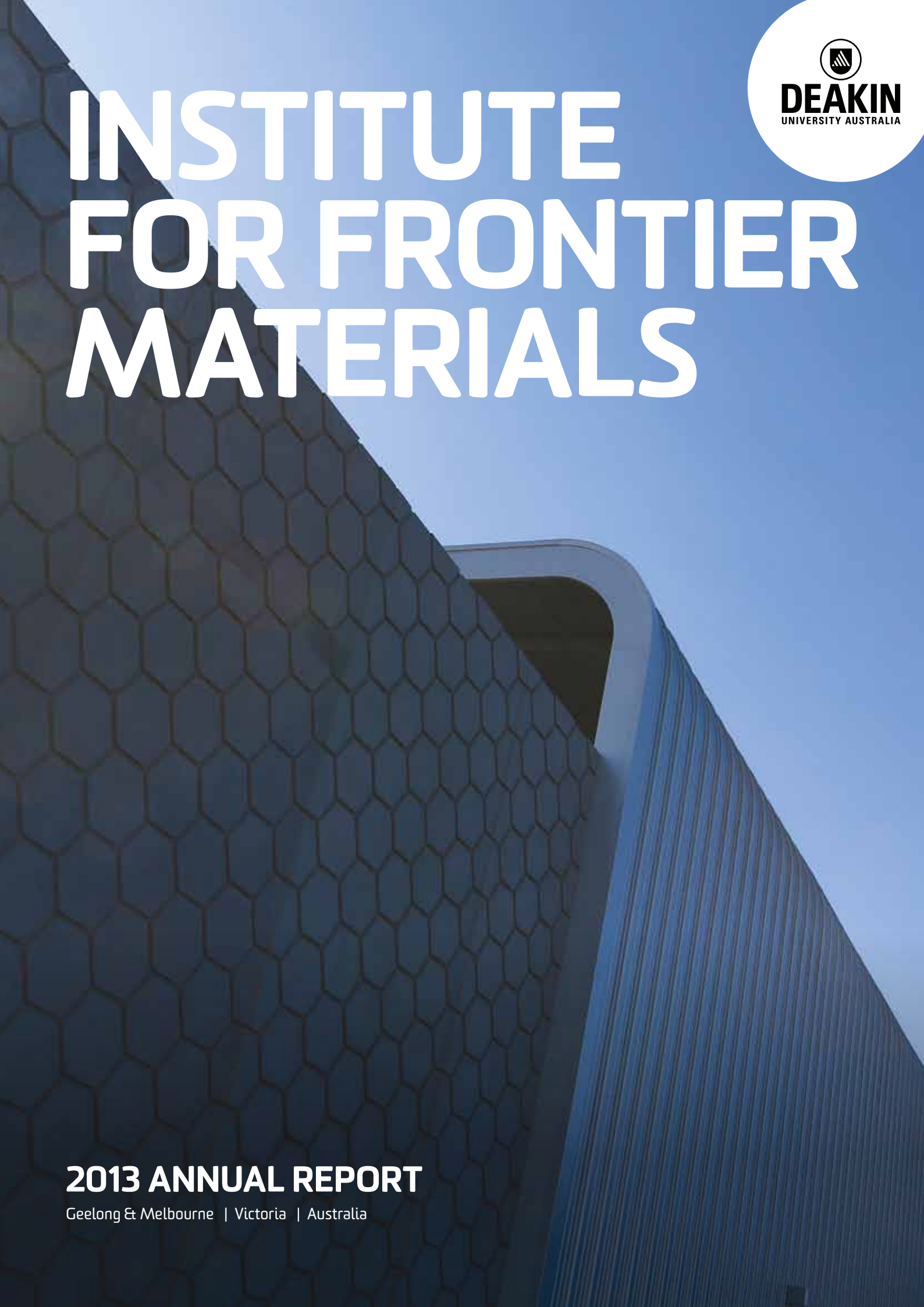


DEAKIN
UNIVERSITY AUSTRALIA

INSTITUTE FOR FRONTIER MATERIALS

2013 ANNUAL REPORT

Geelong & Melbourne | Victoria | Australia

THE YEAR AT A GLANCE

INSTITUTE FOR FRONTIER MATERIALS YEAR AT A GLANCE...

- 164 PhD students from more than 40 countries
- 23 PhD completions
- Member of four CRCs and two ARC Centres of Excellence
- 369 scientific journal papers and 40 conference papers published
- Collaboration with 67 local and international industry partners
- New Cameca LEAP-HR atom probe – for in-depth study of nano-scale features in steel
- IFM Strategic Plan 2013-2018 developed
- Carbon Nexus plant begins operation
- Successful bid for Industry Transformation Hub on Additive Manufacturing with Monash University
- Successful outcome for new ARC Centre of Excellence in Electromaterials
- Four ARC Discovery Grants awarded
- Two ARC DECRAs awarded
- Two ARC Future Fellowships awarded
- Two ARC LIEF grants awarded
- Skilling the Bay $500,000 to industry partner Cytomatrix for short nanofibre plant

CONTENTS

2/ The Year at a Glance

4/ Chairperson's Report

5/ Director's Report

6/ IFM Board Members

7/ Our Vision, Our Mission

8/ International Collaborations

KEY RESEARCH AREAS:

9/ Australian Future Fibres Research and Innovation Centre (AFFRIC)

10/ Carbon Fibres and Composites

13/ Green Natural Fibres

15/ Functional Fibrous Materials and Nanofibres

16/ Biomaterials

17/ Metallic Biomaterials

18/ Molecular Modelling and Simulation

19/ Numerical Modelling and Design of Materials for Lightweight Structures

20/ Corrosion Research Centre

22/ Electromaterials and Energy

24/ Nanotechnology and Energy Storage

26/ Metals

28/ Light Metals

30/ Micro and Nano Systems

32/ Plasma Research

34/ Polymers

COLLABORATIVE CENTRES:

37/ Advanced Manufacturing CRC (AMCRC)

38/ Auto CRC

39/ CRC for Sheep Industry Innovation

40/ Energy Pipelines CRC

FINANCIALS AND OTHER ITEMS:

42/ IFM Financial Summary - 2013

43/ IFM Performance Targets (2010-2013)

44/ IFM Students - 2013

45/ Industry Partners

46/ Seminars

48/ Grant Holders and their Projects

57/ Publications

FROM THE CHAIRPERSON

It is my pleasure to welcome you to the 2013 Annual Report of the Institute for Frontier Materials (IFM), an institute that helps drive Deakin University's goal of high quality discovery, applied and commercial research.

Dr Ben Allardyce and Dr Rangam Rajkhowa examine a solution of processed silk fibres.

Throughout 2013, IFM researchers continued to make outstanding advances in technological fields, including the area of carbon fibre research. A historic moment occurred in November when the 20-ton pilot scale line at Carbon Nexus produced its first carbon fibre. This facility has tremendous potential for the economy of the Geelong region.

During the year we took a number of important steps in growing the University's research base and profile. Continuing our investment in technology, the new plasma research laboratory combines plasma and thermal energy to offer researchers a sophisticated testing platform. Working in the areas of surface modification and nanofabrication, Dr Jane Dai and her team will produce a wide range of beneficial applications in energy, biomedicine, composites, transport and textiles.

In the area of natural fibres, the IFM researchers have established themselves as world leaders in silk fibre research. In one innovative application that aims to solve a problem affecting millions of people, IFM researchers working with Ear Science Institute Australia as part of an ARC Linkage project are using the natural properties of silk fibres to produce an artificial eardrum which could be implanted in a simple outpatient procedure.

Among a number of awards for IFM researchers, a highlight was the presentation of the prestigious Corrosion Medal by the Australasian Corrosion Association to Professor Maria Forsyth. The medal is bestowed for outstanding scientific or technological work in the field of corrosion.

The year ended on a high note with the announcement that IFM was part of a successful proposal for the establishment of a $4 million ARC Industry Transformation Research Hub (ITRH) for Additive Manufacturing and a cutting edge new ARC Centre of Excellence for Electromaterials Science (ACES). Professor Peter Hodgson will lead Deakin's contribution to the ITRH over the next six years and Professor Maria Forsyth will be Associate Director of the new ACES.

Professor Lee Astheimer

Deputy Vice-Chancellor (Research), Chairperson IFM Board

FROM THE DIRECTOR

IFM's staff and students achieved many successes in 2013. This annual report highlights some of these awards and achievements.

Dr Marzieh Parhizkar and Dr Alessandra Sutti with the prototype short nanofibre machine.

We were greatly relieved when construction works finished in Building na early in the year, the AFFRIC laboratories opened and we welcomed CSIRO to the building. The facilities were further enhanced with the opening of the NaturalOne café, which is proving a popular place for staff and students from other parts of the Campus to get together as well as for IFM researchers.

A highlight of the year was the opening of Carbon Nexus and associated laboratories and the move by Associate Professor Bronwyn Fox and her group to the new facility. Full commissioning of the carbon fibre lines was completed and the first research projects with industry were due to start immediately in 2014. The area vacated by the composites group has been refurbished to house the corrosion centre, with the National Facility for Pipelines Coating Assessment to be officially opened early in 2014.

The international focus for the past 12 months has seen extensive developments in India and China – our two target countries. In China I was made a 1000 International Talent, joining IFM's other 1000 Talents, Professors Xungai Wang and Ian Chen. We are also working with Wuhan University of Science and Technology to develop a steel research laboratory.

During the year, IFM developed a strategic plan which will set our research direction for the next five years. From my perspective it has been a very interesting process of engagement with a broad cross section of staff and highlighted a clear unity in our values and direction. The research areas that have been given most priority for the next five years are composites and carbon fibre research, corrosion, natural fibres (in particular cotton) and nanofibres.

IFM achieved an excellent outcome in the ARC grants, especially in terms of the overall University performance. We were awarded four Discovery grants, two ARC Future Fellows, two Discovery Early Career Researcher Awards and two Linkage Infrastructure, Equipment and Facilities grants.

The $500,000 Geelong Future Industry project award to our industry partner Cytomatrix will see a world-first pilot manufacturing plant for the production of short nanofibres at the Geelong Technology Precinct. The project builds on innovative technology recently developed by researchers in the Cytomatrix/IFM biomaterials team. The short nanofibre technology is truly world leading and has enormous potential.

A major focus in 2013 has been to cover the full spectrum of research from fundamental discovery through to market driven applications. We have maintained a steady portfolio of industry partners while also achieving exceptional ratings in our research areas in the past two ERA assessments.

Our future challenge is to continue to grow while maintaining our commitment to excellence and relevance in the face of major challenges to manufacturing related research in Australia.

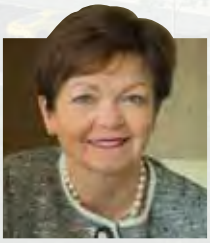
Professor Peter Hodgson

Director, Institute for Frontier Materials

IFM BOARD

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

BOARD MEMBERS 2013



PROFESSOR JANE DEN HOLLANDER

Vice-Chancellor, Deakin University

PROFESSOR LEE ASTHEIMER

Deputy Vice-Chancellor (Research), Deakin University

PROFESSOR PETER D HODGSON

Australian Laureate Fellow and Director of the Institute for Frontier Materials

PROFESSOR BRENDAN CROTTY

Pro Vice-Chancellor Health, Deakin University

PROFESSOR TREVOR DAY

Pro Vice-Chancellor, Faculty of Science, Engineering & Built Environment, Deakin University

PROFESSOR GEOFF STEVENS

Director, Particulate Fluids Processing Centre, Department of Chemical & Biomolecular Engineering, The University of Melbourne

DR KEITH MCLEAN

Theme Leader: Biomedical Materials and Devices, CSIRO Future Manufacturing Flagship

PROFESSOR GORDON WALLACE

Australian Laureate Fellow & Executive Research Director, ARC Centre of Excellence for Electromaterials Science, University of Wollongong

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.

IFM EXECUTIVE TEAM

PROFESSOR
PETER D HODGSON
Director of the Institute for Frontier Materials

PROFESSOR
MARIA FORSYTH
Australian Laureate Fellow

PROFESSOR
XUNGAI WANG
Alfred Deakin Professor

PROFESSOR
MATTHEW BARNETT
ARC Future Fellow and Chair in Metallurgy

PROFESSOR
LINGXUE KONG
Professor (Research)

INTERNATIONAL COLLABORATIONS

Collaboration with overseas partners, including industry, academia and government institutions was enhanced and broadened in 2013.

Visiting WISCO researchers Dr Deng Zhaojun, Chun Lei Bai, Zhu Wanjun and Lin Chengjiang.

CHINA

The Institute for Frontier Materials and the Wuhan Iron and Steel Company (WISCO) held the annual Deakin – WISCO Forum on Advanced High Strength Automotive Material in Wuhan in September with a theme on lightweighting automotive technology.

More than 400 guests from all the leading Chinese and international automotive companies attended the forum, which was sponsored and supported by the China Automotive Engineering Association and China Automotive Lightweighting Technology Innovation Strategic Alliance.

A special session was organised to highlight and celebrate the research collaboration between Deakin University and WISCO. The 2nd Australia-China Forum on innovative environmental remediation through multidisciplinary collaboration was held at Wuhan Textile University in July.

IFM researchers have been recognised at the highest level in China with Professor Peter Hodgson being appointed as one of very few experts under the central Chinese Government's International 1000 Talent Program. IFM is probably the only research institute in the world with three research scientists appointed under this prestigious and competitive program, the others being Professors Xungai Wang and Ying Chen.

IFM has also established strong academic collaborations with Chinese institutions. An agreement was signed with Wuhan Textile University to jointly recruit and supervise PhD students who will undertake research in both institutions. IFM has welcomed the first Chinese in-country PhD student in collaboration with the Institute of Applied Ecology affiliated to the Chinese Academy of Sciences.

Deakin University also welcomed the first cohort of joint undergraduate students with Wuhan University of Science and Technology, a collaboration facilitated by IFM.

The joint IFM research centres with CISRI, WISCO, CATAS and HFUT are all progressing well. There have been many new research programs developed in these centres, highlighted by the successful application of a new program with CISRI under the Chinese 863 Research Scheme, which is similar to an Australian CRC.

INDIA

In 2013, IFM focused on specific industry partners and The Energy and Resources Institute (TERI) partnership. A greater number of IFM staff were involved in visits to enable more interactions with existing and potential partners.

A new MoU was signed with IIT Kanpur as part of the MTech program. In this program, select students are invited to conduct six months of research at IFM as part of their Masters degree. The immediate aims of the program are to foster collaboration between academics, produce quality journal papers and to encourage quality students to undertake a PhD at IFM.

Professor Peter Hodgson visited India in March, resulting in an MOU between Deakin and the Steel Authority of India (SAIL) R&D, and again in July where he signed an MOU between Deakin and IIT Madras in Chennai. In November, Professor Hodgson visited again, where he met with IIT Madras to discuss the establishment of a Centre of Excellence in Advanced Materials and Manufacturing. He hosted a round table for Indian automotive companies to discuss their research needs and possible areas of collaboration.

Professor Xungai Wang, Vice-Chancellor, Professor Jane den Hollander and PhD student Gayathri Devi Rajmohan at Deakin's Diwali celebrations.

AUSTRALIAN FUTURE FIBRES RESEARCH & INNOVATION CENTRE (AFFRIC)

The Australian Future Fibres Research & Innovation Centre (AFFRIC) is a $103 million initiative supported by the Australian and Victorian Governments. AFFRIC is a collaboration between CSIRO Materials Science and Engineering, Deakin University and the Victorian Centre for Advanced Materials Manufacturing (VCAMM).

Led by Professor Xungai Wang, AFFRIC has about 100 staff and research students working at Deakin in four major program areas:

- CARBON FIBRES AND COMPOSITES
- GREEN NATURAL FIBRES
- FUNCTIONAL FIBROUS MATERIALS
- NANOFIBRES

CARBON FIBRES AND COMPOSITES

GROUP MEMBERS (STAFF)	A/Prof Bronwyn Fox, Steve Atkiss, 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, Josephine Posterino, Katrina Robertson, Pedro Sousa, Alex Borda Coca, Alexis Leblais, Madhu Suryanarayana, Tristan Alexander, Kieu Nguyen
GROUP MEMBERS (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, Geo Jose

Carbon fibre composites are increasingly being used across a wide range of industries, such as aerospace, automotive, oil and gas, clean energy and sporting goods, replacing traditional materials such as steel and aluminium.

Associate Professor Bronwyn Fox.

The composites research group at Deakin University has a strong national and international 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 collaborators across the globe gives us a unique capability to tailor the next generation of composite materials from their molecular components.

RESEARCH HIGHLIGHTS

Associate Professor Bronwyn Fox and her team received an ARC Discovery Grant on *Bioinspired interfaces for improved carbon fibre performance*.

The Carbon Nexus Strategic Plan for Research was reviewed by Dow and submitted to the Victorian Government.

Eighteen high-quality journal papers were published including two papers in *Carbon*.

Dr Kevin Magniez was promoted to senior lecturer and Dr Nishar Hameed was promoted to lecturer.

EVENTS/CONFERENCES

The group organised a successful conference on *Carbon Fibre Future Directions* from 26 February – 1 March 2013 with more than 100 attendees.

Carbon Nexus stands at JEC Paris in March and JEC Singapore in June attracted a great deal of interest. JEC is the premier tradeshow and conference for carbon fibre and composite materials.

A/Prof Fox was invited to speak at a number of conferences, including the Society for Advancement of Material and Process Engineering (SAMPE) conference in Long Beach California in May; the Fiber Society meeting in Geelong in May and the 34th Australian Polymer Symposium in Darwin in July.

Professor Jane den Hollander, A/Prof Fox and VCAMM CEO Brad Dunstan were invited by Dow to speak at the Open Innovation Forum in Moscow in October.

Thinker in residence

In June and July, Associate Professor Jeff Wiggins from the University of Southern Mississippi visited Deakin University as Thinker in Residence. During his four-week appointment, A/Prof Wiggins, who is Director of the School of Polymers and High Performance Materials, presented a course in polymer chemistry to undergraduate honours students and a keynote address at a Composites Australia technology seminar. Importantly, he also provided advice and assessment during the final commissioning stages of the Carbon Nexus facility.

Industry visits

The new Carbon Nexus facility has attracted a great deal of interest, reflected in the large number of visits by industry, which average two or three per week. These visitors have included senior representation from Ford, USA, Boeing, DowAksa and Cytec.

The Carbon Nexus facility hosted many visitors in 2013 including the former Governor General, Her Excellency the Hon Quentin Bryce AC CVO.

FOCUS ON RENEWABLES LEADS TO GREEN POLYMER DEVELOPMENT

Since beginning his research as a PhD student at Deakin in 2007, Dr Nishar Hameed has worked on many different projects but bio-renewable materials have been a constant theme.

For his PhD, Dr Hameed's research focused on the self-assembly of block co-polymers for drug delivery. While doing this research he formed a successful collaboration with the Australian Nuclear Science and Technology Organisation (ANSTO) and obtained an AINSE Postgraduate Research Award.

After completing his PhD, Dr Hameed was awarded an Alfred Deakin Post-Doctoral Research Fellowship to continue this research at IFM. He was also working on another project on bio-renewable materials, using natural polymers to produce films and fibres. For this work he received a Smart Geelong Early Career Researcher award in 2010.

Dr Hameed is developing a range of flexible, formable materials from natural polymers using an environmentally friendly pathway.

These bioplastics are made from a combination of natural polymers, such as cellulose from wood pulp as well as wool, silk, and bone powders. In this process, the polymers are dissolved in liquefied salt to form solid materials such as films and fibres for potential application in food packaging, clothing and biomedical repairs.

"People use more than 100 million tons of plastics annually. These non-degradable plastics threaten the environment and use up limited fossil fuel reserves," says Dr Hameed. "Cellulose based blends and composites could also have potential application in the biomedical, electronics, automotive, aerospace and photonics sectors and spawn a self-sustaining green polymer industry."

Dr Hameed is working in collaboration with researchers at Carbon Nexus, CSIRO, ANSTO, Monash University, University of Queensland, Rice University (Texas) and the University of Cambridge.

Dr Nishar Hameed with a sample of his bio-plastic made from a combination of wool and other natural materials.

Photo: The Weekly Times.

Dr Minoo Naebe – research using high-grade composites to produce improved armour.

New materials keep soldiers safer

A research collaboration featuring IFM's Dr Minoo Naebe has been honoured by the Defence Materials Technology Centre (DMTC).

Dr Naebe and her team were presented with the Capability Improvement Award at the DMTC annual conference in March for their project on high curvature armour systems. The project is a collaboration between Deakin, VCAMM, Australian Defence Apparel, the Defence Materials Technology Centre and the Defence Science and Technology Organisation.

The project focuses on developing a suite of next generation manufacturing, materials and process technologies to deliver improved armour for Australian soldiers.

Dr Naebe's collaborative research has helped produce lighter, higher performance combat helmets using the latest ballistic grade of composite materials.

As well as the new combat helmets, Dr Naebe and her team are also developing a new generation of composite armour materials, with 'multi-hit' capability, which are formable to any shape using a simple method.

Dr Naebe and her team also received a JEC Composites Innovation Award at the international JEC composite event in Singapore in June and a Deakin International Research Development Scheme award to visit Sheffield University in UK, where she initiated a new partnership on inkjet printing of nano-composites. The aim of this project is to develop a novel method of using nanomaterials through inkjet printing and to fabricate multiscale (micro/nano) composites with improved structure and properties.

In other awards, Dr Nishar Hameed won a prestigious Victoria Fellowship to develop highly sensitive medical imaging agents which diagnose and distinguish diseased tissue from normal tissue. Dr Hameed also received a Contributing to Australian Science and Scholarship travel award.

A/Prof Fox received a Vice-Chancellor's award, Ideas category, Excellence in Research Advancement and Katrina Robertson received a Vice-Chancellor's award for Outstanding Contribution to Deakin Connectedness.

Carbon Nexus

In 2013, the carbon fibres and composites group moved "up the hill" into the new Carbon Nexus building, which houses a pilot-scale carbon fibre plant. The plant's 20 ton pilot line can manufacture industrially relevant quantities of aerospace grade carbon fibre, providing a unique facility for industry partners and a smaller research line produces fibre for researchers to study the chemical, mechanical and nano-scale characteristics of carbon fibre materials.

The first carbon fibre was produced at Carbon Nexus in November using white fibre precursor provided by an industry partner. The key areas of research for Carbon Nexus in the long term will focus on carbon fibre, composites and process engineering.

Supported by the Victorian State Government under the Victorian Science Agenda (VSA) Strategic Fund and by the Australian Government through the Education Investment Fund, the $34m centre has been developed by Deakin University and VCAMM.

Carbon fibre line.

GREEN NATURAL FIBRES

GROUP MEMBERS (STAFF)	Prof Xungai Wang, Prof Tong Lin, Dr Nolene Byrne, Dr Bruce McGregor, Dr Jingliang Li, Dr Cynthia Wong, Dr Ben Allardyce, Dr Yong Du, Dr Jian Fang, Dr Christopher Hurren, Dr Qing Li, Dr Zhenyu Li, Dr Xin Liu, Dr Maryam Naebe, Dr Haitao Niu, Dr Chuanxing Qin, Dr Rangam Rajkhowa, Dr Lu Sun, Dr Alessandra Sutti, Dr Hongxia Wang, Dr Jinfeng Wang, Dr Jing Wang, Dr Jin Zhang, Dr Yan Zhao
GROUP MEMBERS (STUDENTS)	Zengxiao Cai, Genevieve Crowle, Saeed Dadvar, Chantal Denham, Rasike De Silva, Shan Du, Linpeng Fan, Xing Jin, Jasjeet Kaur, Mehdi Kazemimostaghim, Xueyang Liu, Sepehr Moradi, Seyedeh Azam Oroumei, Esfandiar Pakdel, Amol Janardan Patil, James Preston, Sajjad Shafei, Hao Shao, Muhammad Nadeem Shuakat, Charanpreet Singh, Marinus van der Sluijs, Yao Yu, Chao Zeng, Mingwen Zhang, Hua Zhou, Licheng Zhu

The group is developing environmentally friendly ways of processing natural fibres, using natural fibres for novel applications and identifying their unique features.

Top: PhD student Jasjeet Kaur investigates the unique properties of wild silk cocoons.

Above: Visiting Swedish Surgeon Professor Magnus von Unge (seated) and ESIA director Winthrop Professor Marcus Atlas (second from the left) implant one of the silk films manufactured at Deakin into a dissected human ear canal, at the Ear Science Institute in Perth.

RESEARCH HIGHLIGHTS

In May 2013, the group hosted the Fiber Society conference in Geelong. It was the first time since the inception of the society in 1941 that the conference was held in Australia.

In June 2013, the Cotton Research and Development Corporation (CRDC) Board visited IFM. The Board had the opportunity to tour AFFRIC facilities and interacted with fibre researchers at Deakin on potential cotton related research opportunities. Subsequent to the CRDC Board visit, five preliminary research proposals were submitted to CRDC for consideration, and four of these proposals were accepted to proceed to full project proposal stage, including one large project in collaboration with CSIRO and Wuhan Textile University.

In December, the group hosted a visit of textile scientists from Russia's Central Wool Research Institute and the Moscow State University of Design and Technology. These scientists were part of a delegation developing new trade and scientific collaborations along the wool processing pipeline. As a result of these visits, the University is expected to sign formal cooperation agreements with these institutions.

This year has seen great progress in a collaborative project between AFFRIC and the Ear Science Institute Australia that aims to develop a silk-based eardrum.

Dr Ben Allardyce and Dr Rangam Rajkhowa have spent the last 12 months developing new methods to fabricate regenerated silk films with strength and flexibility to rival cartilage, which is the current graft material of choice to repair large perforations of the eardrum. Alongside the development process, the group has been laying down the framework for a TGA-approved production method that will allow for the fabrication of silk materials in upcoming human clinical trials.

They have also recently purchased a Laser Doppler Vibrometer, a first for Deakin, and are developing a novel in vitro model of the human ear canal to measure nanometer-scale vibrations at frequencies of up to thousands of times a second. The setup will be used in the coming months to measure the frequency response of the silk films in response to soundwaves, in order to produce films that better mimic the vibrations of the human eardrum.

NEW PROJECTS

Australian Wool Innovation (AWI) is funding Dr Bruce McGregor to lead a national team of scientists to identify key issues to improve the fibre quality of the Australian wool clip. Dr McGregor will also assess resources and tools for participants in the wool supply chain that could be used as part of new technical packages for Australian wool producers. Other institutions involved include CSIRO, Australian Wool Testing Authority and the NSW Department of Primary Industries.

To foster innovation in wool fibre science, AWI has also funded Dr Maryam Naebe to examine the potential application of wool in compression athletic wear. This work is highly significant in providing a strong focus for the inclusion of wool in sportswear applications.

Dr Jin Zhang.

STAFF AWARDS

Dr Jin Zhang was awarded a prestigious Australian Government Endeavour Fellowship to work at the National University of Singapore for four months to expand her expertise in biomaterials. Dr Zhang is working on an ARC Discovery Project investigating the composite structures of silkworm cocoons.

Her work explores the intriguing composite structure of the cocoons which have evolved over millions of years. A better understanding of this material will provide a solid knowledge base for bio-mimicking this structure in areas like thermal insulation and lightweight protective garments.

Dr Zhang also received the 2013 Victorian Postdoctoral Fellowship from the Department of State Development, Business and Innovation. She will use the fellowship to continue her research into the mechanisms of how silk cocoons protect wild silkworms from physical attack and extreme weather.

The fellowship will provide a valuable opportunity for Dr Zhang to visit and work in the world's most prestigious silk research organisations, including the University of Oxford, Arizona State University and Fudan University, Shanghai.

Dr Jingliang Li was awarded a prestigious ARC Future Fellowship. This four-year fellowship will allow him to develop functional fibrous materials with novel applications in light harvesting. The materials are formed by self-assembly of chromophores into fibrous structures which direct energy flow and transfer. The materials that mimic the natural light harvesting system have potential to be used as lightweight and cost-effective photovoltaic materials for light harvesting.

SCIENCE HELPS REDUCE THE DRAG

When Draggin Jeans CEO Grant Mackintosh was having trouble spreading the word about his protective jeans in the late 1990s, he decided to demonstrate how good they were by being dragged around a racetrack, sitting on the road behind a car travelling at over 100kph. He stood up and walked away, jeans and self intact. Since then, Draggin Jeans has become the world leader in denim/Kevlar motorcycle clothing.

A collaboration with IFM's Dr Chris Hurren, which began through the Victorian Government's Researcher in Business program, has enabled Draggin Jeans to improve the abrasion resistance of their product even further.

Mr Mackintosh told IFM's annual conference that although he is rigorous about ensuring his protective clothing meets European standards, he doesn't get any feedback from the European testing. This was what IFM and Dr Hurren could offer through their textile testing facilty and an abrasion testing machine purchased from Europe – the only one in Australia.

Now Dr Hurren is investigating whether the comfort of the garment can be increased by making it thinner while still meeting the abrasion standards. He is also testing the pants under different conditions, such as wet and dry roads, or wet and dry material and after a long number of wash cycles.

Through modifying the placement and types of fibres used in the protective layer, Dr Hurren has been able to almost double the abrasion resistance of the fabric. While Kevlar has five times the strength of steel on an equal-weight basis, if it is not used correctly it will provide little or no protection to the wearer. The structure of the protective layer is key to protecting riders when they slide.

Dr Chris Hurren and the abrasion testing machine.

FUNCTIONAL FIBROUS MATERIALS AND NANOFIBRES

GROUP MEMBERS (STAFF)	Prof Tong Lin, Dr Yong Du, Dr Jian Fang, Dr Haitao Niu, Dr Zhenyu Li, Dr Chuanxiang Qin, Dr Hongxia Wang, Mr Armstrong Xie, Dr Yan Zhao
(STUDENTS)	Zengxiao Cai, Esfandiar Pakdel, Charanpreet Singh, Chao Zeng, Hua Zhou, Yang Zhou

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.

IFM researchers are exploring novel properties and applications of functionalised fibres and fabrics, such as "self-cleaning" fabrics for personal protection, thermoelectric fabrics for energy harvesting, fibrous scaffolds for tissue regeneration, and liquid repellent fabrics for desalination of water.

RESEARCH HIGHLIGHTS

The group is developing novel coating technology and formulae for producing durable, functional fibres and fabrics, including:

- "self-cleaning" superamphiphobic fabrics
- directional liquid-transport fabrics
- thermoelectric fabrics for energy harvesting
- electrically-conductive fabrics
- thermally conductive/insulating fabrics
- photochromic fabrics
- fluorescent and UV-shielding fabrics
- novel fibrous materials for healthcare and biological applications
- protective materials

NEW PROJECTS

- Ever dry and self-cooling cotton fabrics, CRDC project
- Functional Innovations for Merino Wool, AWI project

NANOFIBRES

The group's nanofibre research focuses on novel functions and applications of nanofibres and developing new nanofibre production and assembly technologies. Although nanofibres are already being used commercially, their potential has not been fully explored. The group is also developing advanced electrospinning technologies for large-scale nanofibre production.

RESEARCH HIGHLIGHTS

The group is developing novel technology to prepare continuous nanofibre yarns, nanofibre nonwovens and nanofibre devices, including:

- needleless electrospinning
- nanofibre yarn electrospinning
- nanofibre piezoelectric energy harvesters
- inorganic luminescent nanofibres
- nanofibre sensors

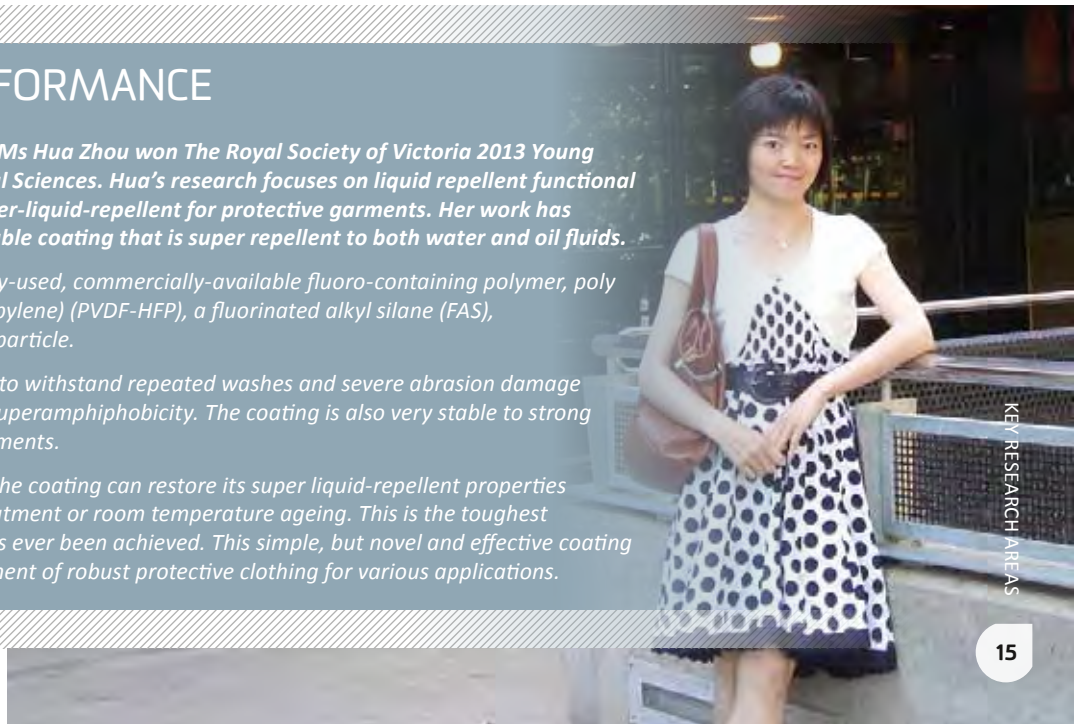
HUA'S ROYAL PERFORMANCE

One of the group's PhD students, Ms Hua Zhou won The Royal Society of Victoria 2013 Young Science Research Prize for Physical Sciences. Hua's research focuses on liquid repellent functional fabric and the applications of super-liquid-repellent for protective garments. Her work has shown a new way to achieve durable coating that is super repellent to both water and oil fluids.

The coating consists of a commonly-used, commercially-available fluoro-containing polymer, poly (vinylidene fluoride-hexafluoropropylene) (PVDF-HFP), a fluorinated alkyl silane (FAS), and a surface modified silica nanoparticle.

The coated fabrics are very robust to withstand repeated washes and severe abrasion damage without apparently changing the superamphiphobicity. The coating is also very stable to strong acid/base, ozone and boiling treatments.

Upon being damaged chemically, the coating can restore its super liquid-repellent properties simply by a short-time heating treatment or room temperature ageing. This is the toughest superamphiphobic coating that has ever been achieved. This simple, but novel and effective coating system may be useful for development of robust protective clothing for various applications.



BIOMATERIALS

GROUP MEMBERS (STAFF)	A/Prof Mark Kirkland, Dr Cynthia Wong, Dr Alessandra Sutti, Dr Marzieh Parhizkar, Dr Julie Sharp, Mrs Christina Kirkland
(STUDENTS)	Magenta Perus, Nishat Sharma

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

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

Skilling the Bay

With the help of a $500,000 grant from the Victorian State Government, a pilot-scale nanofibre facility is being constructed by local manufacturer Austeng at Deakin University. The facility will be used to produce low-cost nanofibres for filtration and other applications. It is based on the development and commercialisation of the group's novel, innovative and world-leading technology for manufacture of short nanofibres.

Initially the plant will manufacture nanofibre-functionalised filters, using the new method which has advantages of lower costs of production, greater flexibility and improved properties over current methods used to produce these high-end filters.

The new pilot facility will establish a platform technology for IFM with a plant that produces a range of short nanofibres suitable for uses in diverse industry sectors (air filtration, medical, surface coatings), as well as in very diverse research areas. Many other applications of the short nanofibres-manufacturing plant are expected to follow, along with diverse industry partnerships.

IFM and the School of Engineering will continue to be actively engaged in the project in the production, modelling, testing and analysis of fibres and the manufacture and testing of the filters.

The grant was awarded to Cytomatrix for technology transfer of Deakin University's IP. The Skilling the Bay Geelong Future Industry Project was initiated by The Gordon in partnership with the Victorian Government, Deakin University and the City of Greater Geelong.

Dr Alessandra Sutti.

RIDING THE SHORT NANOFIBRE WAVE

Dr Alessandra Sutti completed her PhD at the University of Parma in the Emilia Romagna region of Italy, in a city famous for its cheese, prosciutto, architecture and surrounding countryside. What began as a short student exchange visit to the University of Melbourne in 2006, led to a move to Australia and after a short period working in the pharmaceutical industry, a research position at Deakin. It also led to a change in her research focus from nano-materials for sensing applications to polymer nano-materials for bio applications.

Dr Sutti joined the Institute for Technology Research and Innovation in 2008, as a Research Fellow in Professor Tong Lin's group, working on nanostructured biomaterial scaffolds for cell culture. At the end of this project, she moved on to work with Professor Xungai Wang on several projects, including one to develop needle-resistant protective gloves and an AMCRC project, in collaboration with Cytomatrix Pty Ltd to develop a cord-blood stem-cell selection, using 3D scaffolds.

Dr Sutti's major achievement at Deakin is the ongoing development of a ground-breaking technique to produce short nanofibres. Seeded in 2009 under Prof Lin's supervision, this project has so far grown to include a myriad of variations and applications, attracting the interest of several Industry partners. Close collaboration with Dr Paul Collins from the School of Engineering and Dr Egan Doeven from the School of Life and Environmental Sciences has resulted in an enthusiastic multidisciplinary team of researchers furthering the short nanofibre technology and investigating its wider industrial applications. The team's most recent achievements in this field include the preparation of highly novel water-based short nanofibres, and the $500,000 Victorian State Government grant (Skilling the Bay) to the group's Industry partner Cytomatrix Pty Ltd, to develop short nanofibre production capabilities for the filtration Industry.

As a diver used to the warm waters of the Mediterranean, Dr Sutti finds the water in her new home at Torquay rather cold and the current quite strong, but when it comes to her research she has no such fears.

METALLIC BIOMATERIALS

GROUP MEMBERS (STAFF)	Prof Peter Hodgson, Dr Yuncang Li, Dr Cynthia Wong, Dr Ming Wen, Dr Jun Liu
(STUDENTS)	Keivan Alhoeinazari, Yunfei Ding, Dolly Mushahary, Alireza Vahidgolpayegani, Yu Wang, Dongmei Zhang

The metallic biomaterials team at IFM is dedicated to developing novel metallic biomaterials and biocompatible modified surface technology with the aim of reducing costs and improving longevity.

RESEARCH HIGHLIGHTS

Titanium and its alloy scaffolds

New biocompatible titanium alloys/composites have been developed for bear-loading implant materials. TiTaAg and TiNbAg alloys not only show appropriate mechanical properties for bear-loading implant materials but also excellent biocompatibility and anti-bacterial characteristics. Ti/SiO_2, Ti/ZrO_2, $TiNb_2O_5$ and Ti/SrO composites exhibit high strength with advanced biocompatibility and provide appropriate strength when they are scaffolded at high porosity.

Biodegradable magnesium alloys

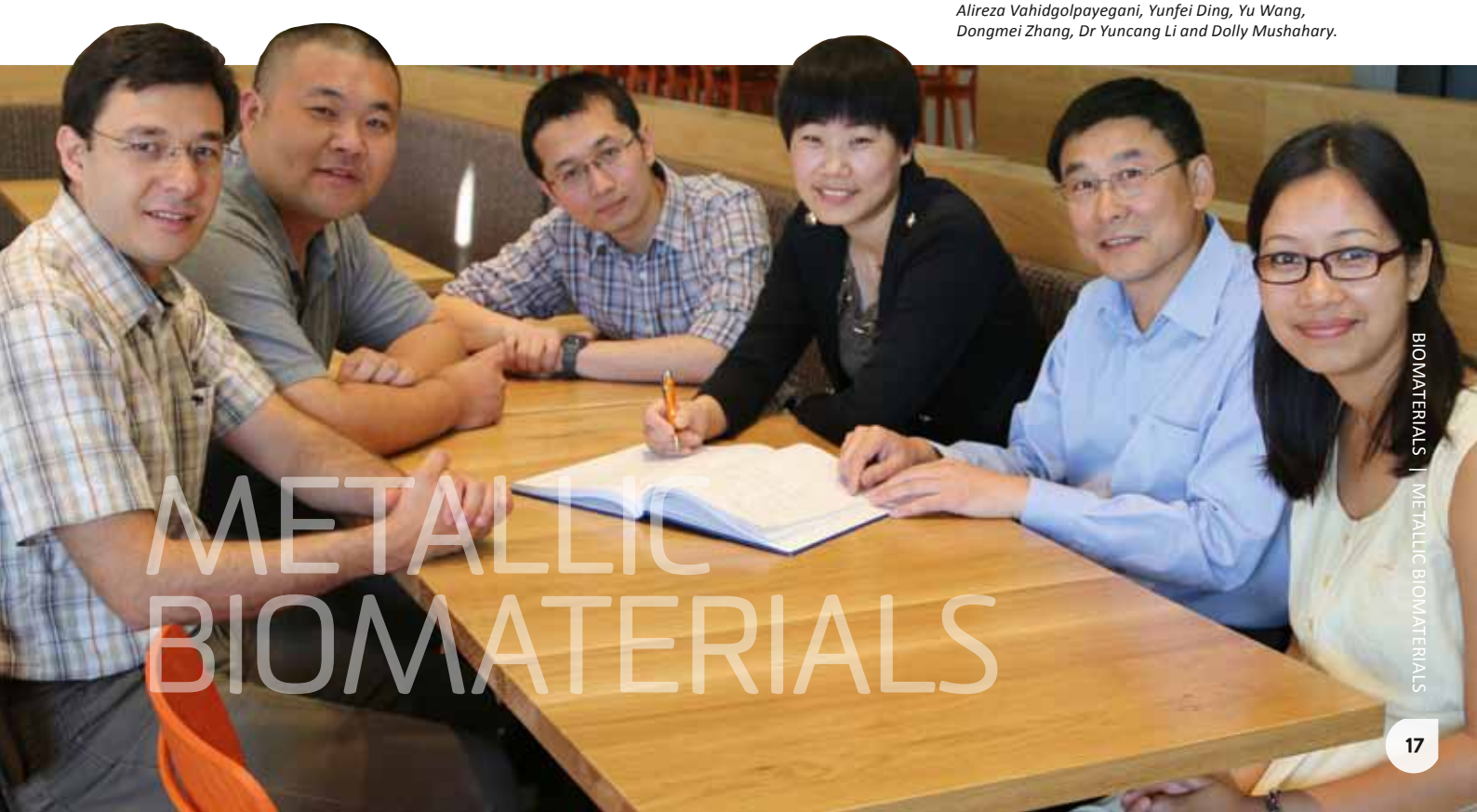
A newly developed series of biocompatible and biodegradable magnesium-zirconia-strontium (Mg-Zr-Sr) alloys with rare earth elements have been developed as new bone implant materials. We have identified that both Zr and Sr are biocompatible Mg alloying elements and both Zr and Sr have a positive impact on the mechanical and biological properties of Mg-Zr-Sr alloys.

EVENTS AND PUBLICATIONS

Fourteen peer reviewed papers were published in high impact factor journals. The result from one of these papers was selected as a cover page in the *Journal of Materials Chemistry A*. Dr Yuncang Li attended the 4th International Conference on Recent Advances in Composite Materials as a guest speaker to deliver a keynote lecture and the 3rd China-Australia Symposium on Biomaterials and Medical Devices Manufacturing Technologies as an invited speaker.

Ms Dolly Mushahary was awarded best poster presentation in the 11th NJ Symposium on Biomaterials Science for her poster titled *"Bioactive scaffolds – from the nano to the macro scale".*

Members of the metallic biomaterials team: Alireza Vahidgolpayegani, Yunfei Ding, Yu Wang, Dongmei Zhang, Dr Yuncang Li and Dolly Mushahary.



MOLECULAR MODELLING AND SIMULATION

GROUP MEMBERS (STAFF)	A/Prof Tiffany Walsh, Dr Pablo Palafox-Hernandez, Dr Zak Hughes
(STUDENTS)	Aaron Brown, Kurt Drew, Anas Sultan, Andrew Church

RESEARCH HIGHLIGHTS

Our collaborative project with Buffalo and Miami Universities, funded by the Air Force Office for Scientific Research (AFOSR) in the US was featured both on ABC News TV and on the Channel 10 program SCOPE. The project is pioneering ways to make 3D assemblies of nanaoparticles using biomolecules, by taking inspiration from nature, such as the bio-inorganic nanostructure of mother-of-pearl. The AFOSR is interested in how the technology could be used to manipulate light, potentially making aircraft invisible to their enemies.

NEW PROJECTS

Associate Professor Tiffany Walsh is part of a new ARC Discovery Project to develop a fundamental understanding of the interfaces within carbon fibre composites and optimise their behaviour via model-guided surface and interface engineering.

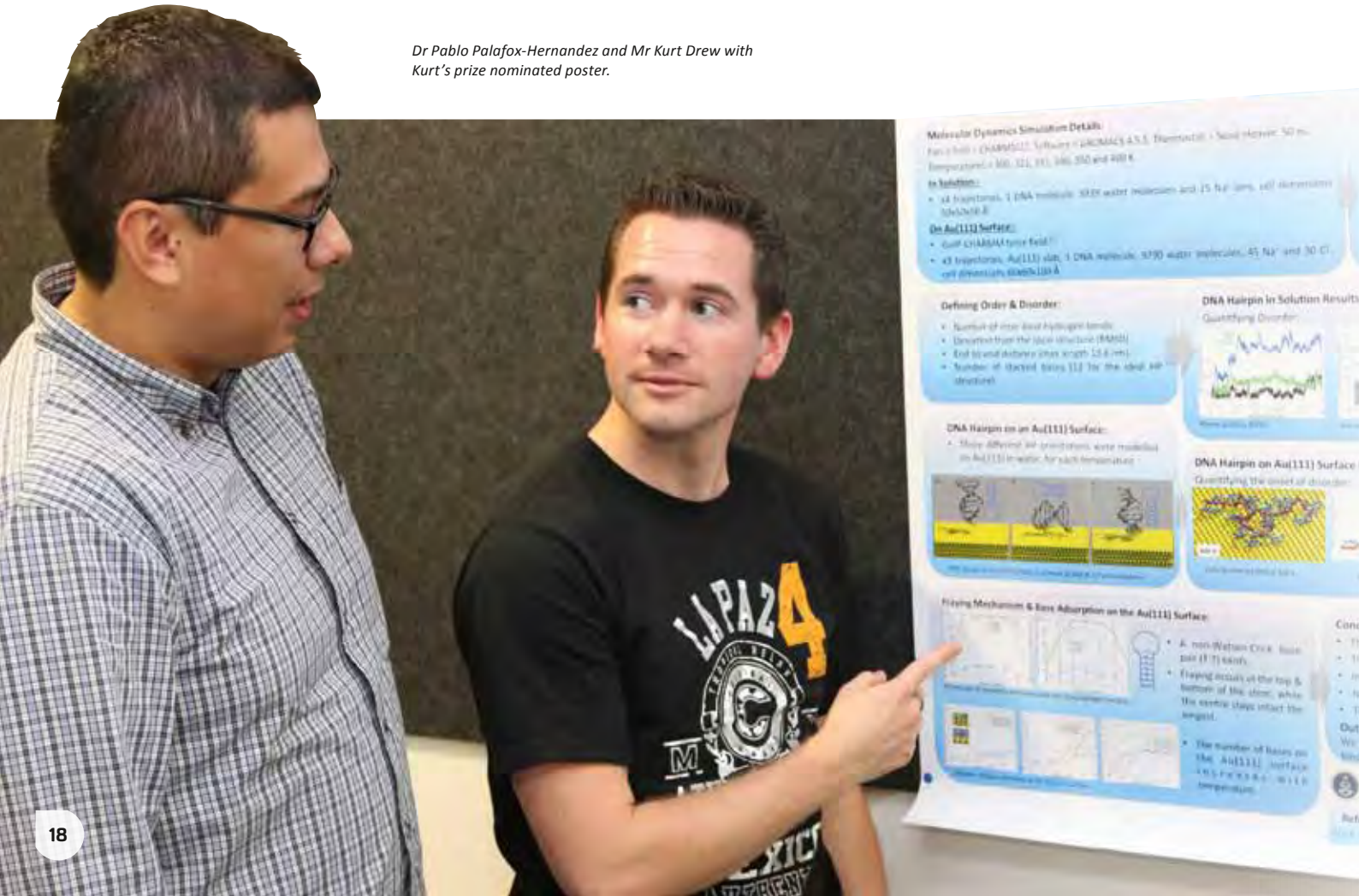
STAFF AWARDS

Research Fellow Pablo Palafox-Hernandez won the prize for the best oral presentation at the Materials Research Society meeting in Boston, for his presentation on *'Towards an atomistic understanding of binding principles for gold-binding peptides'*. At the same meeting, PhD student Mr Kurt Drew was nominated for the Best Poster prize for his poster on *'Atomistic modelling of a DNA-hairpin at the aqueous Au(111) interface'*.

PUBLICATION HIGHLIGHTS

Z. Tang, J. P. Palafox-Hernandez, W. C. Law, Z. E. Hughes, M. T. Swihart, P. N. Prasad, M. R. Knecht and T. R. Walsh, ACS Nano, 7, 9632-9646 (2013). *"Biomolecular Recognition Principles for Bionanocombinatorics: An Integrated Approach to Elucidate Enthalpic and Entropic Factors"*

Dr Pablo Palafox-Hernandez and Mr Kurt Drew with Kurt's prize nominated poster.



NUMERICAL MODELLING AND DESIGN OF MATERIALS FOR LIGHTWEIGHT STRUCTURES

GROUP MEMBERS (STAFF)	Prof Jeong Yoon, A/Prof Bernard Rolfe, Dr Michael Pereira, Dr Tim de Souza, Dr Joseba Mendiguren, Dr Yanshan Lou
GROUP MEMBERS (STUDENTS)	Ahmad Moghadam, Akbar Abvabi, Amir Abdollahpoor, Idalina Alcantara Pinto Martins, Jingsi Jiao, Klaus Fiedler, Mariana Paulino Santos, Ossama Badr, Paul Souza, Pushpakumar Sugirtharaj, James Raggatt

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 team led by Associate Professor Bernard Rolfe was part of a successful bid for a Science and Industry Endowment Fund (SIEF) project to manufacture a small demonstrator aero-engine entirely through additive manufacturing. Deakin's role is based on developing viable weight optimised designs for 3D printing. The project, funded for a total of $4 million over four years will formally begin in 2014. Deakin will receive $600,000 for research and $240,000 to support two PhD students.

The group is also part of a successful proposal for the establishment of a $4 million ARC Industry Transformation Research Hub (ITRH) for transforming Australia's manufacturing industry through high-value additive manufacturing.

Professor Peter Hodgson will lead Deakin's contribution to the Additive Manufacturing ITRH over the next six years, alongside ITRH Director, Professor Xinhua Wu of Monash University.

The ITRH will provide two post-doctoral research fellows and two PhD students. We will provide research on novel alloy powder development, microstructure and thermal treatment knowledge, as well as developing novel weight optimisation routines.

Following on from the success of the team led by Prof Hodgson for an ARC LIEF grant for a flexible roll forming facility for low-cost, lightweight applications, we are negotiating with international software developer dataM. They have agreed to set up a cutting edge line, which will provide them with a potential partner to conduct prototyping studies (to help fund a more advanced line), alongside our research work.

One of our researchers, Ossama Badr, went to Postech Korea to utilise the specific cutting edge material characterisation equipment, in the second half of 2013.

We continue to work on our collaboration with Mondragon University in the Basque region of Spain and have written several joint papers with our colleagues there.

Ford's Manager University Programs, Richard Taube and Associate Professor Bernard Rolfe get together at IFM's annual conference.

CORROSION RESEARCH CENTRE

Corrosion research at IFM targets desalination and water infrastructure, oil and gas refining and production, defence and aerospace, mining and power industries.

In 2013, the corrosion group became the Deakin Corrosion Research Centre – a centre for research in corrosion engineering and surface sciences. The centre is dedicated to a flexible approach towards research and development in a wide range of areas, including infrastructure durability, materials and alloy development, corrosion monitoring and prevention, biocorrosion, and coatings and inhibitors for surfaces and interfaces.

The group's participation in the Energy Pipelines CRC (EPCRC) has been a success. At its meeting in September the EPCRC Board praised the enthusiasm of the Deakin research team and the high quality and relevance of the science they presented. The CEO, Professor Valerie Linton said the ability of the team to get such an impressive program of work up and running in the space of a year was amazing. *(See EPCRC report on page 40).*

GROUP MEMBERS (STAFF)	Prof Maria Forsyth, Prof Mike Yongjun Tan, Prof Bruce Hinton, Dr Patrick Howlett, Dr Daniel Fabijanic, Dr Jianyu Xiong, Dr Dang Nam Nguyen, Mr Davi Abreu, Dr Rajeev Gupta, Ms Sara Abdi Kheibari, Dr Timothy Khoo
GROUP MEMBERS (STUDENTS)	Infant Gabriel Bosco, Peipei Huang, Rainier Catubig, Yafei Zhang, Facundo Varela, Ying Huo, Reza Parvizi, Faribra Mahdavi, Shyama Ranade, Phillip Wyld, Yuhao Luo, Chao Zeng, Yunfei Ding, Dolly Mushahary, Minto Porinchu, Aifang Wei

PhD student, Mr Facundo Varela is testing a new corrosion sensor in the field.

Commissioning of the new National Facility for Pipelines Coating Assessment

From June to December, work was underway commissioning the new National Facility for Pipelines Coating Assessment ready for its opening in early 2014. 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.

New corrosion sensor

We are developing a novel sensor to detect pipeline corrosion, which shows great potential as an effective way to detect and prevent corrosion in underground pipelines. The sensor takes advantage of the features of pipeline coatings to perform electrochemical corrosion rate measurements. The Energy Pipelines CRC is supporting development of the sensor, which simulates the conditions occurring at typical corrosion defects and measures corrosion rates electrochemically. The sensor can check remotely every day and identify localised corrosion in its early stages. Testing in the laboratory has given good results and in 2014 the probe will be tested on pipelines in the field.

Australian Centre for Infrastructure Durability (ACID)

Planning for a new research centre began in 2013. The Australian Centre for Infrastructure Durability (ACID) will be a national centre that brings together corrosion/durability researchers to carry out industry-focused, large-scale research projects. The centre is expected to be launched in September 2014.

NEW PROJECTS

- Stress corrosion cracking of pipeline materials – EPCRC project led by Dr Daniel Fabijanic
- Investigation of lightning damage of energy pipelines – EPCRC scoping study led by Professor Alex Stojcevski

OUTSTANDING RESEARCH HONOURED

Professor Maria Forsyth won the prestigious Corrosion Medal, awarded by the Australian Corrosion Association (ACA). The medal is bestowed for outstanding scientific or technological work in the field of corrosion in Australasia and recognises Prof Forsyth's internationally significant contributions to the field of electromaterials science. Since joining Deakin University in 2010 Prof Forsyth has established the University's major programs in corrosion research and teaching.

Mike Tan was promoted from the level of Associate Professor to Professor.

ELECTROMATERIALS AND ENERGY

GROUP MEMBERS (STAFF)	Prof Maria Forsyth, Prof Tony Hollenkamp (Honorary), Dr Patrick Howlett, Dr Jenny Pringle, Dr Matthias Hilder, Dr Cristina Pozo-Gonzalo, Dr Fangfang Chen, Dr Jaka Sunarso, Dr Timothy Khoo, Shveta Pandiancherri
GROUP MEMBERS (STUDENTS)	Gaetan Girard, Tristan Simons, Cameron Pope, Tarekegn Yarimo, Yajing Yan, Nahid Iranipour, Yogita Oza, Lane MacDonald, Anthony Somers

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

IFM students Anthony Somers, Gaetan Girard and Peipei Huang catch up at the IFM annual conference.

Our research into new materials seeks to enable new device chemistries, such as metal-air or sodium-based batteries, or 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.

FUNDING SUCCESS FOR ELECTROMATERIALS RESEARCH

The year 2013 finished on a high note for our group with the announcement of a new ARC Centre of Excellence for Electromaterials Science (ACES). The new centre, which will be a collaboration between six Australian universities with five new international partner organisations, will build on the significant achievements of the first ACES. The centre received $25 million in funding over seven years for the development of work on smart nano-materials to create 3D devices with advanced capabilities.

ACES will particularly draw on Deakin's work in the energy field, notably through the discovery of new materials and the understanding of charge transfer mechanisms and associated effects on material properties.

NEW PROJECTS

Organic ionic plastic crystals for energy devices

A team comprising Dr Patrick Howlett, Dr Jenny Pringle, Dr Wren Greene and Professor Michel Armand (CIC Energigune) was awarded a new ARC Discovery project to begin in 2014. The project will address the need for improved technologies to allow the efficient production of energy from sustainable sources and for storing energy in safe, stable devices that allow high rates of storage and release. The project will design and characterise novel solid state electrolyte membranes composed of plastic crystals and polymer nanofibres. These materials will have enhanced physical and electrochemical properties, yielding advanced thin film membranes for application in a range of energy production and storage technologies.

Innovative 3D battery composed of woven cathode and anode fibres

A team led by Dr Cristina Pozo-Gonzalo received funding from Deakin's Central Research Grants Scheme to develop an innovative and safe 3D flexible battery composed of woven interconnected electrode fibres using novel weaving technologies and materials.

The project will be carried out in the first half of 2014.

ELECTROMATERIALS AND ENERGY

CONTINUED ...

Professor Maria Forsyth.

MARIA'S MENTORSHIP RECOGNISED

Professor Maria Forsyth was a Eureka Prize finalist in the category of Outstanding Mentor of Young Researchers.

The nomination recognises Prof Forsyth's commitment to providing a dynamic, multidisciplinary and supportive research environment for graduate students. Over the past 10 years she has had more than 30 PhD students and 16 postdoctoral researchers and visiting young researchers working with her.

With her mentoring and support, five of these researchers have gone on to earn their own Australian Postdoctoral Fellowships, Dr Jenny Pringle was awarded a QEII Fellowship, Dr Bjorn Winther-Jensen was awarded a Future Fellowship and recently Dr Wren Greene received an ARC Discovery Early Career Researcher Award.

"I sincerely believe that my role as a research scientist and in particular as an academic, is not only in the creation of new knowledge through my research activities, but also the nurturing and training of knowledge creators; our younger students and early career researchers who will be the next generation of scientists that will contribute to solving societal challenges," Prof Forsyth said.

NANOTECHNOLOGY AND ENERGY STORAGE

GROUP MEMBERS (STAFF)	Prof Ying (Ian) Chen, Dr Alexey Glushenkov, Dr Weiwei Lei, Dr Luhua Li, Dr Dan Liu, Dr Md Mokhlesur Rahman, Dr Tao Tao, Robert Lovett
GROUP MEMBERS (STUDENTS)	Qiran Cai, Deepika Deepika, Srikanth Mateti, Si Qin, Thrinathreddy Ramireddy, Olga Kartachova, Tan Xing, Md Mahedi Hasan Bhuiyan, Mengqi Zhou

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

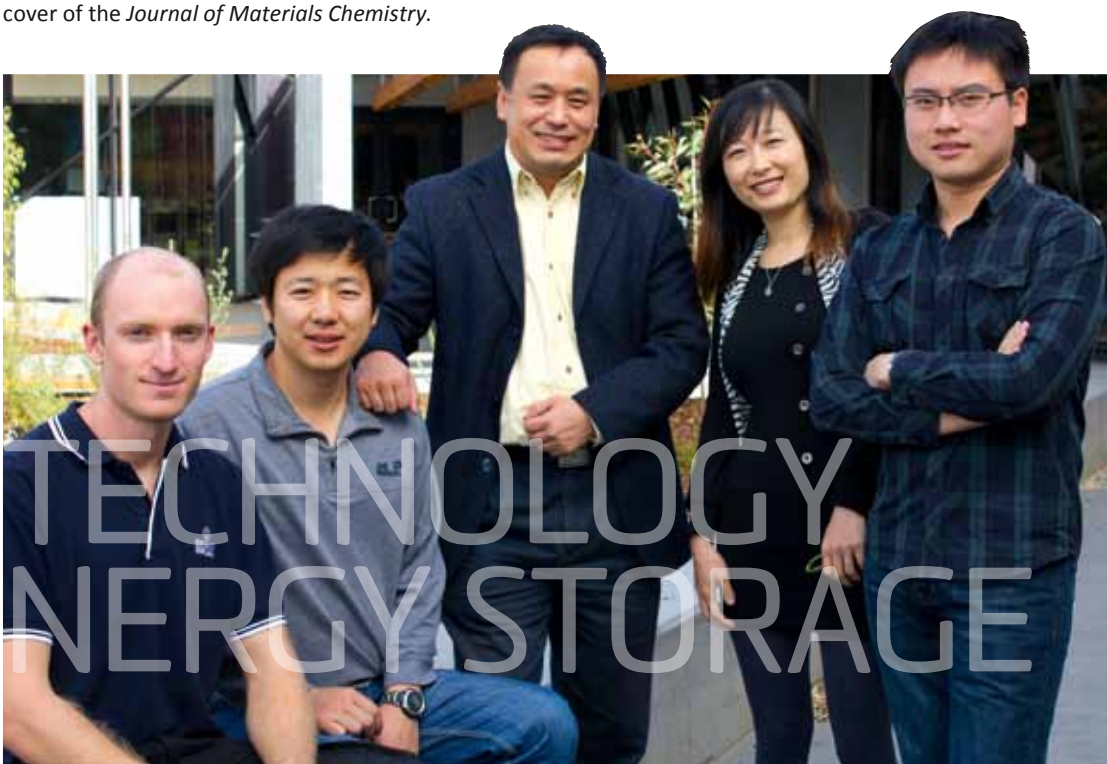
The group's work on the synthesis of novel B-C-N nanomaterials showing enhanced electrochemical performance compared to bulk B-C-N materials and graphite were published in *Chemical Communications* and selected as the cover story for the journal.

The group's research on porous boron nitride nanosheets for effective water cleaning received extensive media coverage and was the subject of numerous enquiries from industry following publication in *Nature Communications*. The new material has a high surface area, super-hydrophobicity, high selective absorption and adsorption capacities for oils, organic solvents, dyes and hydrogen, all properties which make it suitable for cleaning contaminated water. Another advantage is that the saturated BN nanosheets can be cleaned for reuse by simply burning or heating in air due to their strong resistance to oxidation.

Research by PhD student Olga Kartachova on the use of bimetallic tungsten molybdenum oxynitride for electrochemical supercapacitors was highlighted on the cover of the *Journal of Materials Chemistry*.

The group has synthesized an intriguing new form of boron nitride nanomaterials, known as nanoribbons, using a one-step, in-situ unzipping method. New optical properties have been discovered from these nanomaterials. This work, carried out in collaboration with the National Synchrotron Radiation Research Center in Taiwan was published in *Angewandte Chemie International Edition* and selected as a 'hot paper' by the editor.

In pioneering research, Dr Md Mokhlesur Rahman has achieved the preparation of nanocomposite architecture of Fe_2O_3-SnO_2-C anode for lithium-ion battery by combining a molten salt precipitation process and a ball milling method for the first time. In this research, he has demonstrated that low-energy ball milling with a dominating shear action is an excellent technique for spreading small clusters of oxide nanoparticles along the chains of Super P Li carbon black. The results of this research have been published in *Nanoscale*.



The boron nitride nanosheet team (L to R): Mr Rob Lovett, Dr Weiwei Lei, Professor Ying (Ian) Chen, Dr Dan Liu and Mr Si Qin.

NANOTECHNOLOGY AND ENERGY STORAGE

BORON NANOTUBE BREAKTHROUGH

Dr Weiwei Lei is a key member of the team whose ground-breaking research on boron nitride nanosheets was published in Nature Communications in 2013. The work has attracted worldwide interest for its potential application as an efficient and environmentally friendly method of cleaning oil spills.

The nanosheets could quickly and easily soak up floating oil – and do it over and over again using the same material, explains Dr Lei. He says the nanosheets could revolutionise oil spill clean-ups and water purification.

"The effective removal of oils, organic solvents and dyes from water is of significant, global importance for environmental and water source protection," says Dr Lei who received a 2013 Smart Geelong Early Career Researcher award for this pioneering research.

"What we have developed is unique and has enormous potential on the global market," he says. The material has other applications, e.g. for clean energy storage and as high temperature solid lubricants and ultraviolet light emitters.

Dr Lei came to Deakin from the Max Planck Institute of Colloids and Interfaces in Germany in 2011 when he was awarded an Alfred Deakin Postdoctoral Research Fellowship to work with Professor Ying Chen's nanotechnology group.

With his new ARC Discovery Early Career Researcher Award, which commences in 2014, Dr Lei will continue research on boron carbon nitride nanosheets for energy storage applications. The expected outcomes include a new class of light and safe electrode materials, new production techniques and high-performance batteries.

NEW PROJECTS

New electrodes for sodium-ion batteries – Dr Md Mokhlesur Rahman is investigating nanomaterials of oxides as well as materials based on the elements that alloy with sodium. The research is being supported by a 2013 Deakin CRGS grant.

A team led by Dr Alexey Glushenkov secured an IFM small grant as seed funding for a reaction mechanism study in electrode materials of batteries using transmission electron microscopy and nuclear magnetic resonance.

Synthesis, characterization and application of boron nitride nanotube aerogels were conducted by Dr. Luhua Li and Prof Chen for increasing energy efficiency, environmental protection and improving public health. The project was sponsored by Dr Li's Alfred Deakin Postdoctoral Research Fellowship and the University Research Equipment Support Scheme.

Dr Weiwei Lei was awarded a Discovery Early Career Researcher Award (DECRA) for research on synthesis of boron nitride nanosheets with tuneable carbon contents to provide new electrodes of lithium ion batteries with improved capacity, rate capability and cycling stability.

Dr Lei is also leading a team investigating the synthesis of porous BN nanosheets and 3D BN foam for effective water cleaning. This research is supported by a University CRGS grant.

Phosphate polyanion based cathode materials for sodium-ion batteries. This project intends to identify suitable materials for effective use as a cathode for Na-ion batteries. Dr Md Mokhlesur Rahman will focus on a series of phosphate polyanion based cathodes of $NaFePO_4$/C, $NaVPO_4F$/C, Na_2FePO_4F/C, and $NaFe_2Mn\ (PO_4)_3F$/C for potential application in sodium-ion batteries.

STAFF AWARDS

- ARC Discovery Early Career Researcher Awards (DECRA) were awarded to Dr Weiwei Lei and Dr Zhi Xu.
- Dr Alexey Glushenkov was awarded a 2013 France-Australia Science and Technology Collaboration ECR Fellowship from the Australian Academy of Science. The award is aimed at establishing collaborative activities with French institutions.
- Dr Glushenkov was awarded a 2014 Australia Awards Endeavour Research Fellowship. The fellowship will allow him to work at Drexel University in 2014 and strengthen the collaboration between Deakin and Drexel in the area of electrochemical supercapacitors.
- Dr Weiwei Lei was awarded a 2013 Vice-Chancellor's Early Career Researcher award and the 2013 Early Career Researcher in the Smart Geelong awards for his work on boron nitride nanosheets.
- Dr. Luhua Li was awarded an Alfred Deakin Postdoctoral Research Fellowship.
- Dr Glushenkov was awarded a Technology Fellowship from Melbourne Centre for Nanofabrication (MCN). The award will allow him to establish a research program at the facility using the excellent equipment and instrumentation available at MCN. His research project is focused on preparation and modification of electrode materials by atomic layer deposition.
- Ms Olga Kartachova has submitted her PhD thesis.

METALS

GROUP MEMBERS (STAFF)	Prof Peter Hodgson, A/Prof Tim Hilditch, A/Prof Bernard Rolfe, Dr Nicole Stanford, Dr Shokoufeh Malekjani, Dr Matthias Weiss, Dr Michael Pereira, Dr Erik Pavlina, Dr Ilana Timokhina, Dr Hossein Beladi, Dr Daniel Fabijanic
GROUP MEMBERS (STUDENTS)	Amir Abdollahpoor, Buddhika Abeyrathna, Akbar Abvabi, Ossama Badr, Qi Chao, Desinghe Gangoda, Jingsi Jiao, Andreas Kupke, Jascha Marnette, Ahmad Moghadam, Akbar Mostaani, Balaji Trichy Narayanaswamy, Debasis Poddar, Khushboo Rakha, Shahriar Reza, Vadim Shterner, Kongalage Ubhayaratne

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

PhD student Andreas Kupke uses the Instron mechanical tester to perform tensile tests.

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.

Roll forming and stamping research

Roll forming is an important metal forming technology in Australia. The demands for shorter lead times, more complex shapes, new high strength materials and more demanding markets such as the automotive industry, require an improved understanding of the forming process and the increased application of virtual engineering at the design stage.

ARC LIEF funding of $700,000 awarded to the group will establish at IFM, the world's most advanced flexible roll forming facility. It will be the first in the world to allow the roll forming of high strength steel components that are variable in height over the length of the part; this promises significant potential for applications in automotive and aerospace.

The group has further been awarded one Ford University Research Project ($120,000) and one Hubei Province Key Technological Innovation Project ($90,000) both focusing on the flexible roll forming of high strength automotive components for structural and crash applications.

A stand-alone bend tester complete with specialised user software has been finalised. The equipment will enable the analysis of material property variation from coil to coil in an industrial environment with major focus on material parameters important to the roll forming process. This combined with the current research performed by the group on the development of inline process control and shape compensation routines represents a vital step towards a "smart roll former".

Understanding steel behaviour

The development of modern steels is based on tailoring of the microstructure to achieve the required properties. While, historically this was performed at the micro-meter scale length, there is now scope to undertake this at nano-scale or atom scale. The group study is related to the development of ultrafine and nano-scale microstructures in steel as well as changes at shorter scale lengths, such as cluster formation and solute effects. This includes the development of ultrafine ferrite through phase transformation, nano-scale and ultrafine bainite, precipitation and cluster strengthening and bake hardening of steels.

We strengthened our collaboration with Oak Ridge National Laboratory, USA through Professor Michael Miller. Prof Miller, who is recognised as an international leader in the field of atom probe field-ion microscopy and atom probe tomography, visited IFM in May 2013 and gave three lectures on advanced microscopic techniques for the Australian scientific community.

A team led by Dr Nicole Stanford was awarded an ARC Discovery Grant of $800,000 for the strip casting of advanced high strength steels.

METALS

Technical officer David Gray, completes a dip of strip cast.

LIGHT METALS

GROUP MEMBERS (STAFF)	Prof Matthew Barnett, Dr Aiden Beer, Dr Alireza Ghaderi, Dr Zohreh Keshavarz, Dr Peter Lynch, Dr Sitaramu Raju Kada, Mohan Setty, Dr Xiaokai Hu
GROUP MEMBERS (STUDENTS)	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

This year saw the light metals team branching out into new areas to reflect the changing manufacturing landscape in Australia.

RESEARCH HIGHLIGHTS

Significant outcomes include the development of a new design framework for shape memory actuated carbon fibre composites. The actuating components of these novel composites are shape memory titanium and nickel based metal wires. The core of the novelty of the development is a new mathematical model for actuation that was developed using the team's expertise in metal microstructure.

In the past year the group published the first of a series of publications that will come out over the next few years on a method for developing *'the common man's thermoelectric'*. Thermoelectric materials generate electrical power from waste heat but are typically expensive, difficult to manufacture and comprised of toxic materials. The common man's thermoelectric being developed by the group is based on recycled magnesium alloys, readily available doping agents and metallurgical mass production type processing.

The light metals team also discovered a new method for processing titanium billets. The work, which is being patented, involves a novel solution for the breakdown of the coarse structure produced during casting. The invention promises to reduce processing times and increase the longevity of components by raising fatigue and fracture resistance.

Also in 2013, Professor Matthew Barnett undertook visiting professor placements at the University of Manchester for three months and the University of Lorraine (Metz) for five months. Key outcomes of the sabbatical included a new mathematical model for deformation twinning in magnesium alloys and a range of new collaborations with European scientists.

Exchange of students has commenced with the University of Manchester and new projects have begun with Max Planck Institute in Dusseldorf and Georgia Tech in Metz.

The light metals team.

CONTINUED ...

Aluminium extrusion profiles are manufactured at IFM, using a 300T horizontal extrusion press.

NEW PROJECTS

Prof Barnett was awarded an ARC Discovery Grant for a collaborative project with the University of Virginia, US for a project to reduce fuel consumption by weight reduction, using magnesium. The project aims to address magnesium's common failure mechanism, known as deformation twinning. Better understanding of twinning is needed to enhance performance and give automotive makers confidence to use magnesium more widely.

Prof Barnett and his colleague Professor Sean Agnew at Virginia University have recently found evidence that a key missing part of the puzzle is the role of plastic relaxation. The proposed work will use this idea to develop a new fundamental understanding of twinning using novel in-situ diffraction and modelling techniques.

Prof Barnett and team were also successful in their Linkage Infrastructure, Equipment and Facilities (LIEF) grant for a state of the art high temperature nano-indenter. The unit will be the only one in Australia with this capability and will allow the team (a collaboration with The University of New South Wales, the University of Queensland, University of Wollongong and CSIRO) to be among the first in the world to apply this technique to the development of new materials with superior processing performance.

An exciting new collaboration was begun with an innovative Bendigo based company: Keech Castings. The work is aimed at developing new steel grades for excavator teeth used in the mining industry and a Victorian Government equipment grant was secured to develop wear testing capability directly applicable to Australia's tough mining conditions.

STAFF AWARDS

Mohan Setty received a Vice-Chancellor's Professional Staff Development Award which he will use to undertake a course on mechanical testing of metals at ASM Headquarters, Ohio, USA in 2014.

MICRO AND NANO SYSTEMS

GROUP MEMBERS (STAFF)	Prof Lingxue Kong, Dr Mary She, Dr Weimin Gao, Dr Sugumar Dharmalingam, Dr Zheng Peng, Dr Ludovic Dumée, Dr Leonora Velleman, Dr Li He
GROUP MEMBERS (STUDENTS)	Bao Lin, Chengpeng Li, Chunfang Feng, Feng An, Francois-Marie Allioux, Guang Wang, Lijue Chen, Tahir Ghandoori, Weiwei Cong, Xiangping Sun, Xiaowei Dong, Xiaodong She, Xinchu Zhao, Yanan Lv, Yongzhen Li, Youhai Qiu, Yuanyuan Guo, Zhifeng Yi

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

Scattering technology for material characterisation

The characterisation of materials used for micro and nano systems has been significantly enhanced through a strategic partnership with the Australian Nuclear Science and Technology Organisation (ANSTO) and the Australian Synchrotron.

The first ANSTO-Deakin scattering workshop was held with the aim of broadening our fundamental understanding of material properties by taking advantage of the world class facilities at ANSTO and the Australian Synchrotron. This partnership has led to excellent access to beam time at both ANSTO and the Synchrotron on SANS, SAXS, high resolution FTIR, and gamma ray irradiation.

The application of these advanced characterisation technologies to our materials has resulted in the publication of a number of scientific papers in leading materials journals.

Dr Ludovic Dumée.

RECOGNITION OF STELLAR YOUNG SCIENTISTS

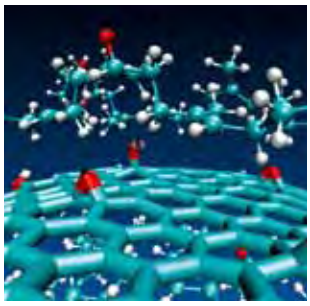
Dr Ludovic Dumée has been recognised in the 2013 Victorian Young Achiever Awards. Dr Dumée was a finalist in the BASF Science and Technology Award.

In his new role as a research fellow at Deakin his work is focussed on gas separation and water desalination. Dr Dumée has worked for more than five years in separation science across a variety of purification systems (membrane distillation, nano-filtration, electro-dialysis, reverse osmosis). He previously worked on carbon nanotube membranes for fast vapour transport and on nano-lithography techniques based on X-ray irradiation to pattern carbon nanotube surfaces. A materials engineer who enjoys working on multi-disciplinary projects he is currently investigating routes to fabricate nano-porous metal membranes by de-alloying, metal nano-fibre spinning, nano-particle electrical sintering and metal functionalised block co-polymer self-assembly.

Although primarily interested in nano-separation, Dr Dumée has also worked on flexible electronics devices fabrication, graphene interface chemistry and advanced composite materials.

***

***Ms Xiaodong She's research into mesoporous silica nanoparticles** has earned her well-deserved recognition at the 4th Conference of the Australia-Chinese Association for Biomedical Sciences Inc in Hangzhou, where she won first prize for her presentation on self-assembly synthesis of hollow mesoporous silica nanoparticles for colon targeting drug delivery systems.*



Self-assembly of oxidized natural rubber with oxidized graphene.

Molecular dynamics simulation

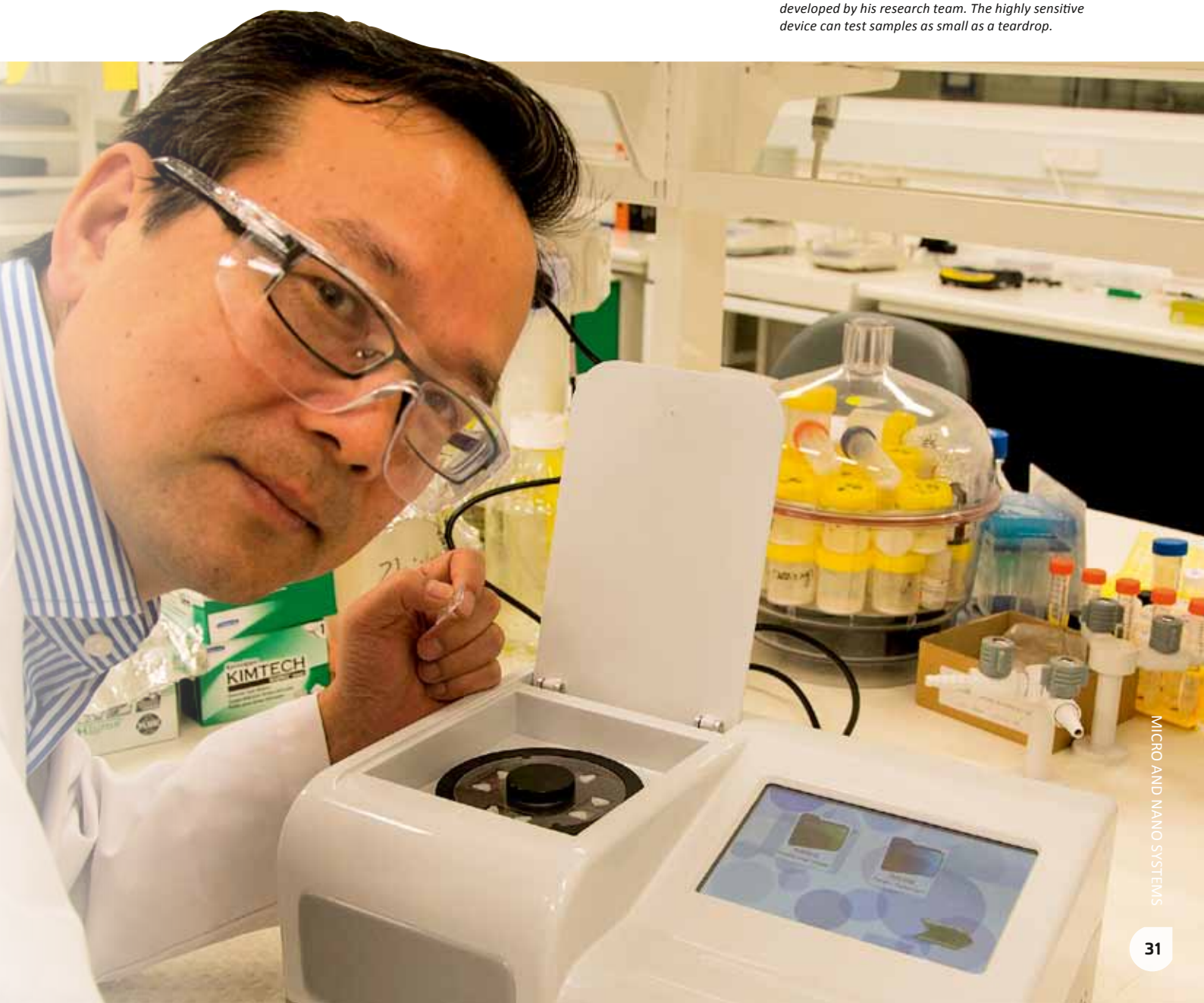
Molecular dynamics is used for the development of new materials and to explain and predict the process of materials synthesis. The group is working in a number of areas including nanofluids for energy management, organic and inorganic membranes for water treatment, applications of graphene, nanofibre generation and natural rubber composites.

Molecular diagnostics

Point-of-care diagnostic technologies with high sensitivity and specificity that can be promptly implemented will be critical to attack outbreaks of infectious diseases such as H1N1 and SARS.

The molecular diagnostics technology developed at IFM manipulates reactions at the molecular level using micro-scale technology. By significantly reducing the amount of reagent and samples used in the tests, the detection time is significantly shortened for major diseases.

Professor Lingxue Kong with the diagnostic device developed by his research team. The highly sensitive device can test samples as small as a teardrop.



PLASMA RESEARCH

GROUP MEMBERS (STAFF)	Dr Jane Dai, Dr Peter Lamb, Dr Abu Sadek, Robert Lovett, Marion Wright
GROUP MEMBERS (STUDENTS)	Gayathri Devi Rajmohan, David Rubin de Celis Leal, Sri Balaji Ponraj, Zhiqiang Chen, Tariq Mehmood, Yang Choon Lim, Md Saiful Islam, Ailan Wan, Haiying Chen

Plasma is present in lightning, auroras, fluorescent lamps and TVs. It is also an exciting new way of shaping materials for scientific and industrial applications.

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

NEW PARTNERSHIPS

The group has formed a number of new partnerships with industry, including:

- Delaminating Resources Pty Ltd for research to develop a novel plasma coating technology for delamination and re-lamination of defective or end of commercial life glass laminates.
- Godfrey Hirst – for a preliminary study for carpet backings.
- Indian Oil – for collaboration on 'Plasma surface functionalization of nanoparticles' and 'Plasma technology for solar cells' through a PhD project and also through short-term visits by Indian Oil research staff to work in the Plasma research facility.

LINKS

During her academic study leave, Dr Jane Dai established collaboration with internationally leading plasma groups which will result in student and staff exchanges over the coming months. Berkeley, University of California, USA; Bari University, Italy (a MOU signed between Deakin and Bari University); The Queen's University, UK, and EMPA, Switzerland have all agreed to collaborate and to encourage student and staff exchanges.

PLASMA RESEARCH

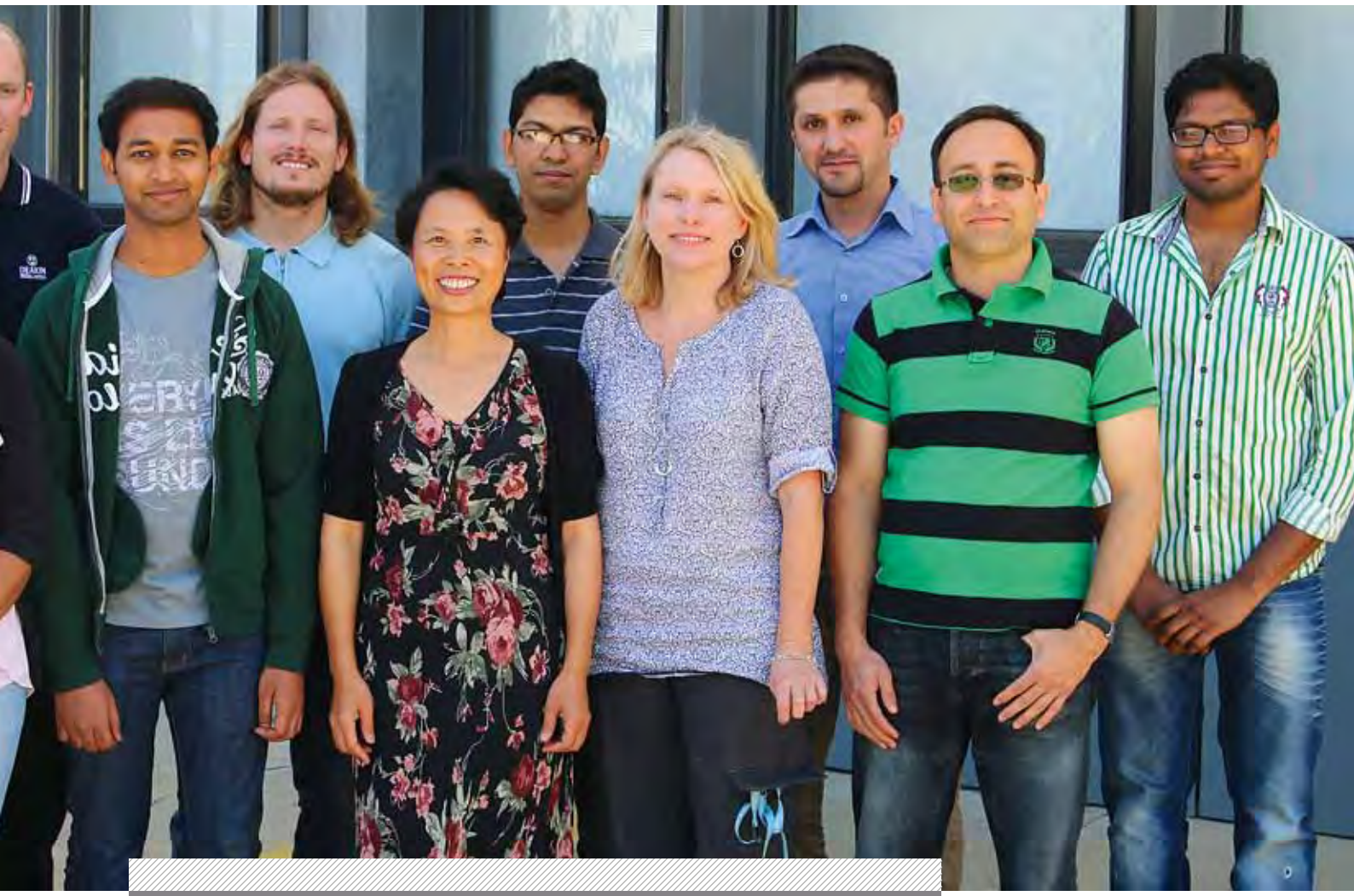
CONTINUED ...

STAFF AND STUDENT AWARDS

A poster by the plasma team on our unique plasma and thermal technology for energy applications received a best poster nomination at the 2013 Meeting of the Materials Research Society and was invited to record an online presentation on the MRS website.

An invited article, 'Plasma research at Deakin University: diverse applications and team spirit' was published in *Australian Physics* in February. This led to an invitation from ANU to jointly apply for an ARC LIEF grant.

Researchers work on the advanced plasma facility.



The plasma research team.

WORKSHOP BRINGS NEW COLLABORATIONS

The group organised and ran an international plasma medicine workshop in August to kick-start the development of this new field in Australia.

The workshop was attended by leading groups from the US and Europe as well as relevant medical researchers from Geelong. Outcomes of the workshop include new projects with the School of Medicine (plasma sterilisation of milk) and the School of Life and Environmental Sciences (plasma-plants), and a collaboration between the School of Medicine and Drexel University, USA.

POLYMERS

GROUP MEMBERS (STAFF)	Prof Qipeng Guo, Dr Ping'an Song, Dr Zhiquang Xu, Marion Wright
(STUDENTS)	Masihullah Jabarulla Khan, Anbazhagan Palanisamy, Shuying Wu, Shuhua Peng, Renyan Xiong, Tao Zhang, Eldho Elias, Deepalekshmi Ponnamma

Through an understanding of fundamental principles in polymer science and technology, the polymers research group aims to develop new polymer 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

Work by PhD student Shuhua Peng on a new class of novel lyotropic liquid-crystalline materials was published as a cover story in the prestigious journal *Langmuir*. The work is a collaboration with Dr Timothy Hughes and Dr Patrick Hartley of CSIRO.

Another of our PhD students, Shuying Wu studied the problem of toughening thermosetting polymers, which is one of the major issues in polymer science and industry. She developed a novel approach to toughen thermosetting polymers by forming tailored nanostructures in thermoset resin matrices. Her work has led to four papers published in *Macromolecules* and *Soft Matter*, as well as an international patent application.

DIC Corporation (Chiba Plant, Japan) has been testing the patented toughener for the company's epoxy resins through an agreement with Deakin Research Commercial.

POLYMERS

Members of the polymers group (L to R): Tao Zhang, Dr Yuanpeng Wu, Anbazhangan Palanisamy, Professor Qipeng Guo, Dr Zhiguang Xu and Dr Ping'an Song.

PhD student Tao Zhang reported a novel route to prepare multi-responsive organogels through charge-driven assembly between a block ionomer and a di-block co-polymer. The organogels are responsive to acids, amines and salts, showing potential for a range of applications. He also successfully prepared high internal phase emulsion organogels from charge-driven assembled polymer organogels. The results were published in *Chemical Communications*.

In 2013 the polymers group developed a new research area in polymer materials for oil, gas and energy industry through collaboration with Southwest Petroleum University, China. The collaborative work on novel water-soluble co-polymers for inhibiting shale hydration was published in *Industrial & Engineering Chemistry Research*.

Fee for service research was conducted for Brian Martin & Associates Pty Ltd for analysis of disbonded surfaces of polyurethane energy pipeline coating.

The research in the polymers group has led to 21 refereed journal papers published in 2013, many in ACS and RSC journals, and one international (PCT) patent application.

Three PhD students completed their doctorates. Dr Shuying Wu was offered a three-year Research Fellowship directly at Level B at RMIT University and Dr Shuhua Peng was awarded a prestigious three-year Australian Solar Institute Postdoctoral Fellowship at the University of Melbourne.

The third student to graduate, Dr Renyan Xiong investigated developing bioplastics from natural polymers. She worked on a project to create sustainable alternatives to plastics that are both biodegradable and use renewable resources. In particular, she has demonstrated an effective approach for the processing of biodegradable blends from natural and synthetic polymers. The results were published in *Carbohydrate Polymers*.

Dr Guobo Huang, an associate professor at Taizhou University (China) was awarded a prestigious 2014 Alfred Deakin Postdoctoral Research Fellowship to join the polymers group, one of only three offered to IFM.

NEW PROJECTS

Dr Ping'an Song *"Flame-retardant polymer nanocomposites with functionalized cellulose nanofibres,"* Alfred Deakin Postdoctoral Research Fellowship 2013.

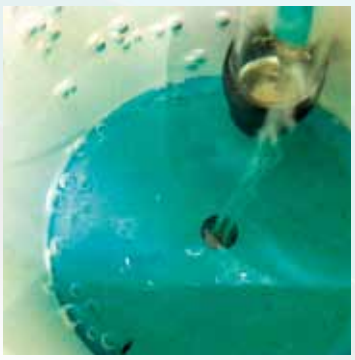
Dr Guobo Huang "High-performance polyurethane elastomers reinforced with self-assembled nanoorganogels", Alfred Deakin Postdoctoral Research Fellowship 2014.

Dr Shuhua Peng, Professor Qipeng Guo, Dr Shuying Wu, and Dr Tim Hughes from CSIRO following the graduation of Shuhua and Shuying.

COLLABORATIVE CENTRES

The Institute for Frontier Materials was a partner in the following Cooperative Research Centres in 2013:

- ADVANCED MANUFACTURING CRC (AMCRC)
- AUTO CRC
- SHEEP CRC
- ENERGY PIPELINES CRC



ADVANCED MANUFACTURING CRC (AMCRC)

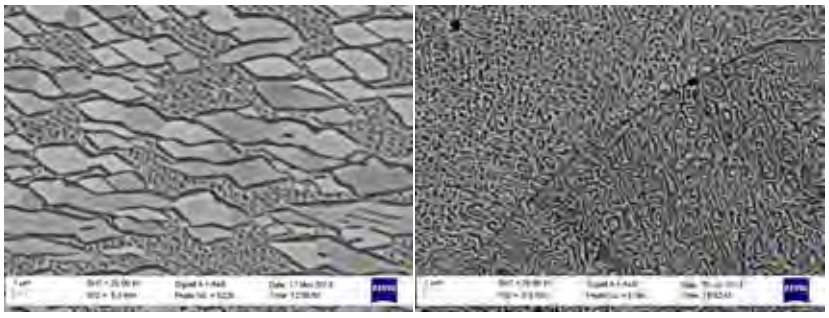
The Advanced Manufacturing CRC (AMCRC) was established in 2008 with Commonwealth funding of $35 million over seven years, matched with industry contributions of $21 million.

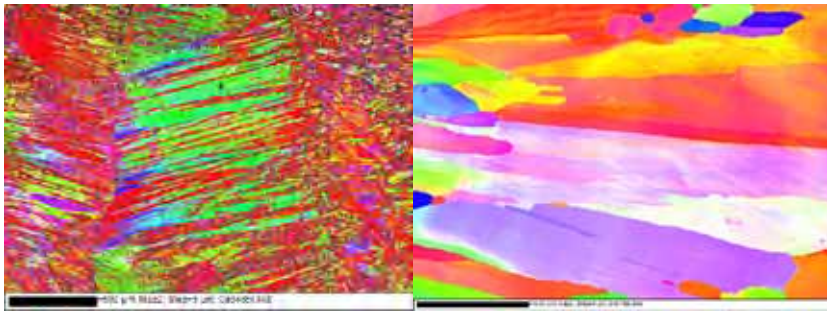
Several projects were completed in 2013, including a project on "microstructure and properties of bulk high entropy alloys formed by direct laser melting".

This Strategic Fund Project awarded to Dr Dan Fabijanic explored the potential to produce additive manufactured 5-element high entropy alloy system (NiCrFeCoAlx) by direct laser melting in collaboration with the Monash Centre for Additive Manufacturing (Monash University).

The project determined the process conditions to produce bulk specimens of single phase high entropy alloys. Compressive and tensile specimens were manufactured directly from powdered materials and material testing revealed a strong material anisotropy. Fundamental aspects of material deformation mechanisms and the role of texture were explored.

SEM AsB images of direct laser manufactured high entropy alloys.





EBSD images of deformed high entropy alloys.

A collaborative two-year project involving IFM, Cytomatrix Pty Ltd and the Monash Institute of Medical Research (MIMR) to develop a novel three-dimensional cell culture device continued over 2013.

The primary goal of this project is to develop a clinical-grade device for the expansion of haematopoietic stem cells (the stem cells in bone marrow that give rise to blood cells).

The device is based on high-surface area non-woven scaffolds developed by IFM and Cytomatrix Pty Ltd. Cells selected from human umbilical cord blood samples will be expanded on the non-woven scaffolds and later transplanted in mouse models to investigate efficacy and safety of the device.

The use of this closed-bag culture device would enable haematopoietic stem cells from umbilical cord blood which are available in limited numbers to be expanded in the laboratory in a cost-effective manner. This will then lead to an "off-the shelf" product to be used for haematopoietic stem cell transplantation in patients with diseases such as leukaemia.

The project involves materials scientists and cell biologists at IFM, who have examined ways of functionalising the scaffold to enhance cell selection and expansion, working with scientists at MIMR who will perform stem cell transplants in mouse models.

The project is expected to be completed by June 2014.

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

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.

In 2012, we completed projects in lightweighting a canopy and feasibility of flexibly roll forming parts. The first project (partnering with an international company) realised up to 22 per cent weight saving by a re-design and some material substitution. The manufacture of the canopy was also improved through design improvements. Our research partners in the project (VPAC) were able to suggest improvements in the shape of the canopy to reduce drag by 30 per cent.

The second project (with an international company and the Malaysian Automotive Institute) was to assess the feasibility of converting a currently stamped part into a flexibly roll formed part.

After completing a literature review, we generated an advanced material model that could be run on a general FEA code. Finally, we delivered a report on the feasibility of flexibly roll forming a particular component chosen by the industry partner.

A third project on tool wear (again with an international company and the Malaysian Automotive Institute, and supported by Metalsa Australia) started in 2013 and will continue in 2014. This project is the first stage to understand a particular tool wear issue at a stamping company.

Two records of invention on automotive body structures were published. The first on side impact energy absorbing structure and the second on lower floor body structure.

Professor Peter Hodgson became the Director of Research Quality at the AutoCRC, and Associate Professor Bernard Rolfe took over Prof Hodgson's former position as Lightweighting Theme Leader.

CRC FOR SHEEP INDUSTRY INNOVATION

The CRC for Sheep Industry Innovation is a national program aimed at improving productivity gain, wool and meat quality, and genetic improvement. The CRC extended its contract with Deakin University in the area of wool quality and the comfort properties of next-to-skin knitwear.

Deakin University staff have played a key part in identifying the influence of fibre, yarn and fabric properties on the comfort and handle of knitwear worn close to the skin.

The extension will allow Drs Bruce McGregor and Maryam Naebe to further explore and quantify ways to improve comfort and handle properties of knitwear.

Deakin University staff made a major contribution to a special issue of the *Journal of the Textile Institute.* The focus of this special issue was the CRC's research effort in comfort attributes of wool fabrics and photostability of wool fibres.

Australian fine wool is a luxury animal fibre, used primarily for fine apparel products Despite this, the stigma of prickle and photo-yellowing 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 and photostability issues with wool knitwear.

Dr Maryam Naebe with the Wool Comfort Meter, developed as part of the Sheep CRC to test comfort properties of knitwear.

SHEEP CRC

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.

Deakin University joined the EPCRC in 2012 and leads the four projects in the CRC's research program on coatings and corrosion. The goal of this research program is to cost-effectively extend the life of pipeline infrastructure by mitigating corrosion and environmentally assisted degradation of pipelines. Professor Mike Tan is the leader of 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. Other research themes include cathodic protection, stress corrosion cracking, and pipeline corrosion measurement and prediction.

During 2013, the National Facility for Pipeline Coating Assessment (NFPCA) was established at Deakin's Geelong Waurn Ponds Campus (total EPCRC cash funding $273,200). The aim of the NFPCA is to provide an independent testing facility able to perform standard and custom designed testing of energy pipeline coatings. The NFPCA is unique in Australia and is essential for building up a capability for pipeline coating selection, research and development. The NFPCA also performs commercial independent coating tests for coating manufacturers, suppliers, applicators and end users in Australia and overseas.

Findings from the coating and corrosion research will be combined to predict pipeline life based on materials, corrosion protection and environment. In 2014, two new EPCRC research projects will start at Deakin University on stress corrosion cracking of gas pipeline steel and on lightning damage of energy pipelines.

PhD student Ying Huo checks the effects of electrical interference signals on the effectiveness of cathodic protection of pipeline steel.

FINANCIAL REPORT

The Institute for Frontier Materials Financial Reporting 2013:

- FINANCIAL SUMMARY
  - Total Research Income by Category - Actual 2013 ($M)
- PERFORMANCE TARGETS 2010 - 2013
  - Total Research Income by Category ($M)
  - Total Research Income by Category % - Actual 2013 ($M)
  - HDR Student Load (Equivalent Full time, 2010 - 2013)
  - HDR Student Completions (2010 - 2013)
  - Publications (2010 - 2013)
  - 2013 Grant Applications

IFM FINANCIAL SUMMARY - 2013

TOTAL RESEARCH INCOME BY CATEGORY - ACTUAL 2013 ($M)

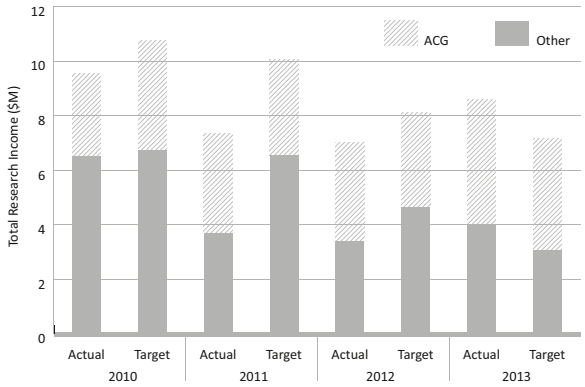
FINANCIAL SUMMARY - FOR PERIOD ENDED 31 DECEMBER 2013	2013 Actual
INCOME	**$**
External Research Income	11,187,692
Strategic Initiatives	-
Operational Initiatives	1,260,964
University Operating Funds	7,677,908
Research Allocation	8,054,823
Total Income	**28,181,387**
EMPLOYMENT COSTS	
Academic Salaries	12,101,680
General Salaries	3,976,694
Other Employment Costs	29,711
Contractors	7,858
Total Employment costs	**16,115,944**
NON SALARY EXPENSES	
Buildings & Grounds Infrastructure Costs	320,169
Communication/Advertising, Marketing & Promotions	30,463
Consumables	1,211,020
Depreciation & Amortisation	5,148,266
Equipment - Repairs, Maintenance & Other Costs	1,365,076
Financial, Borrowing, Debtors & Currency Costs/Legal Costs & Consultants	671
Inter Budget Centre/Internal Charges/Recoveries	262,846
Contributions to other Universities	366,145
Other Costs	460,513
Professional, Legal and Consultants	174,693
Staff Recruiting, Training & Other/Library Information Resource Expenses	372,431
Student Expenses	1,331,213
Travel, Catering & Entertainment	827,239
Total Non Salary Expenses	**11,870,745**
Surplus/(Deficit)	**194,699**

IFM PERFORMANCE TARGETS (2010 - 2013)

TOTAL RESEARCH INCOME BY CATEGORY ($M)

CATEGORY	2010		2011		2012		2013	
	ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET
ACG	3	4	3.6	3.5	3.5	3.5	4.5	3.5
Other	6.5	6.7	3.7	6.5	3.5	4.6	4	3.7
Total $M	**9.5**	**10.7**	**7.3**	**10**	**7**	**8.1**	**8.5**	**7.2**

2013 results do not include $624K infrastructure and excluded research income.



***ACG (Australian Competitive Research Grants – Category 1)** gives the income obtained in national competitive grants, the term used to describe a group of some 70 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.

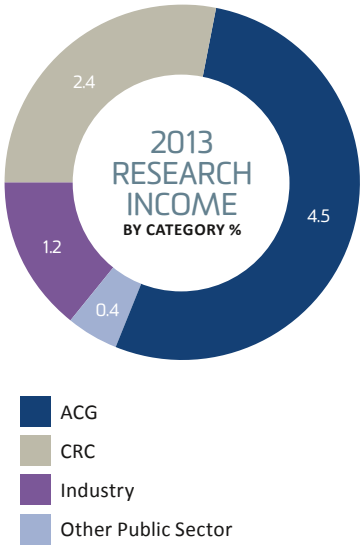
***Other public (Other Public Sector Research funding – Category 2)** is government funding, Federal or State, from schemes not included in the ACG group and not necessarily determined through a competitive process; it includes contract research and research-related consultancies.

***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.

TOTAL RESEARCH INCOME BY CATEGORY - ACTUAL 2013 ($M)

CATEGORY	ACG	CRC	INDUSTRY	OTHER PUBLIC SECTOR
Total $M	**4.5**	**2.4**	**1.2**	**0.4**



HDR STUDENT LOAD (EQUIVALENT FULL TIME, 2010-2013)

2010		2011		2012		2013	
ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET
138	118	153	154	128	128	**153**	**153**

HDR STUDENT COMPLETIONS (2010 - 2013)

2010		2011		2012		2013	
ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET
16	13	14	16	16	21	**23**	**18**

PUBLICATIONS (2010 - 2013)

2010		2011		2012		2013	
ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET	ACTUAL	TARGET
171	100	293	123	132	139	**170**	**135**

2013 GRANT APPLICATIONS

GRANTS	APPLIED	SUCCESS	% SUCCESS	AMOUNT AWARDED*
Reportable - Category 1 Applications	47	16	34%	$4,452,684
Reportable - Category 2-4 Applications	37	30	81%	$2,387,788
Non-Reportable - Other	27	16	59%	$374,692

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

IFM STUDENTS - 2013

Buddhika Abeyrathna
Amir Abbas
Usman Ali
Feng An
Yang An
Murugesan Annasamy
Sarmad Aslam
Makoto Atake
Steven Babaniaris
Khashayar Badii
Ossama Badr
Ehsan Bafekrpour
Ehsan Bahrami Motlagh
Md Mahedi Bhuiyan
Infant Bosco
Aaron Brighton
Rachel Brokenshire
Aaron Brown
Peter Bruchmueller
Laurine Buscara
Qiran Cai
Zengxiao Cai
Erwan Castanet
Rainier Catubig
Thomas Chaffraix
Rechana Chandrasekharan
Qi Chao
Lijue Chen
Ronghua Chen
Zhiqiang Chen
Tarekegn Chimdi Yarimo
Rita Choudhary
Andrew Church
Weiwei Cong
Genevieve Crowle
Rasike De Silva
Deepika Deepika
Chantal Denham
Ashley Denmead

Satyaveer Dhinwal
Yunfei Ding
Xiaowei Dong
Kurt Drew
Shan Du
Fawzi Ebrahim
Eldho Elias
Ahmad Erfani Moghadam
Linpeng Fan
Chunfang Feng
Klaus Fiedler
Desinghege Gangoda
Tahir Ghandoori
Gaetan Girard
Nicolas Goujon
Tingting Guo
Yuanyuan Guo
Ninghui Han
Linda Hillbrick
Tingting Hou
Peipei Huang
Ying Huo
Nahid Iranipour
Masihullah Jabarulla Khan
Matthew Jennings
Jingsi Jiao
Xing Jin
Geo Jose
Jithin Joseph
Olga Kartachova
Jasjeet Kaur
Mehdi Kazemimostaghim
Bhawna Khemchandani
Apurv Kumar
Pawan Kumar
Andreas Kupke
Bingshan Li
Chengpeng Li
Quanxiang Li
Yongzhen Li
Bao Lin
Xueyang Liu

Yanan Lv
Ajay Mahato
Fariba Mahdavi
Mohammad Maniruzzaman
Gopinatha Manjaiah
Jascha Marnette
Srikanth Mateti
Jonathan McDonald
Amritpreet r Minhas
Sepehr Moradi
Matthew Moss
Akbar Mostaani
Dolly Mushahary
Sahar Naghashian
Robert Nunn
Paul Okonkwo
Seyedeh Oroumei
Raudhah Othman
Yogita Oza
Esfandiar Pakdel
Anbazhagan Palanisamy
Amol Janardan Patil
Kirin Patil
Debasis Poddar
Deepalekshmi Ponnamma
Sri Ponraj
Cameron Pope
James Preston
Si Qin
Youhai Qiu
Gayathri Devi Rajmohan
Khushboo Rakha
Deepa Chandran Ram
Mahendra Ramajayam
Thrinath Reddy Ramireddy
Shyama Deepak Ranade
Shahriar Reza
David Rubin De Celis Leal
Gourab Saha
Laura Sanchez Cupido
Prabhukumar Sellamuthu
Linden Servinis
Sajjad Shafei
Hao Shao

Nishat Sharma
Xiaodong She
Vadim Shterner
Muhammad Shuakat
Manikandakumar
Shunmugavel
Rupinder Sian
Tristan Simons
Charanpreet Singh
Subhash Sista
Anthony Somers
Paul Souza
Anas i Sultan
Xiangping Sun
Arwa Tawfeeq
Balaji Trichy
Narayanaswamy
Alireza Vahidgolpayegani
Facundo Varela
Guang Wang
Jiangting Wang
Jin Wang
Yu Wang
Samiksha Wasnik
Frank Will
Shuying Wu
Zhi Gang Xie
Tan Xing
Renyan Xiong
Mohamad Yahaya
Yajing Yan
Zhifeng Yi
Yao Yu
Hassan Zaid
Badar Zaidi
Chao Zeng
Dongmei Zhang
Mingwen Zhang
Tao Zhang
Yafei Zhang
Xinchu Zhao
Hua Zhou
Mengqi Zhou
Yang Zhou
Licheng Zhu
Marinus van der Sluijs

INDUSTRY PARTNERS

FIBRES AND TEXTILES

- Australian Wool Innovation
- Australia Defence Apparel
- Brookland Greens Medical Centre
- Cashmere Connections Pty Ltd
- Cotton Research and Development Corporation
- Cytomatrix Pty Ltd
- Draggin Jeans Ltd
- Ear Science Institute Australia Incorporated
- Geofabrics Australasia Pty Ltd
- Godfrey Hirst Carpets
- Guangzhou Textile Union Group Co
- International Fibre Centre (IFC)
- Logistik Unicorp
- Nplex Pty Ltd
- EP Robinson Pty Ltd
- Rural Industries R&D Corporation
- Shangdong Ruyi Technology Group
- Zhejiang Shenzhou Woollen Textile Co
- Zhik Pty Ltd

METALS AND COMPOSITES

- Aircraft Plastics Australia Pty Ltd
- Backwell IXL
- BHP Billiton
- Bluescope Steel Ltd
- Carbon Revolution Pty Ltd
- DataM Software GMBH
- DHS Emergency
- Ford Motor Company
- FTS Australasia Pty Ltd
- GM Holden
- Hard Technologies Pty Ltd
- JE Hoffmann Engineering Pty Ltd
- Keech Castings
- Laboratoire De Physique Et Mecanique Des Materiaux
- Malaysian Automotive Institute
- Metalsa Australia
- OneSteel Ltd
- Powercor Australia Ltd
- Qenos
- QuickStep Technologies Pty Ltd
- SAMMITR
- Shinil Chemical Company
- Tata Steel Pty Ltd
- United Surface Technologies Pty Ltd
- VR TEK Wheels Pty Ltd
- Wuhan Iron and Steel (Group) Corporation
- ZedCon Scientific Services

ELECTROMATERIALS AND CORROSION

- AECOM
- Agricultural Organics Pty Ltd
- AusComposites Manufacturing Facility
- Australian Pipeline Industry Association
- APA Group
- CPE Systems
- Cytec Canada Inc
- Defence Materials Technology Centre
- 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

SEMINARS

During the year, many visitors from other research institutions in Australia and overseas as well as industry collaborators presented seminars at IFM. Below is a list of external speakers. Many IFM researchers also presented seminars to their colleagues about their research.

JANUARY

Rich Kish, International Sales Manager, Q-Lab
Paint and polymer degradation – a practical approach to accelerated testing

APRIL

Dr Anders Engstrom & Dr Qing Chen, Thermo-Calc Software, Stockholm, Sweden
Thermo-Calc

Prof Peidong Wu, McMaster University, Ontario, Canada
On lattice strain evolution and twinning-detwinning in Mg alloy ZK60A under cyclic loading

Dr Jelena Rnjak-Kovacina, Dept of Biomedical Engineering, Tufts University, Boston
Developing novel silk-based scaffolds for soft tissue engineering purposes

Dr Thomas Stoughton, General Motors
Forming Limit Diagrams in Anisotropic Metals

JUNE

Prof Kourosh Kalantar-Zadeh, Micro/nanoelectronics and Sensors Group Leader School of Electrical and Computer Eng. RMIT University
Two-dimensional semi-conducting transition metal chalcogenide

Dr Jun Ma, Institute of Chemistry, Beijing, the Chinese Academy of Sciences
Highly conducting yet solution-processable graphene for engineering applications

Dr Tony Murphy, CSIRO
Why metal vapour is important in arc welding

MARCH

Prof Johanna Buchet, VTT Technical Research Centre of Finland
VTT research of cellulosic fibres- from molecular level to final products

Dr Maria Bellantone, Senior Publishing Editor, Springer
Scholarly publishing made easy

A/Prof Hisanao Usami, Shinshu University, Japan
Development of multichannel reactors for large-scale photochemical reactions

Prof Aikra Uedono, Tsukuba University, Japan
Characterisation of open volumes in amorphous materials using positron annihilation

MAY

Dr Stuart Lucas, Acting Deputy Chief Science Research Program Leader, Fibre Science & Materials Performance
CSIRO's program

Prof Xiumei Mo, College of Chemistry, Chemical Engineering and Biotechnology, Donghua University, Shanghai
Electrospinning nanofibres for tissue engineering

Dr Kohsaku Ushioda, Nippon Steel & Sumitomo Metal Corp, Japan
Bidirectional presentations

SEMINARS

AUGUST

Prof Bill Graham, Queen's University, Belfast UK
Studies of plasma properties and their interactions with liquid media and with bacteria and cancer cells

Prof Rob Short, Uni of SA
Plasma and its role in treating severe burns and chronic wounds

Prof Liming Dai, Thinker in Residence
HDR workshop: how to become an outstanding HDR student

Dr Greg Fridman, Drexel University, USA
Nano- and micro-second pulsed dielectric barrier discharge plasma-assisted wound sterilization, wound healing, and tissue regeneration

Prof Sundar Manoharan, Indian Institute of Technology, Kanpur
Facilities and research initiatives at the nanocenter

Dr Dirk Hegemann, Empa, Swiss Federal Laboratories for Materials Science and Technology, St.Gallen, Switzerland
Considering the Plasma/Substrate Interaction during Film Growth

Rick Verhoef, Laboratoire Plasma et Conversion d'Energie (LAPLACE)
About LAPLACE

Dr Jiabao Yi, University of New South Wales
Nanostructured Oxide Magnetic Semiconductors for Spintronics Devices

OCTOBER

Dr Mike Kuiper, Victoria Life Sciences Computation Initiative (VLSCI)
Modelling proteins on ice – or how to get your computer to freeze

vlsci
LIFE SCIENCES COMPUTATION

DECEMBER

Prof Daquan Zhang, Shanghai University of Electric Power
Corrosion and protection of thermal power equipment

JULY

Dr Keith Millington, CSIRO
Detecting free radicals in skin exposed to UV radiation

Dr Molly Shoicet, University of Toronto, Canada
3D hydrogel patterning for guided cell growth

Prof Liming Dai, Case Western Reserve University, Thinker in Residence
Introduction to the work of Prof Dai's group

CASE WESTERN RESERVE UNIVERSITY

SEPTEMBER

Dr Mickey Huson, CSIRO
Physical and chemical heterogeneity of carbon fibre

Dr Stuart Gordon, CSIRO
Morphology and tensile properties of bast fibres extracted from cotton stalks

Dr Kei Saito, Monash University
Green Polymers - from Photo-responsible Reversible Polymers to Lignin Based Polymers

David Rossouw, McMaster University, Ontario Canada
High-resolution TEM-EELS studies of metallic nanostructures and carbon nanotubes

Dr David Larson, CAMECA Instruments, USA
Directions in atom probe tomography

NOVEMBER

Dr Andrew Poole, CSIRO Materials Science and Engineering
Marine antifouling research at CSIRO

B.S. Murty, IIT Madras
Nanocrystalline high entropy alloys – a new class of exciting materials

Dr Katarzyna Grabowska, Technical University of Lodz, Poland
Twisting with imagination

CSIRO

GRANT HOLDERS AND THEIR PROJECTS

CATEGORY 1 - AUSTRALIAN COMPETITIVE GRANTS

COMMONWEALTH SCHEMES

AUSTRALIAN RESEARCH COUNCIL DISCOVERY	INVESTIGATOR	INDUSTRY PARTNER / FUNDING BODY	YEARS	ARC / C'LTH FUNDING	INDUSTRY FUNDING
Magnetic manipulation of liquid droplets for novel channel-free microfluidics and microreactors	Yan Zhao		2011 - 2013	$292,428	
Superhydrophobic fabrics for solar desalination of seawater	Hong Xia Wang		2011 - 2013	$265,898	
Directional fluid-transfer in thin porous materials with imbalanced wettability	Tong Lin; Xin Liu		2011 - 2014	$221,620	
Understanding the composite structures and properties of wild silk cocoons	Xungai Wang, Rangam Rajkhowa; Jingliang Li		2012 - 2014	$322,075	
Advanced high strength steels produced by energy efficient direct strip casting	Peter Hodgson; Nicole Stanford		2013 - 2015	$435,771	
Toughening thermosets by highly ordered nanostructures	Qipeng Guo		2012 - 2014	$149,000	
Nanoporous nanorods with improved electrochemical properties	Ying Chen; Alexey Glushenkov		2013 - 2015	$334,232	
Understanding the interaction between wool fibre surface and ionic liquids	Xungai Wang; Nolene Byrne		2013 - 2015	$314,232	
Future sodium based electrochemical energy storage technologies	Maria Forsyth		2013 - 2015	$415,002	
Ultra-fine boron nitride nanotubes	Ying Chen		2011 - 2013	$385,712	
AUSTRALIAN RESEARCH COUNCIL LINKAGE	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**INDUSTRY FUNDING**
Engineering a silk fibroin based ear drum with optimum acoustic properties	Xungai Wang	Ear Science Institute Australia (ESIA)	2011 - 2015	$428,537	$125,000
Advanced 3D fibrous structures for vascular graft applications	Xungai Wang	Brookland Greens Medical Centre	2011 - 2013	$173,264	$60,000
Flexible roll forming of advanced high strength steel sheet	Peter Hodgson; Matthew Barnett; Bernard Rolfe	Australian Rollforming Manufacturers Pty Ltd; BlueScope Steel Ltd; data M Sheet Metal Solutions; Wuhan Iron and Steel (Group) Corporation	2012 - 2014	$290,440	$150,000
Developing an environmentally friendly, low cost solution to reduce wear and improve productivity in metal forming	Bernard Rolfe; Peter Hodgson; Maria Forsyth; Michael Pereira	Ford Australia	2012 - 2014	$425,763	$189,000
Australian Ultrafine Wool Dehairing and Processing	Xungai Wang; Christopher Hurren	Shangdong Ruyi Woolen Textile Co Ltd	2012 - 2015	$278,790	$135,000

Reducing the environmental impact of steel making through direct strip casting	Peter Hodgson; Nicole Stanford		2013 - 2016	$90,000	
Cytec Project - Phosphonium ionic liquids for advanced lithium energy storage systems	Maria Forsyth; Patrick Howlett	Cytec Canada Inc	2012 - 2015	$179,922	$173,444
AUSTRALIAN RESEARCH COUNCIL AUSTRALIAN LAUREATE FELLOWSHIP	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**INDUSTRY FUNDING**
Metal Processes and Products for a Sustainable Future	Peter Hodgson		2009 - 2014	$2,055,030	
New Materials for a Sustainable Energy Future	Maria Forsyth		2011 - 2016	$2,260,000	
AUSTRALIAN RESEARCH COUNCIL AUSTRALIAN FUTURE FELLOWSHIP	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**INDUSTRY FUNDING**
Growing a multi-scale internal structure: new wrought metals for energy conservation	Matthew Barnett		2011 - 2014	$844,915	
Piezoelectric nanofibre membranes with built-in p-n junction: new self-rectifying piezoelectric power generators	Tong Lin		2012 - 2016	$747,650	
AUSTRALIAN RESEARCH COUNCIL AUSTRALIAN - DISCOVERY EARLY CAREER RESEARCHER AWARD	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC/C'LTH FUNDING**	**INDUSTRY FUNDING**
Investigation and development of biological anti-adhesive coatings	George Warren Greene		2013 - 2015	$383,279	
AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC/C'LTH FUNDING**	**INDUSTRY FUNDING**
Centre for Design in Light Metals	Peter Hodgson; Matthew Barnett; Barry Muddle	Monash University, University of Sydney, The University of New South Wales, University of South Australia, The University of Melbourne, University of Queensland, Department of Innovation, Industry and Regional Development	2005 - 2013	$3,200,000	
Centre for Electromaterials Science	Maria Forsyth; Jenny Pringle		2010 - 2013	$913,202	
COTTON RESEARCH & DEVELOPMENT CORPORATION	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CRDC FUNDING**	**INDUSTRY FUNDING**
Development of low twist fine count yarns and fabrics from Australian Long Staple Upland cotton	Xungai Wang	CRDC	2010 - 2014	$360,000	
Design of thermal cotton/wool fabrics from Australian premium cotton and wool fibres	Xungai Wang	CRDC	2013 - 2015	$494,963	
Improving length, strength and fitness of cotton fibre: A PhD study	Rangam Rajkhowa; Xungai Wang	CRDC	2013 - 2016	$138,000	

GRANT HOLDERS AND THEIR PROJECTS

New developments and opportunities for cotton yarns and fabrics	Xungai Wang; Christopher Hurren; Lu Sun	CRDC	2013 - 2014	$72,635	
AUSTRALIA-CHINA SCIENCE AND RESEARCH GRANT	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**SIEF / C'LTH FUNDING**	**INDUSTRY FUNDING**
Australia-China Research Centre for Light Metals	Peter Hodgson	Department of Innovation, Industry, Science and Research - Australia-China Science and Research Fund	2013	$3,338	
AUSTRALIAN WOOL INNOVATION GRANTS	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**AWI FUNDING**	**INDUSTRY FUNDING**
Identification and elimination of AOX on chlorinated wool	Nolene Byrne; Xungai Wang	Australian Wool Innovation Limited	2012 - 2013	$109,000	
Fibre quality: Meeting market requirements	Bruce McGregor	Australian Wool Innovation Limited	2013 - 2015	$216,960	
A new alternative to chlorination for shrink proof treatment of wool stage 1 development of wool specific ionic liquids	Nolene Byrne; Xungai Wang	Australian Wool Innovation Limited	2012 - 2013	$248,594	
Proof of concept for directional water-transport wool fabrics	Tong Lin	Australian Wool Innovation Limited	2013 - 2014	$70,000	
Investigating the surface of chlorinated wool - towards zero AOX residuals	Nolene Byrne; Xungai Wang	Australian Wool Innovation Limited	2013 - 2014	$41,700	

NON-COMMONWEALTH SCHEMES

AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING (AINSE)	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**AINSE FUNDING**	**INDUSTRY FUNDING**
Alignment of nanostructures templated from lyotropic liquid crystals	Lingxue Kong; Weiwei Cong	AINSE	2012 - 2013	$20,417	
Patterned functionalization, stitching and decoration of carbon nanotube and graphene porous composites by gamma-irradiation	Ludovic Dumée	AINSE	2013	$8,400	
NATIONAL CENTRE OF EXCELLENCE IN DESALINATION	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**AINSE FUNDING**	**INDUSTRY FUNDING**
Smart Materials for Corrosion Management	Maria Forsyth	DEWHA	2011 - 2014	$450,000	
NCED Scholarship - Design and characterisation of novel nano-porous metal membranes by specific metal allow films de-alloying	Peter Hodgson; Lingxue Kong; Ludovic Dumée; Bao Lin	DEWHA	2013 - 2015	$30,000	
SCIENCE AND INDUSTRY ENDOWMENT FUND (SIEF) GRANTS	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**AINSE FUNDING**	**INDUSTRY FUNDING**
Manufacture of a small areo-engine entirely through additive manufacturing	Peter Hodgson	Science and Industry Endowment Fund (SIEF)	2013 - 2107	$600,040	

CATEGORY 2 - OTHER PUBLIC SECTOR INCOME					
COMMONWEALTH / STATE FUNDING	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**C'LTH/STATE FUNDING**	**INDUSTRY FUNDING**
Strategies for developing self-repairing oxides to protect steel system	Maria Forsyth	CSIRO	2011 - 2014	$97,600	
Underpinning development in advanced materials with molecular simulation	Tiffany Walsh	VESKI Victorian Endowment for Science Knowledge and Innovation	2012 - 2015	$150,000	
ADA Researcher in Business hemp project	Christopher Hurren; Jin Wang	DIISR Grant - Enterprise Connect - Department of Innovation, Industry and Regional Development	2012 - 2013	$133,374	
Microfluidic devices for pedigree analysis	Peter Hodgson	Department of Business and Innovation - Small Technologies Industry Uptake Program	2013	$10,000	
Victoria India Doctoral Scholarships VIDS Program 2013	Xungai Wang	Department of Business and Innovation - Victoria India Doctoral Scholarships VIDS Program	2013	$90,000	

CATEGORY 3 - INDUSTRY AND OTHER FUNDING					
AUSTRALIAN GRANTS	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**C'LTH / STATE FUNDING**	**INDUSTRY FUNDING**
PE pipe material upgrade feasibility study	Bronwyn Fox; Kevin Magniez; Minoo Naebe	Qenos	2012 - 2013		$286,050
Fibre alternative to nitrocellulose in lateral flow assays	Christopher Hurren	Nplex Pty Ltd	2013 - 2014		$58,460
Pipeline coating testing and assessment	Mike Yongjun Tan; Davi Abreu	Denso Australia Pty Ltd	2013		$24,450
Technical consultancy	Daniel Fabijanic	Hard Technologies	2013		$1,800
Process proving of boronizing in a fluid bed reactor	Daniel Fabijanic	Department of State Development Business and Innovation / Hard Technologies	2013 - 2014	$50,000	$12,500
Strategies to improve the ductibility of Zn6Al3Mg coatings	Daniel Fabijanic	OneSteel Wire Pty Ltd	2013 - 2014		$30,500
Researcher in Business Project with T J McLean Investments - Recycling bulky waste to reduce carbon emission and landfill	Lingxue Kong; Fenghua She	GT Recycling	2013 - 2014		$104,298
High curvature armour systems	Bronwyn Fox; Daniel Mark Fabijanic; Minoo Naebe	VCAMM	2013 - 2014		$519,709

GRANT HOLDERS AND THEIR PROJECTS

Portable powerstorage	Patrick Craig Howlett; Maria Forsyth; Xungai Wang; Tong Lin; Jian Fang	VCAMM	2012 - 2014		$276,173
Flue gas flow modelling for the F3301 convective section and improvement to gas flow in the F3301 convection banks	Lingxue Kong; Weimin Gao	Shell Refining (Australia) Pty Ltd	2012 - 2013		$90,365
Shell Geelong salt water cooling water intake sand settling study	Lingxue Kong; Weimin Gao	Shell Refining (Australia) Pty Ltd	2013		$55,000
SP Ausnet grid energy storage project	Patrick Craig Howlett; Maria Forsyth	SP AusNet	2013 - 2014		$19,722
Development of new materials via melt compounding of recycled thermoplastics with nanotechnology and micro-technology solutions	Kevin Jeane-Claude Magniez; Madhusudan Suryanarayana	Australian Composite Technology	2013		$31,250
Extreme sports safety program	Christopher James Hurren	Draggin Jeans	2013 - 2014		$98,929
Production of a pilot manufacturing plant for the manufacture of short nanofibres	Alessandra Sutti; Marzieh Parhizkar	Cytomatrix Pty Ltd	2013 - 2014		$219,088
URP flexible roll forming of automotive structures	Bernard Rolfe; Matthias Weiss	Ford Motor Co of Australia	2013 - 2014		$75,488
Nanostructured steels for ground engaging tools	Daniel Fabijanic; Matthew Barnett	Department of State Development Business and Innovation/Keech Australia Pty Ltd	2013 - 2014	$50,000	$12,500

INTERNATIONAL FUNDING	INVESTIGATOR	INDUSTRY PARTNER / FUNDING BODY	YEARS	C'LTH FUNDING	INT'L FUNDING
Bio-nanocombinatorics to achieve precisely-assembled multicomponent, functional hybrid nanomaterials	Tiffany R Walsh	Air Force Office of Scientific Research United States of America	2012 - 2017		$532,852
Cold stamping of advanced high strength steels	Peter Hodgson; Matthew Barnett; Lingxue Kong	Wuhan Iron and Steel (Group) Corporation	2012 - 2015		$150,000
Durable water resistant coating	Tong Lin	CarPro Trading Ltd	2012 - 2013		$15,000
Modification of wool with photo-catalysed oxidation and its effect on dyeing properties	Xungai Wang; Jingliang Li; Weiguo Chen	Zhejiang Shenzhou Woollen Textile Co Ltd	2012 - 2014		$100,000
Hemp fibre separation	Christopher Hurren	Logistik Unicorp Inc	2012 - 2014		$37,987

CATEGORY 4 - COOPERATIVE RESEARCH CENTRES (CRC)					
CAST CRC	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CRC FUNDING**	**INDUSTRY FUNDING**
Wrought magnesium alloy development	Matthew Barnett	CRC - CAST	2006 - 2013	$1,469,225	
AUTO CRC	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CRC FUNDING**	**INDUSTRY FUNDING**
3-101 Pickup canopy development	Kevin Magniez; Timothy de Souza	AUTO CRC	2012 - 2103	$256,270	
Tool wear prediction model on the stamping of AHSS and UHSS	Bernard Rolfe; Matthias Weiss; Michael Pereira	AUTO CRC	2013 - 2104	$116,000	
3-105 Flexible roll forming of a component section from AHSS	Bernard Rolfe; Matthias Weiss	AUTO CRC	2013	$214,895	
3-118 High-volume process to manufacture carbon fibre composite parts for automotive applications	Bronwyn Fox; Kevin Magniez; Claudia Garschke	AUTO CRC	2013 - 2015	$823,500	
Lightweight vehicle structures 3-102 from high strength metals - CECAP Research Project	Zohreh Keshavarz; Peter Hodgson	AUTO CRC	2012 - 2014	$695,000	
AMCRC	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CRC FUNDING**	**INDUSTRY FUNDING**
Development of macroporous scaffolds for biomedical applications	Peter Hodgson; Xungai Wang	AMCRC	2008 - 2014	$2,686,122	
Manufacturing of bio composites for automotive applications - Scholarship Erwan Castanet	Kevin Magniez; Erwan Castanet	AMCRC	2013 - 2015	$99,000	
Nano-enhanced carbon fibre composites	Bronwyn Fox; Kevin Magniez	AMCRC	2009 - 2013	$122,654	
Microstructure and properties of bulk high entropy alloys formed by direct laser sintering	Daniel Fabijanic	AMCRC	2013	$127,234	
Quickstep & RST	Bronwyn Fox	AMCRC	2009 - 2013	$914,705	
Novel self-healing fibre-reinforced composites	Kevin Magniez; Alessandra Sutti	AMCRC	2010 - 2014	$128,611	
ENERGY PIPELINES CRC	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CRC FUNDING**	**INDUSTRY FUNDING**
RP2-06 Coating facility phase 2	Mike Yongjun Tan; Qipeng Guo	EPCRC	2013 - 2014	$135,600	
RP2-08B Transient loss of cathodic protection - phase 2	Mike Yongjun Tan; Maria Forsyth; Subrat Das	EPCRC	2012 - 2015	$299,000	
RP2-11 Coating cracking and disbondment	Mike Yongjun Tan; Maria Forsyth; Qipeng Guo	EPCRC	2012 - 2015	$293,000	

GRANT HOLDERS AND THEIR PROJECTS

Pipeline health monitoring and life prediction	Mike Yongjun Tan; Bruce Hinton; Subrat Das; Alex Stojcevski	EPCRC	2012 - 2015	$429,500	
Quickstep & RST	Bronwyn Fox	AMCRC	2009 - 2013	$914,705	
Novel self-healing fibre-reinforced composites	Kevin Magniez; Alessandra Sutti	AMCRC	2010 - 2014	$128,611	
Hemp fibre separation	Christopher Hurren	Logistik Unicorp Inc	2012 - 2014		$37,987
COOPERATIVE RESEARCH CENTRE (CRC) - SHEEP	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CRC FUNDING**	**INDUSTRY FUNDING**
Sheep CRC Colour Program - Deakin 01-Wool Colour	Xungai Wang	Sheep CRC	2009 - 2014	$883,695	
Greasy wool handle	Bruce McGregor	Sheep CRC	2011 - 2013	$60,000	

EXTERNAL GRANTS - NON-REPORTABLE					
AUSTRALIAN RESEARCH COUNCIL LINKAGE INFRASTRUCTURE EQUIPMENT (LEIF) GRANT	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**INDUSTRY FUNDING**
Facility for in-situ NMR of advanced materials and devices	Maria Forsyth; Jenny Pringle; Peter Hodgson; Ying (Ian) Chen	Monash University	2011 - 2013	$1,468,000	
AUSTRALIAN NATIONAL DATA SERVICE (ANDS) GRANTS	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**EDUCATION INVESTMENT FUND (EIF)**
Development of nanostructured electrode materials for sodium-ion batteries	Alexey Glushenkov	Academy of the Social Sciences in Australia	2013		$6,600
COLLABORATIVE RESEARCH NETWORK	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**INDUSTRY FUNDING**
Education, active living and water: leveraging Victoria universities research investment	Lingxue Kong	DIISR Collaborative Research Newtorks	2012 - 2014		$237,603
EDUCATION INVESTMENT FUND (EIF) GRANT	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**ARC / C'LTH FUNDING**	**EDUCATION INVESTMENT FUND (EIF)**
Australian National Fabrication Facility Ltd	Xungai Wang; Tong Lin	Monash University	2011 - 2014		$1,000,000

INTERNAL GRANTS - NON-REPORTABLE					
CENTRAL RESEARCH GRANTS SCHEME (CRGS)	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**DVCR FUNDING**	**INDUSTRY FUNDING**
Nanocomposite hybrid anodes in lithium-ion batteries in electric vehicles/hybrid electric vehicles	MD Mokhlesur Rahman	Deakin University	2013	$20,000	
Piezoelectric electrospun nanofibres for highly-efficient mechanical-to-electrical energy conversion	Jian Fang	Deakin University	2013	$20,000	
Functional fabrics with a super-repellency to ultralow surface-tension oil fluids	Hongxia Wang	Deakin University	2013	$18,000	
Highly active ionic liquid based organocatalysts for green chemical applications	Luke Henderson	Deakin University	2013	$20,000	
Production and application of graphene-like boron nitride nanosheets	Luhua Li	Deakin University	2013	$20,000	
Superhydrophilic treatment and reducing photo-yellowing of wool with organic/inorganic hybrids	Yan Zhao	Deakin University	2013	$18,000	
Nanostructured electrode materials for sodium-ion batteries	Alexey Glushenkov	Deakin University	2013	$22,000	
New experimental NMR methods for the characterisation of advanced materials	Luke O'Dell	Deakin University	2013	$22,000	
DEAKIN INTERNATIONAL RESEARCH DEVELOPMENT SCHEME (IRDS)	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**DVCR FUNDING**	**INDUSTRY FUNDING**
2013 IRDS Award	Minoo Naebe		2013	$8,383	
2013 IRDS Award	Lingxue Kong		2013	$15,000	
DEAKIN UNIVERSITY THINKER IN RESIDENCE	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**DVCR FUNDING**	**INDUSTRY FUNDING**
Prof Jeffrey Wiggins	Bronwyn Fox	Deakin University	2013	$10,000	
Prof Michel Armand	Maria Forsyth	Deakin University	2014	$30,000	
Dr Liming Dai	Tong Lin	Deakin University	2013	$20,000	
RESEARCH EQUIPMENT SCHEME (RESS)	**INVESTIGATOR**	**INDUSTRY PARTNER / FUNDING BODY**	**YEARS**	**CENTRAL FUNDING**	**INDUSTRY FUNDING**
Low-gamma solid-state NMR probe with two channels and variable temperature capabilities	Luke O'Dell	Deakin University	2013	$50,000	
Discovery hybrid rheometer	Xungai Wang	Deakin University	2013	$110,000	
Sintering and heat-treatment facility at high temperature and ultrahigh vacuum	Peter Hodgson	Deakin University	2013	$115,000	

GRANT HOLDERS AND THEIR PROJECTS

ALFRED DEAKIN FELLOWSHIPS	INVESTIGATOR	INDUSTRY PARTNER / FUNDING BODY	YEARS	DVCR FUNDING	INDUSTRY FUNDING
Weiwei Lei	Ying (Ian) Chen		2011 - 2013	$182,099	
Li He	Lingxue Kong		2012 - 2013	$145,166	
Dr Dan Liu	Ying (Ian) Chen		2012 - 2013	$164,690	
Abu Sadek	Xiujuan (Jane) Dai		2013 - 2015	$201,023	
Ping'an Song	Qipeng Guo		2013 - 2014	$193,389	
Ming-hui Cai	Peter Hodgson		2012 - 2013	$140,130	
Jun Liu	Yuncang Li		2012 - 2013	$204,932	
Dengke Yang	Maria Forsyth		2012 - 2013	$164,690	
Dang Nam Nguyen	Maria Forsyth		2012 - 2013	$104,690	
Dr Chuanxiang Qin	Tong Lin		2012 - 2013	$157,035	
Yong Du	Tong Lin		2013 - 2014	$90,950	
Abdullah Kafi	Bronwyn Fox		2012 - 2013	$196,110	

PUBLICATIONS

BOOKS

1 Li, Zhenyu and Wang, Ce 2013, One-dimensional nanostructures electrospinning technique and unique nanofibers, Springer, Heidelberg, Germany.

2 Liu, Xiang Yang and Li, Jing-Liang 2013, Soft fibrillar materials: fabrication and applications, Wiley-CVH, Weinheim, Germany.

BOOK CHAPTER

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