collaborations to include major engineering and durability firms AECOM and Vinsi Partners.

NEW PROJECTS

- A project to further enhance the capability of the NFPCA by achieving NATA accreditation and by extending the facility's capabilities in coating flexibility and cathodic disbondment testing and assessment ($100,000)
- Initiation of stress corrosion cracking – EPCRC project (Phase 1 led by Dr Daniel Fabijanic, $260,000)
- Lightning damage to energy pipelines – EPCRC scoping study (Led by Prof Alex Stojcevsk and Dr Aman Than Oo of School of Engineering, $30,000)
- Coating testing projects by National Facility for Pipeline Coating Assessment (about 10 contracted coating testing projects).

INTERNATIONAL COLLABORATION

Collaborations began with Wuhan University of Science and Technology, China in the areas of corrosion and pipeline research, aimed to enhance Deakin's major international teaching and research collaboration initiatives.

Collaboration with Beijing University of Chemical Technology continued on a Chinese Scientific Foundation grant project to study the effects of inhibitors in the nucleation and development processes of localised corrosion.

Professor Mike Tan chaired the oil and gas pipeline and corrosion monitoring sessions and delivered keynote lectures for the 19th International Corrosion Conference which took place at Jeju Island, South Korea in November.

10
journal and major conference papers prepared

CASE STUDY

> A new sensor is being developed to detect and prevent dangerous corrosion in pipelines.

NOVEL SENSOR TO DETECT PIPELINE CORROSION

A new corrosion sensor being developed by IFM researchers offers exciting potential as an effective way to detect and prevent dangerous corrosion in underground pipelines.

High pressure underground pipelines are typically protected against corrosion with a combination of barrier coatings and cathodic protection systems. When their coatings become 'disbonded' pipelines become susceptible to corrosion that can eventually lead to leaks or catastrophic failure.

Maintaining the vast network of pipelines that carry oil and gas across Australia is a massive task, which involves millions of dollars a year spent in regular assessment to detect corrosion issues and target sections that need to be replaced or repaired.

Safe operation of pipelines relies on this inspection to detect and repair disbonded areas but digging up pipelines is expensive. So, pipeline managers use sophisticated indirect assessment techniques to locate and prioritise defective areas. Even so, the tools available do not always detect localised corrosion.

The new sensor, which enables continuous and real-time monitoring of the efficiency of cathodic protection and the initiation and spread of localised corrosion, could complement these methods to detect and prevent dangerous corrosion. The sensor is being developed by a research team led by Professors Mike Tan and Maria Forsyth, supported by the EPCRC. It can check remotely every day and identify localised corrosion in its early stages. It is part of the EPCRC sponsored work, which has an ambitious goal of cost-effectively extending the safe operating life of energy pipelines to 100 years through monitoring and predictive tools.

"The development of sensors is a critical step for improving our ability to quantify the effects of key factors that influence buried steel pipeline corrosion and for providing in-situ monitoring and site specific warning of pipeline damage," says Prof Mike Tan.

The advantages of sensors over other methods include their low operational costs, their flexibility for use with different pipeline designs and their high inspection frequency. Deakin University PhD student, Mr Facundo Varela is the driving force behind the development of this new sensor.

He says it is an exciting new technology that could help us to see an essentially invisible process that occurs underground and to inexpensively evaluate the associated risks in minutes. Prototypes of the probe are now being intensively tested in the laboratory and in big sandboxes that simulate field conditions.

In the next phase of the research, the probe will be tested on pipelines in the field.

ELECTROMATERIALS AND ENERGY

GROUP MEMBERS

STAFF: Prof Maria Forsyth, Prof Tony Hollenkamp (Adjunct), A/Prof Patrick Howlett, Dr Jenny Pringle, Dr Fangfang Chen, Dr Daniel Gunzelmann, Dr Matthias Hilder, Dr Timothy Khoo, Dr Cristina Pozo-Gonzalo, Dr Konstantin Romanenko, Dr Anthony Somers, Dr Xiaoen Wang, Dr Hyun Gook (Martin) Yoon, Dr Haijin Zhu, Dr Erlendur Jonsson, Dr Luke O'Dell, Dr Wren Greene, Mr Liyu Jin

STUDENTS: Danah Tawfiz Hasan Al-Masri, Srdan Begic, Shannon Biddulph, Asing (Xingyu) Chen, Gaetan Girard, Nahid Iranipour, Lane MacDonald, Faezah Makhlooghiazad, Yogita Vijaykumar Oza, Rossie Rao, Cameron Pope, Yajing Yan, Yundong Zhou, Tingting Huo, Ninghui Han

> Dr Yogendra Vashishtha, Principal Engineer Asset Innovation and DER (SP Ausnet), with A/Prof Patrick Howlett. The company has worked with IFM researchers to create a lithium battery energy bank as back-up for the Melbourne power grid.

Energy and electromaterials research at IFM aims to develop new energy technologies through the creation of new electroactive materials.

Our research into new materials seeks to enable new device chemistries, such as metal-air or sodium-based batteries, and to improve the performance, safety and durability of existing technologies such as lithium-ion batteries.

Our research focuses on developing a new generation of energy devices using novel nanostructures and electromaterials. It encompasses materials engineering, electrochemistry and surface science and the application of these technologies to the problems which occur at materials surfaces where electrochemical processes take place.

Our research group includes the ARC Centre of Excellence for Electromaterials Science based at the Melbourne Burwood Campus.

RESEARCH HIGHLIGHTS

Funding success for electromaterials research

2014 was a great year for the group. Prof Forsyth, A/Prof Howlett and Dr Pringle were part of a successful bid for a new ARC Centre of Excellence for Electromaterials Science (ACES).

This success provides significant long term funding for the group, including three Research Fellows and seven HDR students. New ACES projects include materials for air-electrodes, flow batteries and thermoelectrochemical cells. Another ACES initiative will be the establishment of a new joint research Masters of Electromaterials between Deakin and the University of Wollongong.

A/Prof Howlett, Dr Pringle and Dr Greene (with Prof Michel Armand, a former Deakin Thinker-in-Residence) were also successful in the award of an ARC Discovery Project.

NEW PROJECTS

The team has had some exciting developments in using in-situ NMR imaging to model the morphology in solid state electrolytes and using this to understand and control ionic conduction in these materials.

Using the excellent NMR facilities led by Prof Forsyth, coupled with the enhanced capability of molecular modelling of electrolytes led by Dr. Fangfang Chen, and access to the Australian Synchrotron, the team is making great advances in determining the relationship between ion conduction and structure. This includes a recent publication in the high impact *Journal of the American Chemical Society*.

Sodium battery research was also a highlight in 2014, with the team spearheading three distinct approaches to developing safe, efficient electrolytes based on either ionic liquids, high glass transition temperature ionomers or plastic crystals.

IBA 2014 – PROGRAM PACKS A POWERFUL PUNCH

IFM researchers Dr Patrick Howlett and Dr Alexey Glushenkov were part of the organising committee for the International Battery Association annual conference held in Brisbane in March. They also hosted a workshop on the topical issue of energy storage in the Australian context.

About 200 people attended the conference, which included invited speakers from around the world as well as practical applications of battery science and technology.

The event provided an opportunity for battery scientists and technologists to come together to discuss the latest developments in international research in a wide range of battery technologies, ranging from lithium, sodium and magnesium based cells to lead-acid and redox-flow battery systems.

> Professor Maria Forsyth chaired the 14th ISPE conference in Geelong.

14TH INTERNATIONAL SYMPOSIUM ON POLYMER ELECTROLYTES

Chaired by Prof Maria Forsyth, and with Dr. Jenny Pringle, Dr. Cristina Pozo-Gonzalo, Dr. Tim Khoo and Dr. Luke O'Dell on the organising committee, the electromaterials group at Deakin hosted the 14th International Symposium on Polymer Electrolytes.

The conference ran from 24-29 August 2014 at The Pier Geelong Waterfront.

The ISPE is one of the best-known conferences in this field and attracts hundreds of delegates from around the world. About 150 people from over ten countries attended ISPE14, which included plenary and invited talks by world-renowned researchers.

The conference, which provided a multidisciplinary forum focusing on novel electrolyte materials, including polymer and ionic liquids, was a big success and received many compliments from international speakers and delegates.

INDUSTRY ENGAGEMENT AND COMMERCIALISATION

- **Toyota** – Technology Evaluation Agreement signed and supplied the company with a range of new electrolyte materials for assessment. Project is ongoing, with plans for expansion early 2016
- **OneSteel Arrium** – contract work completed and will visit in early 2015 to discuss further work
- **Amperex Technology Limited** (battery supplier) – visited labs in China and materials transfer agreement is being developed
- **Ausnet Services** – ongoing consultancy for implementation and operation of a 1.3 MW large-scale lithium ion battery facility that commenced operation as grid support over the 2014-2015 summer
- **Indian Oil** – company will sponsor two PhD students to work on Oil Miscible Ionic Liquid Additives
- **LG Chem** – Discussions on a new combined project to begin a new area of lithium-battery research, and to host an LG Chem employee as a visiting researcher
- **Our work has resulted in three provisional patents in the pipeline:**
  (i) Na battery electrolytes (with Monash);
  (ii) Zn deposition for Zn-air batteries (based on Tristan Simon's PhD work, with Monash);
  (iii) Mg coating for stents (based on Yafei Zhang's PhD work)
- **Defence Science and Technology Organisation** – Two-year project with Monash University to develop ionic liquid electrolytes for Maritime Division of DSTO to be used in a number of battery applications and carbon dioxide absorbers.

150 people from over 10 countries attended ISPE14

Industry project sees BATTERY technology provide back-up for Melbourne power grid

Prestigious Alfred Deakin MEDAL was awarded to Dr Anthony Somers

> Dr Anthony Somers is congratulated by his proud supervisors, A/Prof Patrick Howlett and Prof Maria Forsyth, following his graduation and presentation of the Alfred Deakin Medal.

AWARDS

Dr Wren Greene received a Vice-Chancellor's Early Career Researcher Award for Research Excellence.

Mr. Tristan Simons and Mr. Tarekegn Chimdi Yarimo successfully finished their PhD and submitted their thesis. Ms. Bhawna Khemchandani successfully completed her PhD project supported by Indian Oil.

Research Fellow, Dr Anthony Somers, who was awarded his PhD last year, has received the prestigious Alfred Deakin Medal for best doctoral thesis. His thesis on *Ionic liquids as lubricants for the aluminium-steel system* was judged on a number of criteria including international recognition, impact and acknowledgment from within the profession. Anthony was one of only two graduates to receive the medal.

In his role as a member of Prof Forsyth's research group, Anthony is continuing his work on ionic liquid inhibitors, exploring their use as lubricants for steel as well as investigating a new area - the potential of ionic liquids as corrosion inhibitors.

COMMUNITY ENGAGEMENT AND RESEARCH TRAINING

In February, IFM laboratories at the Deakin Burwood Campus ran a spectroscopy laboratory class for Year 12 Chemistry students from Ashwood Secondary College. The students were taught a variety of spectroscopy techniques and gained experience running their own IR and NMR spectra. The class was coordinated by Dr Jenny Pringle, with support from Tristan Simons and the rest of the electromaterials team, and the feedback from both the students and teacher was excellent.

In August, some of the ACES team held a practical class on electrodeposition for the same group of students. Dr Anthony Somers gave a short lecture on the theory of electrolysis, followed by a practical session where the students compared the electroplating of copper and silver using our state-of-the-art facilities.

The electromaterials team also made an important contribution to REMSTEP, the Reconceptualising Mathematics and Science Education Project (http://remstep.org.au/).

This is an initiative between the University of Melbourne, Deakin, La Trobe and Monash to improve the standard of high school maths and science teaching.

The electromaterials PhD students and early career researchers paired with 14 pre-service chemistry teachers from the School of Education and explained the science and research strategy behind their projects. The education students then worked with the IFM students to translate this into a teaching package. A publication that examines the learning process for the pre-service teachers through this new initiative is being prepared.

COLLABORATIVE VISIT TO SPAIN

Prof Forsyth, A/Prof Howlett, Dr Cristina Pozo Gonzalo, Dr Anthony Somers and Dr Jenny Pringle were among a group of Deakin staff who visited Spain in April 2014. The purpose of this visit was to establish and grow collaborations in the Basque country, and also investigate future Horizon 2020 funded research opportunities. The visit was partially funded from the Deakin Research International Research Development Scheme and ACES.

The electromaterials researchers attended the "Power Our Future" Conference, hosted by CIC Energigune-Cooperative Research Centre for Energy, in Vitoria-Gasteiz, Spain and toured the CIC facilities. They then attended a three day workshop run by Tecnalia (San Sebastian) to discuss collaborative opportunities. Overall this was a very fruitful visit, with a range of valuable collaborations established.

GROUP MEMBERS

STAFF: Professor Ying (Ian) Chen, Dr Alexey Glushenkov, Dr Weiwei Lei, Dr Luhua Li, Dr Dan Liu, Dr Md Mokhlesur Rahman, Dr Tao Tao, Robert Lovett

STUDENTS: Qiran Cai, Srikanth Mateti, Si Qin, Thrinathreddy Ramireddy, Md Mahedi Hasan Bhuiyan Irin Sultana, Mengqi Zhou, Aleksey Falin, Ye Fan

> Dr Dan Liu, recipient of a prestigious ARC Discovery Early Career Researcher Award.

The group's aim is to develop novel nanomaterials and to use nanotechnology to solve challenges in energy storage (batteries and supercapacitors), environmental protection, health and medicine.

RESEARCH HIGHLIGHTS

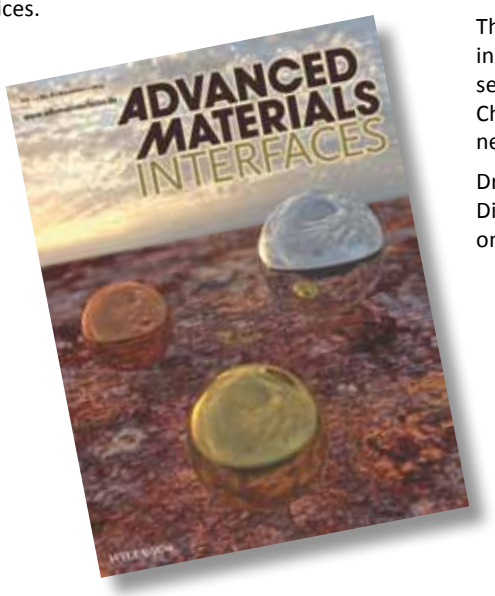
The team, consisting of seven research staff and nine PhD students, published 24 journal articles in 2014, including eight high-impact articles of impact factor >10, won four ARC grants (two Discovery, one Linkage and one LIEF), four international travel grants and a VC's research excellence award.

The major achievements are listed below.

New properties and applications of BN nanosheets

New properties and applications of atomically thin BN nanosheets were discovered for the first time. BN nanosheets show a superior resistance to oxidation up to 800°C under ambient conditions, and this oxidation temperature is much higher than that of graphene [ACS Nano 8, 1457, 2014].

The strong oxidation resistance makes BN nanosheets excellent surface protection layers for metals from oxidation and corrosion, and ideal nanosized fillers in metal and ceramic matrix composites for high-temperature applications [Adv. Mater. Interfaces 1, 1300132, 2014]. The unique electric-field screening in BN nanosheets can help the construction of efficient two-dimensional nanomaterials-based heterostructured devices.



This work was published in the top international nanotechnology journal, Nano Letters [Nano Lett. 15, 218, 2015] and received the following comment on nanotechweb.org: "the atomic BN sheets make perfect substrates". This world-class research achievement in BN nanosheets enhances our leading position in the research field and contributed to our successful new ARC Discovery project.

A new application of porous BN nanosheets has been made after the breakthrough work in 2013 on oil-spillage clean-up by porous BN nanosheets. Three-dimensional architectures were produced from an interconnected flexible network of porous BN nanosheets. The bulk BN nanosheets maintain a very high specific surface area of 1156 m^2/g as well as superb dye absorption capability from water as powder-like BN nanosheets but make practical application much easier [SCIENTIFIC REPORTS | 4 : 4453]. BN nanotube filters were also found to be able to separate water and oil efficiently [Adv. Mater. Interfaces 2014, 1, 1300002].

The innovative application of porous BN sheets and nanotubes in water cleaning resulted in Professor Chen's team being selected as a finalist in the 2014 Australian Innovation Challenge and featured in an article in The Australian newspaper.

Dr Dan Liu was successful in the highly competitive ARC Discovery Early Career Researcher Award (DECRA) for a project on *Novel 3D porous boron nitride foam for water cleaning.*

New three-dimensional electrode materials for batteries and supercapacitors

A remarkable cathode material of LiFe0.4Mn0.6PO4/C microspheres for Li-ion batteries has been produced.

The microspheres exhibit excellent electrochemical performance with high capacity, impressive rate capability and good cycling life due to the 3D carbon network between LiFe0.4Mn0.6PO4 nanoparticles, ensuring that most particles contribute to electron charge-discharge.

The outstanding cathode materials have been produced using industrial techniques and thus can be directly applied to the current industrial production process [J. Mater. Chem. A, 2014, 2, 18831]. Anode materials of Sb-C composite and nanosized SnO2 - Fe2O3 hybrids wrapped by C layers demonstrate best performance in Li storage [J. Mater. Chem. A, 2014, 4282].

The outstanding results have received invited presentations at international conferences (IBA14, 5th ACSMS, IUMRS-ICYRAM).

Several new electrode materials have been developed for Na ion batteries with substantial improvement in cycling stability and energy density (Chem. Commun. 50, (2014) 5057-5060, Journal of Power Sources 271 (2014) 497-503, J. Mater. Chem. A, 3 (2015) 5572).

Dr Md Mokhlesur Rahman won an Alfred Deakin Post-Doctoral Fellowship for a project on electrode materials for Na ion batteries.

Exciting results were also produced in new S-graphene nanocomposites for Li-S batteries of high energy density and cycling performance (Adv. Energy Materials, 2014, 1301988).

Dr Alexey Glushenkov received a Vice-Chancellor's Early Career Researcher Award for Research Excellence for his consistent excellent performance in energy research.

New major international collaboration grant with Wenzhou University

A major international collaboration grant worth 2.8m RMB ($580,000) was awarded by the National Nature Science Foundation of China to Prof Huang's team at Wenzhou University in China and Prof Chen's team from Deakin University to conduct a collaborative research project on battery and fuel cells entitled "Nanostructured Carbon-based Metal Free Electrocatalysis for Oxygen Reduction Reaction" over the next five years (2015-2019).

As far as we know this is the first time this prestigious award has been awarded to an Australian research team. It was based on a successful research collaboration between the two teams that has produced world-class research outcomes in previous years including joint publications in ACS Nano and Advanced Energy Materials.

The award will enable the IFM team to expand its energy and nanomaterials research in coming years.

> Above: Members of the Nanotechnology group: Prof Ying (Ian) Chen, Dr Dan Liu, Dr Md Mokhlesur Rahman, Irin Sultana, Ye Fan, Si Qin, Qiran Cai, Dr Weiwei Lei, Srikanth Mateti, Dr Luhua Li and Rob Lovett.

Deakin-CISRI Joint Energy Materials Research Centre

The Chinese Iron and Steel Research Institute (CISRI) and Deakin joint research centre in energy materials has made substantial achievements in new electrode materials for Li-ion batteries with eight joint publications in Nano Energy, Journal of Materials Chemistry and Carbon.

A jointly supervised student obtained his PhD in November 2014 based on his work on LiMnFePO4 cathode materials.

Future hydrogen fuel

Exciting research in hydrogen fuel production was also made in collaboration with Prof Qiao's team at the University of Adelaide. New efficient graphene based catalysts were developed for production of hydrogen fuel from water [Nature Communications, 5 (2014) 3783].

The fundamental mechanism of the new catalysts was discovered [ACS Nano, 8 (2014) 5290 and ACS Nano, 8 (2014) 6856].

The work was reported by the Geelong Advertiser newspaper on 31 May 2014.

Development of new precursor powders for 3D printing techniques

Three-D printing is an additive manufacturing that is expected to revolutionise future manufacturing due to its advantages in precision production, rapid process and low production costs.

A collaborative research project with Prof Ma's team at RMIT has produced new TiH2 particles for future 3D printing work, which has won an ARC Linkage grant application of $420,000 over three years.

Half of this funding will support the Deakin team to develop the new TiH2 particles.

AWARDS

- Dr Dan Liu was successful in the highly competitive ARC Discovery Early Career Researcher Award (DECRA) in a project on Novel 3D porous boron nitride foam for water cleaning
- Professor Ying Chen was successful in an ARC Discovery grant for a project on Porous Nanosheets
- Prof Chen and Dr Luhua Li were also part of a successful ARC LIEF bid, led by the University of Wollongong for a 'New generation cryogen free physical property measuring system'
- Dr Alexey Glushenkov received a Vice-Chancellor's Early Career Researcher Award for Research Excellence
- Dr MD Mokhlesur Rahman was awarded a prestigious 2015 Alfred Deakin Postdoctoral Fellowship
- Dr Rahman also received an Endeavour Research Fellowship which will support him to work overseas for 4-6 months. He will use the award to work in the Advanced Batteries Laboratory at the National University of Singapore
- Dr Alexey Glushenkov and Dr Luhua Li were awarded Australia-Japan Bilateral Exchange Program fellowships
- Two PhD students successfully obtained their PhD degrees in 2014. Dr Tan Xing moved to Queensland to work for a new battery company and Dr Deepika is working as a researcher at the R&D centre of Indian Oil.

> Dr Alexey Glushenkov (right) and Mengqi Zhou conduct an experiment in atomic layer deposition of titanium nitride films at the Melbourne Centre for Nanofabrication.

METALS

GROUP MEMBERS

STAFF: Prof Peter Hodgson, Prof Matthew Barnett, Prof John Duncan, Prof Jeong Yoon, A/Prof Tim Hilditch, A/Prof Bernard Rolfe, A/Prof Nicole Stanford, Dr Aiden Beer, Dr Hossein Beladi, Dr Thomas Dorin, Dr Daniel Fabijanic, Dr Alireza Ghaderi, Dr Xiaokai Hu, Dr Zohreh Keshavarz, Dr Yuncang Li, Dr Jun Liu, Dr Peter Lynch, Dr Shokoufeh Makekjani, Dr Erik Pavlina, Dr Michael Pereira, Dr Sitaramu Raju Kada, Mohan Setty, Dr Ilana Timokhina, Dr Matthias Weiss, Dr Ming Wen, Dr Jiangting Wang, Dr Ross Marceau

STUDENTS: Keivan Alhoeinazari, Yunfei Ding, Desinghe Shiromani Gangoda, Ajay Kumar Mahato, Arwa Faraj Tawfeeq, Ehsan Bahrami Motlagh, Gourab Saha, Hassan Ramadan Faraj Zaid, Makoto Atake, Rupinder Kaur Sian, Sahar Naghashian, Steven Babaniaris, Ting Ting Guo, Yiping Wu, Rameshkumar Ramkaran Varma, Dolly Mushahary, Alireza Vahidgolpayegani, Yu Wang, Dongmei Zhang, Qi Chao, Debasis Poddar, Balaji Trichy Narayanaswamy, Nima Hagdadi, Kushboo Rakha, Reza Shahriar, Vadim Shterner, Paul Michael Souza, Jithin Joseph, Ajesh Anthony, Raudhah Othman, Mahendra Ramajayam, Sharmistha Dara, Lu Jiang

Metals research at IFM focuses on a number of areas, including the next generation of automotive steels and new surface technologies to optimise performance.

> Research Fellow Dr Thomas Dorin is the driving force behind a new project to recycle aluminium alloys.

The next generation of automotive steels will be composed of complex multiphase structures with engineering nano-components for superior performance. Production and control of parts made from these grades involves many challenges. Our group is exploring new refined multiphase structures and ways of producing them.

Sheet metal forming research at IFM targets the automotive, aerospace and housing industries. Our research focuses on the development of advanced material models and innovative manufacturing technologies for the forming of current and future sheet materials.

Reducing the weight of vehicles for increased fuel efficiency is a high priority and this has intensified the focus on lightweight metals. Researchers working in this area try to understand and exploit the metallurgy of deformation in magnesium, aluminium and titanium to optimise processing techniques and final properties.

RESEARCH HIGHLIGHTS

A team led by A/Prof Nicole Stanford was awarded an ARC LIEF grant of $190,000 for a quench and deformation dilatometer for studying phase transformations under extreme conditions of heating, cooling and deformation that are experienced during industrial processing. The instrument, which is being purchased with support from The University of New South Wales and Monash University, will be used to characterise new processing technologies and alloy systems such as advanced high strength steels, age hardenable magnesium, high entropy alloys and cluster hardening aluminium alloys.

Professor Matthew Barnett received Deakin's highest honour, the title of Alfred Deakin Professor, in recognition of his outstanding contribution to the field of metallurgy research. Professor Barnett is internationally recognised as a leading researcher in the field of deformation behaviour of steels and light metals. In the past 10 years he has secured research funding of more than $12 million from various sources, including more than $7 million from the Australian Research Council.

He has built a very successful research team in light metals, which has won more than seven ARC grants, most notably $2.5 million for the ARC Centre of Excellence for Design in Light Metals and $600K for the prestigious ARC Future Fellowship.

NEW PROJECTS

- ARC Linkage 2015 – Prof Peter Hodgson, Prof Lingxue Kong, Dr Ludo Dumée – Nanoporous metal membranes as a sustainable alternative to conventional membrane materials ($310,000)
- ARC Discovery 2015 – Prof Peter Hodgson, Dr Ilana Timokhina, Prof Mike Miller (ORNL) – A new approach to advanced steels via cluster and precipitate strengthening
- ARC Discovery 2015 – Prof Chris Hutchinson (Monash University), Prof Matthew Barnett – A new paradigm for fatigue-resistant metals: "service strengthening" by dynamic precipitation
- High-impact nanoscience research, ORNL, USA, Dr Ilana Timokhina, 2015.

EVENTS

Atom probe tomography workshop

In September 2014, IFM hosted an Atom Probe Tomography workshop. The workshop, which was organised by Dr Ross Marceau, attracted participants from the US and other universities around Australia. The keynote speaker was Prof Mike Miller, a world renowned scientist from Oak Ridge National Laboratory whose work was instrumental in the development of the atom probe tomography technique.

STUDENT/STAFF AWARDS

- Dr Thomas Dorin received an IFM impact grant of $15,000 to investigate recyclability of copper containing aluminium alloys using direct strip casting. Following the successful preliminary results from this research, Dr Dorin was also successful in the CRGS scheme, receiving a grant of $20,000
- Dr Peter Lynch received an IFM small grant of $24,000 for his research on 3D X-ray grain orientation mapping in aerospace grade titanium alloys
- Prof Peter Hodgson and Dr Ilana Timokhina were successful in a Thinker in Residence application for Prof Mike Miller from Oak Ridge National Laboratory to visit in 2015
- Prof Matthew Barnett received a VC Award for Excellence in Research Supervision (highly commended)
- Dr Ilana Timokhina was recognised as one of the top five referees (from a pool of 1300) for the journal Acta Materialia.

> PhD student Nima Haghdadi explains his poster on grain boundary engineering of duplex steels to Prof Matthew Barnett at the IFM conference.

PUBLICATION HIGHLIGHTS

In 2014, the group had the following papers published in *Acta Materialia*, one of the top journals in their field.

Barnett MR, Ghaderi A, Quinta Da Fonseca J, Robson JD. Influence of orientation on twin nucleation and growth at low strains in a magnesium alloy, *Acta Materialia* 80, 380-391.

Lynch PA, Kunz M, Tamura N, Barnett MR. Time and spatial resolution of slip and twinning in a grain embedded within a magnesium polycrystal, *Acta Materialia* 78, 203-212.

Hossein Beladi, Qi Chao, Gregory S. Rohrer, Variant selection and intervariant crystallographic planes distribution in martensite in a Ti–6Al–4V alloy, *Acta Materialia*, Volume 80, 2014, p. 478-489.

Hossein Beladi, Noel T. Nuhfer, Gregory S. Rohrer, The five-parameter grain boundary character and energy distributions of a fully austenitic high-manganese steel using three dimensional data, *Acta Materialia*, Volume 70, 2014, p. 281-289.

Hossein Beladi, Gregory S. Rohrer, Anthony D. Rollett, Vahid Tari, Peter D. Hodgson, The distribution of intervariant crystallographic planes in a lath martensite using five macroscopic parameters, *Acta Materialia*, Volume 63, 2014, p. 86-98.

Debasis Poddar, Pavel Cizek, Hossein Beladi, Peter D. Hodgson, Evolution of strain-induced precipitates in a model austenitic Fe–30Ni–Nb steel and their effect on the flow behavior, *Acta Materialia*, Volume 80, 2014, p. 1-15.

T. Hickel, S. Sandlöbes, R.K.W. Marceau, A. Dick, I. Bleskov, J. Neugebauer, D. Raabe, "Impact of nanodiffusion on the stacking fault energy in high-strength steels". *Acta Materialia*, 75 (2014), pp. 147-155. [Impact Factor = 3.940, Citations = 1]

Stanford, N., Cottam, R., Davis, B., Robson, J. Evaluating the effect of yttrium as a solute strengthener in magnesium using in situ neutron diffraction (2014) *Acta Materialia,* 78, pp. 1-13.

Herbig, M.; Kuzmina, M.; Haase, C.; Marceau, R.K.W.; Gutierrez-Urrutia, I.; Haley, D.; Molodov, D.A.; Choi, P.; Raabe, D., *Acta Materialia*, Volume 83, January 2015, pp. 37-47.

Professor Matthew Barnett has secured over **$12M** in the past 10 years or research

An ARC LIEF grant of **$190,000** was awarded for a quench and deformation dilatometer

MICRO AND NANO SYSTEMS

GROUP MEMBERS

STAFF: Prof Lingxue Kong, Dr Mary She, Dr Weimin Gao, Dr Zheng Peng, Dr Ludovic Dumée, Dr Leonora Velleman, Dr Li He

STUDENTS: Bao Lin, Chengpeng Li, Chunfang Feng, Feng An, Francois-Marie Allioux, Guang Wang, Lijue Chen, Rita Choudhary, Tahir Ghandoori, Weiwei Cong, Wenbing Li, Xiangping Sun, Xiaowei Dong, Xiaodong She, Xinchu Zhao, Yanan Lv, Yongzhen Li, Youhai Qiu, Yuanyuan Guo, Zhifeng Yi

> Professor Lingxue Kong, investigating applications of MEMS in healthcare.

Our micro and nano systems research takes advantage of the unique properties offered by miniaturised design, devices and systems.

This work has significant potential for biomedical diagnostics, targeted drug delivery systems, water treatment and desalination.

The group focuses on the following technologies:

- Development of lab-on-a-chip diagnostic technology using microfluidics
- Fabrication and characterisation of membranes with unique nanostructures for water treatment and desalination
- Micro and nano encapsulated drug delivery systems for colorectal cancer
- Molecular dynamic simulation.

RESEARCH HIGHLIGHTS

Linkage success

Professor Lingxue Kong and Dr Ludovic Dumée were part of a successful ARC Linkage 2015 project with Australian company Advanced Metallurgical Solutions (AMS) ($600,000). The very promising and highly novel results should lead the way to up-scaling of techniques towards fabricating cheaper and more competitive membranes for water and industrial liquid waste pre-treatments.

Concrete reinforcement from carpet waste

Dr Mary She and Prof Lingxue Kong have developed a new technology for recycling polymer textiles such as carpets. Working in collaboration with Geelong-based textile company Godfrey Hirst and GT Recycling they have found that by modifying the carpet polymers they can maximise their recycling potential without affecting quality.

The recycled textile fibres will be used in reinforcing for footpaths, gravel and road surfaces.

EVENTS

AISRF collaborative workshop on microelectromechanical systems (MEMS)

A collaborative workshop on microelectromechanical systems (MEMS) was held between Deakin University and the University of Mumbai; Shankara Nethralaya Vision Research Foundation, Chennai.

The workshop on the application of MEMS in health care involved leading Australian and Indian scientists and explored the use of MEMS technology for applications, such as point-of-care devices. Such devices have potential, particularly in the Indian market, where inexpensive, portable diagnostics will play an important role in the health care system, especially in regional and rural contexts. The workshop has strengthened the already established strong collaboration between Deakin and our Indian partners.

> Organisers of the AISRF collaborative workshop on microelectromechanical systems.

Membrane ECRs network in Geelong

IFM hosted a Membrane Society of Australasia Early Career Researchers Symposium in November. About 75 researchers from Australia and overseas attended the 3-day event.

Among the highlights were the invited talk by MSA Patron, Professor Tony Fane at the conference dinner and the poster session - 51 posters were received, prompting much interest and discussion from the assembled delegates.

IFM visiting student, Elise des Ligneris received the award for best poster in the Masters category and IFM PhD student Francois-Marie Allioux received the award for best first-year student poster. The symposium featured a series of workshops presented by invited speakers.

Small angle scattering workshop

About 45 researchers from Deakin and elsewhere attended a workshop about the technique of small-angle X-ray scattering (SAXS) and small-angle neutron scattering (SANS) held at IFM in March.

Organised by Prof Lingxue Kong and ANSTO's Dr Chris Garvey, the 2-day event provided information which will help researchers to design and analyse measurements at advanced facilities such as the Australian Synchrotron and ANSTO's Opal Research reactor.

The presentations included a number of case studies, with speakers from RMIT University, ANSTO, Monash, University of Queensland and Deakin.

AWARDS

Dr Ludovic Dumée was awarded a prestigious 2015 Alfred Deakin Postdoctoral Research Fellowship.

Dr Dumée was also recognised at the 2014 Smart Geelong Network awards, winning the category for Early Career Innovator of the Year for his work on the design of novel metal membrane materials for water purification and desalination.

CASE STUDY

CONCRETE OUTCOME FOR CARPETS

Old carpets that would normally go to landfill could now be given new life in cement footpaths, driveways and roads.

A collaboration between IFM researchers, Geelong's GT Recycling and Australia's largest carpet manufacturer, Geelong-based Godfrey Hirst has resulted in a new technology for recycling polymer textiles.

The development has been a pet project for GT Recycling general manager, Trevor McLean for the past 10 years. "There has been no carpet recycling technology on the market in Australia, but we knew there was potential," he says.

The Federal Government's "Enterprise Connect" program provided the way forward by supporting IFM researcher Dr Mary She to work closely with the company over the past two years.

Dr She brought her own 10 years of textiles recycling expertise to the project, along with the support of a wider team of researchers, led by Professor Lingxue Kong.

"This project aligned perfectly with Deakin's commitment to serve our local community," said Dr She. "It also reflects our wider focus on fibre and it is great for the environment that we can help to reduce textile waste in this way."

CEO of Godfrey Hirst, Kim McKendrick, said the company had a strong commitment to sustainable manufacturing and disposal. "We have supply chain control of our operations, from fibre making to delivery. Recycling our offcuts and used carpets will be the final link in the chain," he said.

"Working with Dr She and GT Recycling, we have been able to modify the polymers in our carpets to optimise recycling potential, without affecting the quality of the carpet."

The recycled textile fibres – to be known as "GTfibrecrete" - will be used as reinforcing in footpaths, gravel and road surfaces.

"By adding less than four per cent of polymer fibres to cement paths, we have seen less cracks, less rain damage, greater flexibility and improved durability – and we have removed the need for wire mesh in certain applications. This will result in longer life and less maintenance, which should be very attractive to councils across Australia," said Prof Kong.

"The recycled fibres will cost only a fraction of the new fibres, which cost up to $30 a kilo, and they are virtually indistinguishable from the new fibres from a performance perspective."

Professor Kong is optimistic that, in the medium-term, the recycled fibres will be adopted by the broader construction industry - and our old carpets will find new life in our walls and ceilings - as well as underfoot.

> Prof Lingxue Kong (right) and members of the team from GT Recycling and Godfrey Hirst.

GROUP MEMBERS

STAFF: Dr Xiujuan Jane Dai, Dr Zhiqiang Chen, Dr Peter Lamb, Dr Abu Sadek, Robert Lovett, Marion Wright, Ladge Kviz

STUDENTS: Arun Thandassery Parambil Ambujaksh, Xiao Chen, David Rubin de Celis Leal, Gayathri Devi Rajmohan, Sri Balaji Ponraj, Mohammad Maniruzzaman

> IFM's advanced plasma facility is being used to produce surface coatings with novel properties.

Plasma research at IFM provides a platform technology for collaborative research and solutions for industry.

RESEARCH HIGHLIGHTS

Working with Deakin Research Commercial, we successfully obtained a Department of Business and Industry Technology Development voucher with Austral Services Group Pty Ltd to develop a plasma delamination process for laminated glass ($62,500).

An improved design for a method of generating plasma in liquids has allowed much higher levels and selectivity of reactive species.

Dr Cormac Corr from ANU presented a series of lectures on plasma physics and plasma diagnostics and collaborated in a project on plasma diagnostics. This enabled a great improvement in our understanding of liquid plasma.

Prof Yakov Krasik from Israel delivered a series of lectures on plasma in liquids and collaborated in a project on wastewater treatment and fertiliser production.

We obtained funding to set up atmospheric pressure plasma equipment to allow larger industrial samples to be treated. This will help secure industrial projects in glass delamination, food sterilization/packaging, textiles, metal anti-corrosion coatings, and carbon fibre sizing.

Carbon Revolution approached us for assistance with a plasma solution to an industrial performance problem.

Dr Dai was invited to chair the Gaseous Electronics Meeting (GEM) (Conference) to be held in February 2016 at Deakin. Further details can be found at www.deakin.edu.au/GEM2016.

2 exciting new projects for Plasma Research

NEW PROJECTS

The new method developed for liquid plasma greatly helped two projects that arose from the 2013 Plasma Medicine Workshop and also led to two exciting new projects:

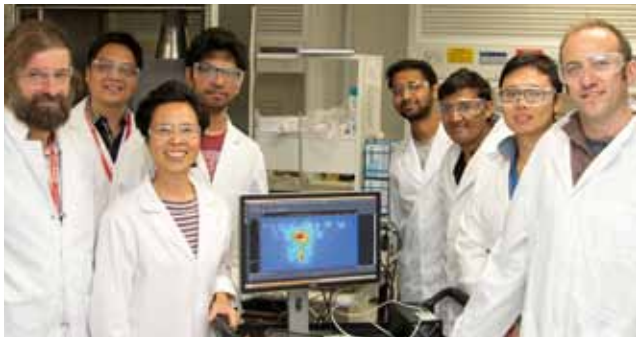
i) Improved production and selection of reactive species in liquid plasma. This is a collaborative project with researchers at Universities in UC Berkeley, Queen's University Belfast, Bari University Italy, and Technion - Israel Institute of Technology Israel.

ii) Plasma assisted electrochemical process for improved nanofabrication. This will offer scope for improved materials for energy capture and storage.

STAFF AND STUDENT AWARDS

The application to support Prof Riccardo d'Agostino (Bari University, Italy) as a Deakin University Thinker in Residence for 2015 was successful.

Sri Balji Ponraj represented IFM in the University final of the 3 minute Thesis competition.

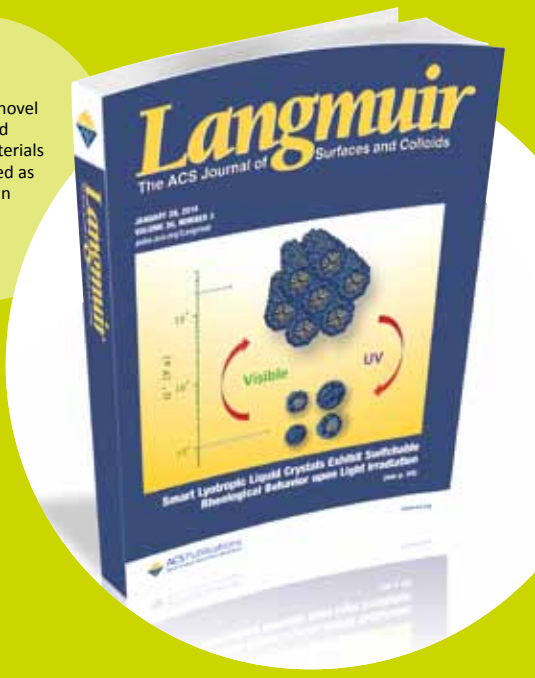


> The plasma group with research collaborator Dr Cormac Corr (right) from the Plasma Research Laboratory at ANU.

GROUP MEMBERS

STAFF: Prof Qipeng Guo, Dr Ping'An Song, Dr Yuanpeng Wu, Dr Zhiquang Xu, Marion Wright

STUDENTS: Anbazhagan Palanisamy, Tao Zhang, Masihullah Jabarulla Khan, Eldho Elias, Deepalekshmi Ponnamma



> A report into novel lyotropic liquid -crstalline materials was highlighted as a cover story in *Langmuir*.

Through an understanding of fundamental principles in polymer science and technology, the polymers research group aims to develop new materials that will meet a diverse range of applications.

Our recent success includes development of a new cost-effective and environmentally friendly solution for tyre recycling and establishment of a pilot plant for an industry partner.

Research areas include:

- Polymer synthesis, processing and characterisation
- Advanced thermosets for high performance coatings, adhesives and composites
- Polymer blends, composites and nanocomposites
- Polymer gels and membranes
- Biodegradable polymers for biomedical applications
- Green processing of natural polymers
- Rubber and plastics recycling
- Polymer materials for oil, gas and energy industry.

RESEARCH HIGHLIGHTS

PhD student Anbazhagan Palanisamy developed a facile method for fabrication of multimicellar vesicles from self-assembled complexes of a flexible coil-like block copolymer and a rigid rod conjugated homopolymer *(RSC Adv. 2014, 4, 54752-54759)*. He investigated large compound vesicles from amphiphilic block copolymer/rigid-rod conjugated polymer complexes, showing that the interpolyelectrolyte complex formed between PAA and PANI plays a key role in the morphology transformation and that the kinetic pathway of nanoparticle formation can be controlled through water addition methods and is critical in the formation of multi-geometry nanoparticles *(J. Phys. Chem. B, 2014, 118, 12796-12803)*.

Former PhD student Shuhua Peng reported a new class of novel lyotropic liquid-crystalline materials and investigated photo-responsive amphiphiles, demonstrating that self-assembly and photo-responsive behaviour is extremely sensitive to the position of the photoactive moiety within the surfactant molecular architecture *(Langmuir 2014, 30, 866-872; J. Mater. Chem. C, 2014, 2, 8303-8312)*.

The work was also highlighted as a cover story in the prestigious journal *Langmuir*. This research was carried out in collaboration with Dr Timothy Hughes and Dr Patrick Hartley of CSIRO.

PhD student Tao Zhang reported a novel approach for preparation of polyoxometalate-based hybrid organogels from a triblock copolymer via charge-induced assembly. Polyoxometalates (POMs) are discrete inorganic transition-metal oxide clusters with distinct size, charge and shape, which have obtained widespread applications because of their properties - from photochromism, electrochromism, magnetism, and catalysis to chirality. This approach is generally applicable in the processing and applications of POMs materials *(RSC Adv. 2014, 4, 35055-35058)*.

In 2014, the group's research expanded in the area of polymer materials for the oil, gas and energy industry. Prof Qipeng Guo, PhD student Tao Zhang and fellow researchers Dr Yuanpeng Wu and Dr Zhiguang Xu, investigated high internal phase emulsion (HIPE) xerogels for oil-water separation and for enhanced oil spill recovery. Magnetic materials based on hybrid HIPE organogels were developed and were shown to be excellent candidates for absorption of oil from water *(Chem. Commun., 2014, 50, 13821-13824)*. HIPE xerogels based on charge-driven assembled polymer HIPE organogels were prepared by freeze-drying and examined as oil absorbents for oil spill recovery *(J. Mater. Chem. A, 2015, 3, 1906-1909)*.

A series of novel water-soluble copolymers, complexes of copolymers and ionic liquids were developed for inhibiting shale hydration through collaboration with Southwest Petroleum University *(Ind. Eng. Chem. Res., 2014 53, 2903-2910; New J. Chem., 2015, 39, 2155-2161)*.

In 2014, we continued to collaborate with Zhejiang University in developing stable superhydrophobic surface based on silicone combustion product. A silicone combustion product was found to possess superhydrophobicity, which can be utilized to fabricate a robust superhydrophobic surface by hot-pressing *(RSC Adv. 2014, 4, 56259-56262).* We collaborated with Mahatma Gandhi University on developing carbon nanotube based elastomer composites as multifunctional materials under the DIRI program *(J. Mater. Chem. C, 2014, 2, 8446-8485).* We also had a fruitful collaboration with the University of Kashan in polymer blends and nanocomposites *(Soft Matter, 2014, 10, 5550-5558; Phys. Chem. Chem. Phys., 2014, 16, 10679-10687; PLoS One 2014, 9(2), e88715; Nano 2014, 9, 1450065).*

Prof Qipeng Guo and PhD student Tao Zhang invented an oil absorbent technology. This invention involves developing absorbent material based on open cell thermoplastic sulfonated polystyrene porous xerogel for absorbing hydrophobic liquid.

> Prof Lee Astheimer, Deakin University DVC(R) and Mr Gary Heyden, Manager Deakin Research Commercial, meet collaborators from Dongfang Turbine Co Ltd.

It is very effective at absorbing hydrophobic liquids such as oil (i.e. petroleum, animal or plant oil). In addition to rapidly absorbing hydrophobic liquids, the porous xerogel can be produced in a very cost effective manner, which may include using waste polystyrene. A provisional patent has been filed based on this technology and Prof Guo is working with Deakin Research Commercial to commercialise it.

The industry engagement efforts have successfully led to the establishment of two long-term international partnerships for the polymers group:

- A 5-year research project on nano-toughened benzoxazine resins and high performance composites with Sichuan SZD New Materials Co. Ltd, a leading Chinese manufacturer of thermoset resins for the structural composite, adhesive, electronic, coating and construction markets
- A partnership with Dongfang Turbine Co Ltd (DTC), one of the largest backbone enterprises under the direct administration of the Chinese Central Government. DTC and Deakin signed a Memorandum of Understanding in December 2014, to develop collaboration in polymers research, which will result in a 5-year research project on high performance epoxy resins and composites.

NEW

new class of novel lyotropic liquid-crystalline materials reported

5-YEAR

research project on high performance epoxy resins and composites

TWO

long-term international partnerships established

NEW PROJECTS

High-performance polyurethane elastomers reinforced with self-assembled nanoorganogels, Dr Guobo Huang, Alfred Deakin Postdoctoral Research Fellowship 2014.

Epoxy coating, Prof Qipeng Guo, 2014-2015, DENSO Australia.

Nanotoughened benzoxazine resins and high performance composites, Prof Qipeng Guo, 2015-2019, Sichuan SZD New Materials Co, Ltd.

COLLABORATIVE CENTRES

THE INSTITUTE FOR FRONTIER MATERIALS WAS A PARTNER IN THE FOLLOWING COOPERATIVE RESEARCH CENTRES IN 2014:

> Auto CRC

> Sheep CRC

> Energy Pipelines CRC

ABOUT AUTO CRC

The Cooperative Research Centre for Advanced Automotive Technology (AutoCRC) was created in December 2005 as part of a national strategy to secure Australia's position in the global automotive industry.

> The Auto 2020 roadmap for Australia will assist Australia become an automotive technology provider for Asia.

The Auto CRC was refunded from 2012 to 2017 to implement the Auto 2020 roadmap for Australia.

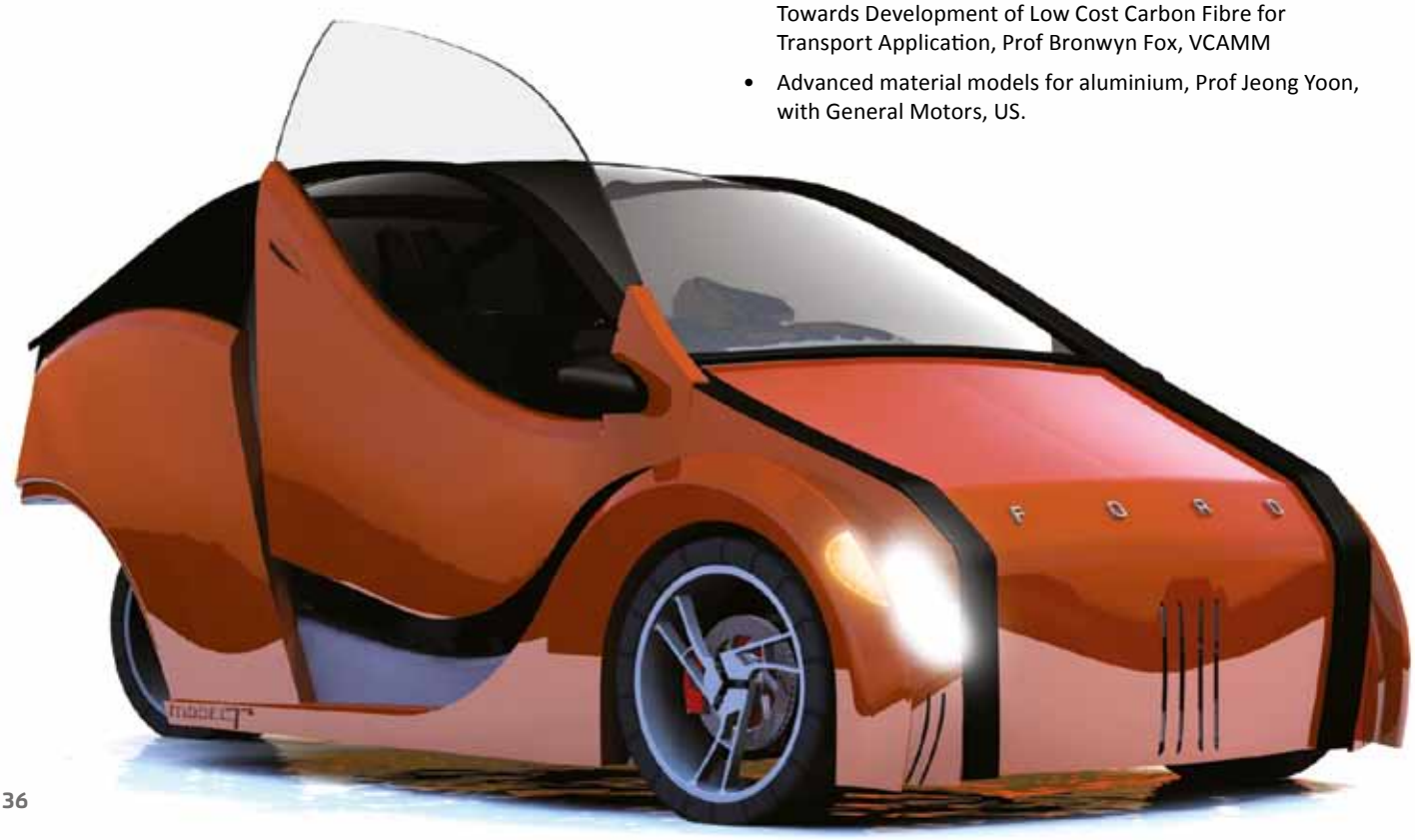
This will assist in the transformation of Australia from being an innovation follower to a technology provider for the Asian region in strategic areas of the automotive industry. IFM is the lead institute for the lightweighting theme in the Auto CRC's sustainable manufacturing research area.

A project on tool wear (with an international company and the Malaysian Automotive Institute, and supported by Metalsa Australia) was completed in 2014. This project is the first stage to understand a particular tool wear issue at a stamping company. The project developed a model to predict tool life for a Malaysian stamping company's tooling dies. We hope to commercialise the model in future.

NEW PROJECTS

- High-volume process to manufacture carbon fibre composite parts for automotive applications, Prof Bronwyn Fox, Multimatic, VCAMM
- Fundamental Understanding of Carbon Fibre Properties: Towards Development of Low Cost Carbon Fibre for Transport Application, Prof Bronwyn Fox, VCAMM
- Advanced material models for aluminium, Prof Jeong Yoon, with General Motors, US.

> Our multi-material lightweight design vision for the future.



SHEEP CRC

ABOUT SHEEP CRC

The CRC for Sheep Industry Innovation is a national program aimed at improving productivity gain, wool and meat quality, and genetic improvement.

> The CRC has made a major research effort in fabric comfort assessment using new rapid techniques and fabric handle attributes of wool fabrics.

Deakin University's role has been to understand the drivers of comfort and handle properties of next-to-skin knitwear composed of Merino wool.

Using both commercial and experimental fabrics and yarns has enabled Dr Bruce McGregor and Dr Maryam Naebe to quantify wool fibre, yarn and fabric properties associated with preferred comfort sensations. During the past year they investigated the role of fibre and fabric properties on wetness traits, such as sweaty sensations experienced during exercise and hot and humid conditions. They also carried out research to evaluate a new rapid and cheaper fabric assessment protocol.

Deakin University staff made a major contribution to a special issue of the Textile Research Journal. The focus of this special issue was the CRC's research effort in fabric comfort assessment using new rapid techniques and fabric handle attributes of wool fabrics.

> Dr Bruce McGregor tests the fabric handle attributes of wool fabric samples.

> Dr Maryam Naebe investigates the comfort properties of different fabrics using the Wool Comfort Meter.

Australian fine wool is a luxury animal fibre, used primarily for fine apparel products. Despite this, the stigma of prickle discomfort may stop people buying wool garments, particularly for next-to-skin knitwear.

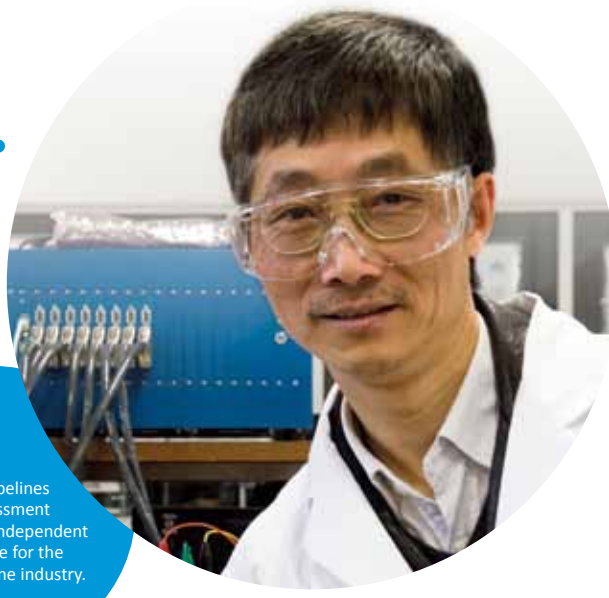
The special issue of the journal provided the latest research developments in managing and overcoming perceived comfort issues with wool knitwear.

Dr McGregor and Dr Naebe also featured in a story about the CRC research on ABC TV's Landline program.

ABOUT ENERGY PIPELINES CRC

The Energy Pipelines CRC (EPCRC) was established in 2010 to provide research and education to support and benefit the energy pipeline industry in Australia.

The CRC is supported by a combined $27.48 million from the Australian Government and industry as well as a $50 million in-kind contribution from the universities and industry. This funding is spread over the EPCRC's 10-year life span.



> The National Facility for Pipelines Coating Assessment provides an independent testing service for the energy pipeline industry.

Deakin University joined the EPCRC in 2012 and leads the program 2 on coatings and corrosion. The goal of this research program is to cost-effectively extend the life of pipeline infrastructure by mitigating corrosion and pipeline degradation. Professor Mike Tan leads this program. A major area of research concerns coating selection, application and testing, which is supported by the new National Facility for Pipeline Coating Assessment (see page. 20). Other research themes include cathodic protection, stress corrosion cracking and pipeline corrosion measurement and prediction. EPCRC research projects started at Deakin in October 2012.

On March 5, 2014, the National Facility for Pipelines Coating Assessment (NFPCA) was officially launched by Energy Pipelines CRC Director, Prof Valerie Linton and Deakin Deputy Vice-Chancellor Research, Professor Lee Astheimer.

The facility, which is located at the Geelong Technology Precinct, is now an independent laboratory. The NFPCA is designed as a multipurpose testing service and research facility. It was set up in response to Australian energy pipeline industry needs for enhanced coating research, training, testing and materials assessment capabilities.

Services include testing to support pipeline coating selection and development. Already, the laboratory is performing regular tests for five pipeline and coating industry companies. An increase in demand for testing services is expected with further enhancement in NFPCA's accreditation and capacities.

A new phase of the NFPCA development has been initiated to achieve critical NATA accreditation and to extend the research and testing capabilities in coating flexibility assessment with a new $100,000 project.

Several new EPCRC funded projects have started in 2014:

- to understand the initiation of stress corrosion cracking (Phase 1 led by Dr Daniel Fabijanic, $260,000)
- to investigate lightning damage to energy pipelines – EPCRC scoping study (Led by Prof Alex Stojcevsk and Dr Aman Than Oo of School of Engineering, $30,000).

Several new projects are under active development to start in early 2015.

IFM FINANCIAL SUMMARY - 2014

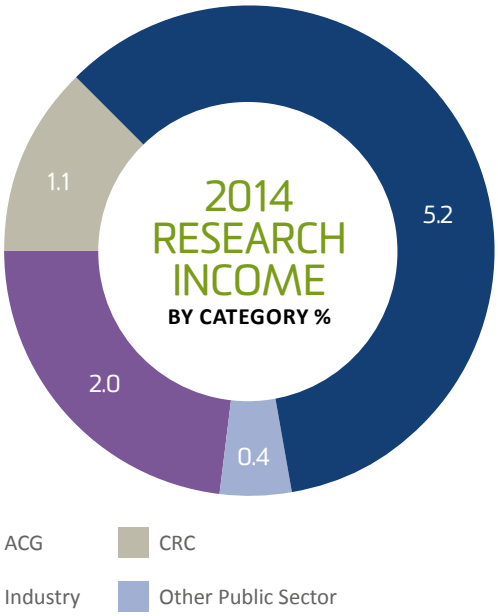
TOTAL RESEARCH INCOME BY CATEGORY - ACTUAL 2014 ($M)

FINANCIAL SUMMARY - FOR PERIOD ENDED 31 DECEMBER 2014	2014 Actual
INCOME	**$**
External Research Income	11,025,388
Other External Income	309,347
University Operating Funds	7,293,735
Research Allocation	8,354,543
Total Income	**26,983,013**
EMPLOYMENT COSTS	
Academic Salaries	12,686,945
General Salaries	4,649,080
Other Employment Costs	55,378
Contractors	63,159
Total Employment Costs	**17,454,561**
NON SALARY EXPENSES	
Buildings & Grounds Infrastructure Costs	175,616
Communication / Advertising, Marketing & Promotions	108,597
Consumables	1,218,374
Depreciation & Amortisation	1,846,375
Equipment - Repairs, Maintenance & Other Costs	1,469,332
Financial, Borrowing, Debtors & Currency Costs	-
Inter Budget Centre / Internal Charges / Recoveries	285,272
Contributions to other Universities	580,793
Other Costs	530,878
Professional, Legal and Consultants	192,268
Staff Recruiting, Training & Other / Library Information Resource Expenses	340,298
Student Expenses	1,490,867
Travel, Catering & Entertainment	963,171
Total Non Salary Expenses	**9,201,841**
Surplus/(Deficit)	**326,610**

IFM PERFORMANCE TARGETS (2011 - 2014)

TOTAL RESEARCH INCOME BY CATEGORY - ACTUAL 2014 ($M)

CATEGORY	ACG	CRC	INDUSTRY	OTHER PUBLIC SECTOR
Total $M	5.2	1.1	2.0	0.4



HDR STUDENT LOAD (EQUIVALENT FULL TIME, 2012-2014)

2012	2013	2014
128	141	**144**

HDR STUDENT COMPLETIONS (EQUIVALENT FULL TIME, 2012-2014)

2012	2013	2014
21	18	**23**

PUBLICATIONS (2012-2014)

2012	2013	2014
132	170	**170**

*Results are based on HERDC publication points as currently recorded.

***ACG (Australian Competitive Research Grants – Category 1)** gives the income obtained in national competitive grants, the term used to describe a group of some seventy research grant schemes to which all universities can apply and where awards are based on merit of the application and the research team. The ARC and NHMRC are two of the major funding bodies included in this list.

***Other public (Other Public Sector Research funding – Category 2)** is government funding, Federal or State, from schemes not included in the ACG group and not necessarily determined through a competitive process; it includes contract research and research-related consultancies.

***Industry (Industry and Other Funding – Category 3)** includes all research funding from industry, international sources, donations, bequests and foundations, and Higher Degree by Research fee income for domestic and international students.

***CRC (Category 4)** is a university's research income from Cooperative Research Centres excluding their own contribution. *Note: CRC income is based on financial year results.*

2014 GRANT APPLICATIONS

GRANTS	APPLIED	SUCCESS	% SUCCESS	AMOUNT AWARDED*
Reportable - Category 1	34	14	41%	$1,914,709.00
Reportable - Category 2 - 4	45	33	73%	$5,127,009.00
Non-Reportable - Other	27	17	59%	n.a.

*The amount awarded represents the amount awarded over the total life of the project as initially communicated by the funding agency.

INDUSTRY PARTNERS

AUSTRALIA

FIBRES AND TEXTILES

- Australian National Fabrication Facility
- Australian Wool Innovation
- Australia Defence Apparel
- Brookland Greens Medical Centre
- Cashmere Connections Pty Ltd
- Charles Parsons P/L
- Cotton Research and Development Corporation
- Cytomatrix Pty Ltd
- Defence Materials Technology Centre
- Draggin Jeans Ltd
- Ear Science Institute Australia Incorporated
- Geofabrics Australasia Pty Ltd
- Godfrey Hirst Carpets
- International Fibre Centre (IFC)
- Logistik Unicorp
- Nplex Pty Ltd
- EP Robinson Pty Ltd
- GT Recycling
- Rural Industries R&D Corporation
- Sheep CRC
- Technical Textiles and Nonwoven Association
- Ug Manufacturing Co Pty Ltd
- VCAMM
- Zhik Pty Ltd

METALS AND COMPOSITES

- Australian Roll Forming Manufacturers (ARM)
- Auto CRC
- Backwell IXL
- BHP Billiton
- Bluescope Steel Ltd
- Carbon Revolution Pty Ltd
- DataM Software GMBH
- Defence Materials Technology Centre (DMTC)
- Defence Science & Technology Organisation (DSTO)
- DHS Emergency
- Ford Motor Company
- GM Holden
- Hard Technologies Pty Ltd
- JE Hoffmann Engineering Pty Ltd
- Keech Castings
- Metalsa Australia
- OneSteel Ltd
- Powercor Australia Ltd
- Qenos
- QuickStep Technologies Pty Ltd
- Shinil Chemical Company
- Studco Building Systems
- Tata Steel Pty Ltd
- Thyssenkrupp Mannex
- United Surface Technologies Pty Ltd
- VCAMM
- VR TEK Wheels Pty Ltd
- ZedCon Scientific Services

ELECTROMATERIALS AND CORROSION

- AECOM
- Agricultural Organics Pty Ltd
- AusComposites Manufacturing Facility
- Ausnet Services
- Australian Pipeline Industry Association
- APA Group
- CPE Systems
- Defence Materials Technology Centre
- Delaminating Resources Pty Ltd
- Denso (Australia) Pty Ltd
- Honda R&D Co., Ltd
- Horizon Fuel Cells Technologies
- Hydrochem Pty Ltd
- Jemena
- National Centre for Excellence in Desalination
- ROC Oil (WA) Ltd
- Rockingham Desalination Research Facility
- Santos Ltd
- Seagas
- Shell Refinery (Australia) Pty Ltd
- Stockbrands Co Pty Ltd
- Sussex Material Solutions

INTERNATIONAL

- Air Force Office for Scientific Research (USA)
- Air Force Research Labs (USA)
- Baosteel (China)
- Bharat forge (India)
- The Boeing Company (USA)
- Chinese Iron and Steel Research Institute
- Cytec (Canada)
- Data M Sheet Metal Solutions (Germany)
- Donaldson Co (USA)
- Dongfang Turbine Co (China)
- DowAksa (Turkey, USA)
- Esquel (Hong Kong)
- Ford (USA)
- Fred Hutchinson Cancer Research Center (USA)
- HeiQ Materials AG (Switzerland)
- Holding Company Composites (Russia)
- Hyundai Motor Company (South Korea)
- Indian Oil (India)
- Kocel Ltd (China)
- Kolon Industries (Korea)
- Logistik Unicorp (Canada)
- Multimatic (Canada)
- Polygauss Ltd (UK)
- POSCO (South Korea)
- Sammitr Motors (Thailand)
- Shandong Ruyi Technology (China)
- Sichuan ShangZhiDeng New Materials Co (China)
- Universal Alloy Corporation (USA)
- Wuhan Iron and Steel (Group) Corporation (China)
- Zhejiang Shenzhou Woollen Textile Co Ltd (China)

GRANT HOLDERS AND THEIR PROJECTS

AUSTRALIAN RESEARCH COUNCIL LINKAGE

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Xungai Wang, Dr Alessandra Sutti, Dr Rangam Rajkhowa, Dr Cynthia Wong, A/Prof Mark Kirkland	Short silk nanofibre based 3D scaffolds with enhanced biomimicry	2014-2017	Cytomatrix	$696,264
Prof Peter Hodgson, Prof Stephen Gray, Prof Lingxue Kong, A/Prof Mikel Duke, Dr Ludovic Dumee, Mr Gilbert Erskine	Functional nano-porous metal membranes for novel separations in sustainable industrial processes	2014-2017	Advanced Metallurgical Solutions Pty Ltd	$550,222
Prof Xungai Wang, Dr Rangam Rajkhowa, Robert Marano and Marcus Atlas	Engineering a silk fibroin based eardrum with optimum acoustic properties	2011-2015	Ear Science Institute, Australia	$553,547
Prof Peter Hodgson, Prof Matthew Barnett, A/Prof Bernard Rolfe	Flexible roll forming of advanced high strength steel sheet	2012-2014	Australian Rollforming Manufacturers Pty Ltd; BlueScope Steel Ltd; data M Sheet Metal Solutions; Wuhan Iron and Steel (Group) Corporation;	$440,440
A/Prof Bernard Rolfe, Prof Peter Hodgson, Prof Maria Forsyth, Dr Michael Pereira	Developing an environmentally friendly, low cost solution to reduce wear and improve productivity in metal forming	2012-2014	Ford Australia	$189,000
Prof Xungai Wang, Dr Christopher Hurren	Australian ultrafine wool dehairing and processing	2012 - 2015	Shangdong Ruyi Woollen Textile Co Ltd	$413,790
A/Prof Michael Ferry, A/Prof Nicole Stanford, Prof Peter Hodgson	Reducing the environmental impact of steel making through direct strip casting	2013-2016		$90,000
Prof Maria Forsyth, A/Prof Patrick Howlett	Phosphonium ionic liquids for advanced lithium energy storage systems	2012-2015	Cytec Canada	$355,366
Prof Qian Ma, Prof Ying Chen, G Erskine, C Zhang	A transformational approach to enabling the low cost fabrication of intricate titanium components, led by RMIT	2014-2016		$420,000

AUSTRALIAN RESEARCH COUNCIL LINKAGE INFRASTRUCTURE EQUIPMENT AND FACILITIES (LIEF)

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
A/Prof Nicole Stanford, Prof Peter Hodgson, Prof Michael Ferry, A/Prof Christopher Hutchinson, Prof Matthew Barnett, Dr Thomas Dorin	Quench and deformation dilatometer for studying phase transformations	2015	ARC	$229,000
Prof Shi Xue Dou, Dr Germanas Peleckis, Prof Xiaolin Wang, Dr Jiabao Yi, Prof Yiu-Wing Mai, Dr Luhua Li, Prof Roger Lewis, Prof Ying Chen, Prof Geoffrey Spinks	New generaton cryogen free 14 Tesla physical property measurement system, led by UoW	2015		$420,000
Prof M Barnett, Prof P Hodgson, Prof P Y Chen, Prof Q Guo, Dr K Laws, Dr C Caceres, Dr D Qiu, Prof Kiet Tieu, Prof E Pereloma, Dr R O'Donnell	In-situ elevated temperature nano-indentation, Hysitron nano-indenter	2014		$220,000

GRANT HOLDERS AND THEIR PROJECTS

AUSTRALIAN RESEARCH COUNCIL LINKAGE INFRASTRUCTURE EQUIPMENT AND FACILITIES (LIEF) (CONTINUED)

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof P Hodgson, Dr M Weiss, A/Prof B Rolfe, Prof J Yoon, Dr N Stanford, A/Prof S Kalyanasundaram, A/Prof P Compston, Prof L Zhang, Prof Y Zheng, Dr D Wei, A/Prof M Dargusch, Dr G Wang, Dr R O'Donneel	Flexible forming facility for low-cost lightweight applications	2014		$280,000
A/Prof G Prusty, A/Prof Paul Compston, Prof Liyong Tong, Prof K Kwok, Prof B Fox, Dr Youhong Tang, Dr R Ojeda Rabanal, Prof D Bhattacharyya, Dr N St John, Dr A Beehag, Dr M Sterbic, Prof Brian Uy, Prof V Sahajwalla, Dr G Pearce, Prof Qing-Hua Qin, Prof E Morozov, Prof L Ye, Prof K Rasmussen, Dr F Mashiri, Dr Rajarshi Das, Dr Stuart Wildy	A facility for automated fabrication of high performance bespoke components, led by UNSW	2014		$500,000

AUSTRALIAN RESEARCH COUNCIL DISCOVERY

TEAM	PROJECT TITLE	YEARS	TOTAL AWARDED
Prof Peter Hodgson, Dr Ilana Timokhina, Prof Michael Miller	A new approach to advanced steels via cluster and precipitate strengthening	2015-2017	$325,500
Prof Ying Chen, A/Prof Chunyi	Porous nanosheets	2015-2017	$325,500
Dr Hongxia Wang, Dr Yan Zhao, Prof G Rutledge	Water-phase assembly of durable, superamphiphobic, self-cleaning surfaces	2015-2017	$236,700
Dr Christopher Hutchinson, Prof Matthew Barnett, Prof Alexis Deschamps	A new paradigm for creating fatigue-resistant light metals, led by Monash University	2015-2018	$120,000
A/Prof Darren Martin, Prof Bronwyn Fox, Dr Bronwyn Laycock, Prof Eric McFarland, Dr Pratheep Kumar Annamalai	High performance sustainable carbon fibres from Australian spinifex grass, led by The University of Queensland	2015-2017	$23,400
Prof Tong Lin, Prof Xin Liu	Directional fluid transfer in thin porous materials with imbalanced wettability	2011-2014	$221,620
Prof Xungai Wang, Dr Rangam Rajkhowa, Dr Jingliang Li	Understanding the composite structures and properties of wild silk cocoons	2012-2014	$322,075
Prof Peter Hodgson, A/Prof Nicole Stanford	Advanced high strength steels produced by energy efficient direct strip casting	2013-2015	$435,771
Prof Qipeng Guo	Toughening thermosets by highly ordered nanostructures	2012-2014	$149,000
Prof Ying Chen, Dr Alexey Glushenkov	Nanoporous nanorods with improved electrochemical properties	2013-2015	$334,232
Prof Maria Forsyth	Future sodium based electrochemical energy storage technologies	2013-2015	$415,002
Prof Tong Lin, Dr Jian Fang, Prof Liming	Functional fibres for diverse applications	2014-2016	$309,000
A/Prof Patrick Howlett, Dr J Pringle, Prof Michel Armand, Dr George Greene	Novel solid state electrolyte membranes composed of plastic crystals and polymer nanofibres	2014-2016	$270,000
Prof Bronwyn Fox, Prof Sally McArthur, Prof Tiffany Walsh, Dr Luke Henderson, Dr Luke O'Dell	Interfaces within carbon fibre composites	2014-2016	$390,000

GRANT HOLDERS AND THEIR PROJECTS

AUSTRALIAN RESEARCH COUNCIL DISCOVERY (CONTINUED)

TEAM	PROJECT TITLE	YEARS	TOTAL AWARDED
Prof Matthew Barnett, Prof Sean Agnew	Deformation twinning in magnesium	2014-2016	$360,000
Prof Xungai Wang, Dr Nolene Byrne	Understanding the interaction between wool fibre surface and ionic liquids	2013-2015	$310,000

AUSTRALIAN RESEARCH COUNCIL DISCOVERY EARLY CAREER RESEARCHER AWARD

TEAM	PROJECT TITLE	YEARS	TOTAL AWARDED
Dr Dan Liu	Novel Three Dimensional Porous Boron Nitride Foam for Water Cleaning	2015-2017	$111,971
Dr George Greene	Investigation and development of biological anti-adhesive coatings	2013-2015	$383,279
Dr Weiwei Lei	New two-dimensional nanomaterials of boron carbon nitride nanosheets	2014-2016	$367,420

AUSTRALIAN RESEARCH COUNCIL AUSTRALIAN LAUREATE FELLOWSHIP

TEAM	PROJECT TITLE	YEARS	TOTAL AWARDED
Prof Maria Forsyth	New materials for a sustainable energy future	2011-2016	$2,260,000

AUSTRALIAN RESEARCH COUNCIL AUSTRALIAN FUTURE FELLOWSHIP

TEAM	PROJECT TITLE	YEARS	TOTAL AWARDED
Prof Matthew Barnett	Growing a multi-scale internal structure: new wrought metals for energy conservation	2011-2014	$844,915
Prof Tong Lin	Piezoelectric nanofibre membranes with built-in p-n junction: new self-rectifying piezoelectric power generators	2012-2016	$747,650
A/Prof Joselito Razal	Spinning nanosheets for versatile applications	2014-2017	$749,160
Dr Jingliang Li	Supramolecular assembly of chromophores: the effects of nucleation kinetics on their molecular packing, fibre structure and light harvesting efficiency	2014-2017	$661,840

AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE

TEAM	PROJECT TITLE	YEARS	TOTAL AWARDED
Prof Maria Forsyth	ARC Centre of Excellence for Electromaterials Science, led by University of Wollongong	2014-2020	$4,537,000

AUSTRALIAN RESEARCH COUNCIL INDUSTRIAL TRANSFORMATION RESEARCH HUB

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Xinhua Wu, Prof Peter Hodgson, Prof Christopher Davies, Dr Wenyi Yan, Dr Mark Easton, Prof Yi-Bing Cheng, A/Prof Matthew Dargusch, A/Prof Bernard Rolfe, Prof Lyndon Edwards, Mr Damien Miller, Mr Gavin Becker, Dr Emilie Herny, Dr Robert Hobbs, Dr Roger Lumley, Mr Thomas Hawkes, Mr Kevin Lee	ARC Research Hub for Transforming Australia's Manufacturing Industry through High Value Additive Manufacturing led by Monash University	2013-2018	ARC	$1,321,040

GRANT HOLDERS AND THEIR PROJECTS

OTHER COMMONWEALTH FUNDING

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Peter Hodgson	Manufacture of a small aero-engine entirely through additive manufacturing	2013-2017	Science and Industry Endowment Fund (SIEF)	$600,040
Prof Maria Forsyth	Strategies for developing self-repairing oxides to protect steel system	2011-2014	CSIRO	$97,600
Mr Infant Bosco	Electrochemical Study of Corrosion in Aluminium Al2020 and Al7075	2014-2015	CSIRO research grant	$8,909

AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING (AINSE)

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Bronwyn Fox, Mr Srinivas Nunna	Making low cost Australian carbon fibres	2014-2015	AINSE award	$17,500

AUSTRALIAN ACADEMY OF SCIENCE

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Dr Alexey Glushenkov	Sodium-ion batteries: electrode development and application of in-situ transmission electron microscopy	2014-2016	AAS Travel - Exchange - Japan, Fellowship	$5,300
Dr Luhua Li	Synthesis and Application of Boron Nitride Nanomaterials	2014-2016	AAS Travel - Exchange - Japan, Fellowship	$6,500

NATIONAL CENTRE OF EXCELLENCE IN DESALINATION

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Maria Forsyth	Smart Materials for Corrosion Management	2011-2014	DEWHA	$450,000
Prof Peter Hodgson, Prof Lingxue Kong, Dr Ludovic Dumée, Mr Bao Lin	NCED Scholarship - Design and characterisation of novel nano-porous metal membranes by specific metal allow films de-alloying	2013-2015	DEWHA	$30,000

GRANT HOLDERS AND THEIR PROJECTS

INDUSTRY AND OTHER FUNDING

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Tiffany Walsh	Underpinning development in advanced materials with molecular simulation	2012-2015	Victorian Endowment for Science, Knowledge and Innovation (VESKI)	$150,000
Dr Alessandra Sutti, Dr Paul Collins	HeiQ Australia Research Program 2014/15	2015-2019	HeiQ Australia Pty Ltd	$1,833,333
Dr Alessandra Sutti; Dr Marzieh Parhizkar	Production of a pilot manufacturing plant for the manufacture of short nanofibres	2013-2014	Cytomatrix Pty Ltd	$219,088
Prof Xungai Wang	Novel spinning technologies for fine and high quality Australian cotton yarns	2014-2017	Cotton Research and Development Corporation	$814,551
Dr Xin Liu, Dr Yan Zhao	Novel anti-wetting and self-sterilising cotton fabrics	2014-2017	Cotton Research and Development Corporation	$299,500
Prof Xungai Wang	Development of low twist fine count yarns and fabrics from Australian Long Staple Upland cotton	2010-2014	Cotton Research and Development Corporation	$360,000
Prof Xungai Wang	Design of thermal cotton / wool fabrics from Australian premium cotton and wool fibres	2013-2015	Cotton Research and Development Corporation	$494,963
Prof Xungai Wang, Dr Rangam Rajkhowa	Improving length, strength and fitness of cotton fibre, PhD project	2013-2016	Cotton Research and Development Corporation	$138,000
Prof Xungai Wang, Dr Christopher Hurren, Dr Lu Sun	New developments and opportunities for cotton yarns and fabrics	2013-2014	Cotton Research and Development Corporation	$72,635
Prof Xungai Wang, Dr Nolene Byrne	Ionic liquids for the shrink-resist treatment of wool - post oxidation and alternative resin	2014-2015	Australian Wool Innovation Limited	$160,245
Prof Tong Lin	Cooling and thermal regulating wool fabrics	2014-2015	Australian Wool Innovation Limited	$54,100
Dr Bruce McGregor	Fibre quality: meeting market requirements	2013-2015	Australian Wool Innovation Limited	$216,960
Prof Tong Lin	Proof of concept for directional water-transport wool fabrics	2013-2014	Australian Wool Innovation Limited	$70,000
Dr Nolene Byrne, Prof Xungai Wang	Investigating the surface of chlorinated wool - towards zero AOX residuals	2013-2014	Australian Wool Innovation Limited	$41,700
Dr Nolene Byrne, Mr Troy Resic	Ionic liquids and wool research project	2014-2016	Australian Wool Innovation scholarship	$66,000
Dr Christopher Hurren, Dr Jinfeng Wang	Improving grease recovery in wool scouring	2014-2015	Australian Wool Innovation Limited	$230,264
Dr Jinfeng Wang, Dr Nolene Byrne	Consultancy agreement - shrink resist processes	2014	Australian Wool Innovation Limited	$71,300

GRANT HOLDERS AND THEIR PROJECTS

INDUSTRY AND OTHER FUNDING (CONTINUED)

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Mike Yongjun Tan, Mr Davi Abreu	Pipeline coating testing and assessment - Universal Corrosion Coatings	2013-2015	Universial Corrosion Coating	$29,220
Dr Daniel Fabijanic, Prof Matthew Barnett	Nanostructured steels for ground engaging tools	2013-2014	Department of State Development Business and Innovation/Keech Australia Pty Ltd	$62,500
Prof Matthew Barnett, Dr Daniel Fabijanic, Mr Gourab Saha	A method for developing steels for wear resistance in ground engaging applications	2013-2019	Keech Australia Pty Ltd student project	$80,000
Prof Mike Yongjun Tan, Mr Davi Abreu	Pipeline coating testing and assessment - Atlas Steels	2014	ATLAS SPECIALTY METALS PTY LTD (Atlas Steels)	$4,000
Dr Christopher Hurren	Fibre alternative to nitrocellulose in lateral flow assays	2014-2015	Nplex Pty Ltd	$313,700
Mr Davi Abreu, Prof Mike Yongjun Tan	Pipeline coating testing and assessment - Stockbrands Co Pty Ltd	2014	Stockbrands Co Pty Ltd	$3,600
Dr Matthias Weiss	Investigation of anisotropy in aluminium sheet using a cupping test	2014	ThyssenKrupp Mannex Pty Ltd	$5,760
Dr Minoo Naebe, Prof Bronwyn Fox, Dr Daniel Fabijanic	High curvature armour systems	2014-2015	VCAMM and DMTC	$195,160
A/Prof Patrick Howlett, Prof Maria Forsyth, Prof Xungai Wang, Prof Tong Lin, Dr Jian Fang	Portable power storage	2012-2015	VCAMM research grant	$300,486
Dr Minoo Naebe, Prof Bronwyn Fox	High barrier and strength polyethylene nanocomposites	2014-2018	Qenos	$200,000
Dr Daniel Fabijanic	Strategies to improve the ductibility of Zn6AI3Mg coatings	2013-2014	One Steel Wire Pty Ltd	$36,500
A/Prof Patrick Howlett	Corrosion behaviour of ZnAILi, ZnAI and ZnAIMg	2014	One Steel Wire Pty Ltd	$19,300
Prof Lingxue Kong, Dr Fenghua She	Researcher in Business Project with T J McLean Investments - Recycling bulky waste to reduce carbon emission and landfill	2013-2014	GT Recycling	$104,298
Prof Jeong Yoon	A study for design technology of heavy plate rolling mill without thickness ratio limit	2014-2015	POSCO	$60,000
Dr Daniel Fabijanic	Process proving of boronizing in a fluid bed reactor	2013-2014	Department of State Development Business and Innovation/Hard Technologies	$62,500
A/Prof Patrick Howlett	SP AusNet grid energy storage project	2013-2014	SP AusNet	$19,700
Dr Christopher Hurren	Extreme sports safety program	2013-2014	Draggin Jeans	$98,929
A/Prof Bernard Rolfe, Dr Matthias Weiss	Flexible roll forming of automotive structures	2013-2014	Ford Motor Co of Australia University Research Project	$75,488

GRANT HOLDERS AND THEIR PROJECTS

INDUSTRY AND OTHER FUNDING (CONTINUED)

TEAM	PROJECT TITLE	YEARS	INDUSTRY PARTNER/ FUNDING BODY	TOTAL AWARDED
Prof Peter Hodgson, Dr Matthias Weiss	Micro-roll forming of fuel cell bipolar plates	2014-2016	Ford USA	$41,339
Dr Matthias Weiss, A/Prof Bernard Rolfe	Advanced high strength steel development and safe parts manufacture project	2013-2015	Wuhan Iron and Steel (Group) Corporation	$47,034
Prof Peter Hodgson, Prof Matthew Barnett, Prof Lingxue Kong	Cold stamping of advanced high strength steels	2012-2015	Wuhan Iron and Steel (Group) Corporation	$150,000
Prof Tiffany Walsh	Bio-nanocombinatorics to achieve precisely-assembled multicomponent, functional hybrid nanomaterials	2012-2017	US Air Force Office of Scientific Research	$532,852
Prof Xungai Wang, Dr Jingliang Li, Weiguo Chen	Modification of wool with photo-catalysed oxidation and its effect on dyeing properties	2012-2014	Zhejiang Shenzhou Woollen Textile Co Ltd	$100,000
Dr Christopher Hurren	Hemp fibre separation	2012-2014	Logistik Unicorp Inc	$37,987
Dr Daniel Fabijanic	Determination of the role of pipe wall surface finish and contaminants in the development of conditions the enable the initiation of Stress Corrosion Cracking	2014-2015	Energy Pipelines CRC	$260,000
Prof Mike Yongjun Tan, Prof Qipeng Guo	RP2-06 Coating facility phase 2	2013-2014	Energy Pipelines CRC	$135,600
Prof Mike Yongjun Tan, Prof Maria Forsyth, Subrat Das	RP2-08B Transient loss of cathodic protection - phase 2	2012-2015	Energy Pipelines CRC	$299,000
Prof Mike Yongjun Tan, Prof Maria Forsyth, Prof Qipeng Guo	RP2-11 Coating cracking and disbondment	2012-2015	Energy Pipelines CRC	$293,000
Prof Mike Yongjun Tan; A/Prof Bruce Hinton; Subrat Das; Prof Alex Stojcevski	Pipeline health monitoring and life prediction	2012-2015	Energy Pipelines CRC	$429,500
Prof Bronwyn Fox, Dr Minoo Naebe, Dr Claudia Creighton	Low Cost Automotive Grade PAN based Carbon Fibers	2014-2016	Ford USA/Auto CRC project	$335,080
Dr Minoo Naebe, Dr Claudia Creighton, Prof Bronwyn Fox	High Volume Process to Manufacture of Carbon Fibre Reinforced Composite parts for Automotive Applications	2014-2015	The Boeing Company/Auto CRC project	$176,750
A/Prof Bernard Rolfe, Dr Matthias Weiss, Dr Michael Pereira	Tool wear prediction model on the stamping of AHSS and UHSS	2013-2014	Auto CRC	$116,000
Dr Zohreh Keshavarz, Prof Peter Hodgson	Lightweight vehicle structures from high strength metals	2012-2014	Auto CRC	$695,000
Dr Kevin Magniez, Erwan Castanet	Manufacturing of biocomposites for automotive applications	2013-2015	Auto CRC scholarship	$99,000
Dr Kevin Magniez, Dr Alessandra Sutti	Novel self-healing fibre-reinforced composites	2010-2014	AMCRC	$128,611
Prof Xungai Wang	Sheep CRC Colour Program - Deakin 01-Wool Colour	2009-2014	Sheep CRC	$883,695

PUBLICATIONS

BOOKS

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