Queensland Centre for Advanced Materials Processing and Manufacturing (AMPAM)

2014 ANNUAL REPORT

The University of Queensland

31 March 2015
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OPENING OF THE
ADVANCED ENGINEERING BUILDING

The Advanced Engineering Building (AEB) was officially opened on Wednesday, 10 September 2014.

The (then) State Government Minister for Education, the Honourable Minister John-Paul Langbroek, MP and the Federal Member for Ryan, Mrs Jane Prentice, MP were invited to officially open the Building. Also in attendance was the Chancellor, Mr John Story, the Vice-Chancellor, Professor Peter Høj and the Faculty Executive Dean, Professor Simon Biggs.

This report follows the items required under the Head Agreement for AMPAM.
2.0 2014 AMPAM RESEARCH

2.1 HIGHLIGHTS, BREAKTHROUGHS OR DIFFICULTIES ENCOUNTERED

The AMPAM research program has continued to deliver outcomes as described in the following:

• In 2014 the Assistant Minister for Defence, Stuart Robert, announced an extension of funding for the Defence Materials Technology Centre (DMTC) for a further 3 years from mid-2015 to 2018. The DMTC has contributed over $5,000,000 to AMPAM for the period 2008-2015.

• AMPAM researchers including Emeritus Professor St John, Associate Professor Dargusch and Associate Professor Nogita are Chief Investigators on two new ARC Research Hubs which were both opened in 2014 -

1. The ARC Research Hub for Australian Steel Manufacturing will develop breakthrough process innovations to enable the Australian steel industry to improve its global competitiveness. Based on an integrated, value chain approach to innovation in the steel sector, the Research Hub includes projects on innovation strategy and management, customer-focused product development, innovation in coating and surface engineering technology, and economic and environmental sustainability of iron and steel making. This Research Hub is valued at $5,000,000 over 6 years. In October 2014, UQ officially commenced the project with two part time research support staff and one PhD student participating in these activities.

2. The ARC Research Hub for Transforming Australia's Manufacturing Industry through High Value Additive Manufacturing will be established to underpin the uptake of metal alloy based additive manufacturing in Australia (including 3D printing). Research will cover the issues that need to be resolved for success, including the effects of non-equilibrium solidification, process optimisation to achieve quality, consistency and repeatability, and new user-friendly design tools to realise the benefit of free-form manufacturing. Real components will be studied to give immediate impact. The Research Hub will also train the highly skilled people needed for this growing industry. This Research Hub is valued at $4,000,000 over 6 years. The activities in 2014 were primarily concerned with negotiations with industry and research participants and the development of detailed research plans. The Hub was officially opened in November 2014 and agreements have been executed in 2015. It is expected that work will commence in April 2015.

• UQ researchers further strengthened the collaborative research relationship with China. In 2014, the Shandong-Queensland Research Centre for Advanced Metals (SQAM) was established. It is expected that the SQAM will attract more research funding from both Chinese government and industries.
• The Nihon Superior Centre for the Manufacture of Electronic Materials (NSCMEM) has been successful in securing external funding for the coming years. NSCMEM has secured a Hydrexia Ltd. Pty. Project ($150,000 from July 2013 to Dec 2016), a Nihon Superior Co. Ltd. project ($1,000,000 starting from April 2013 through to June 2016), and NSCMEM directorship engagement for 10 years ($1,800,000 until June 2025). In 2014, NSCMEM research resulted in 8 peer reviewed journal publications, 3 refereed conference proceedings, 13 conference presentations (including 1 keynote speech and 2 invited talks), and access to 7 synchrotron beam time sessions. Associate Professor Kaz Nogita, the Centre Director, contributed to organizing an international conference through his participation in an International Advisory Board for the International Conference on Advanced Material Engineering & Technology (ICAMET 2014), Ho Chi Minh City, Vietnam, 4-6 December (2014). Dr Guang Zeng from the Centre was awarded his PhD in October 2014.

• A new ARC linkage grant (LP140100485) was awarded to Associate Professor Nogita, Emeritus Professor St John and Associate Professor Dargusch to undertake work in the area of external fields during solidification of joining processes. This grant is valued at $473,000.

• Work has continued in the development of materials for electronic interconnects in the rapidly evolving electronics manufacturing sector. A deep understanding of the material behaviour during soldering has been achieved by applying advanced characterisation techniques including synchrotron powder XRD and real-time X-ray imaging during solidification and solder wetting. The proficiency that AMPAM researchers have developed in these synchrotron techniques, at national and international facilities, will be applied in the ARC research Hub for Australian Steel Manufacturing with BlueScope steel, with the involvement of Mr Matthew Gear, a newly appointed AMPAM PhD student.

• AMPAM researchers have been working closely with engineers from Cook Medical Australia to develop next generation endovascular medical devices. This work has been supported by an ARC Linkage project (LP120100353) and a RPP Project (2011003744). To date, the project has developed a number of prototype stent grafts that achieve a 25% reduction in stent profile compared to the stents currently implanted into patients. The smaller prototypes developed in this project will mean that less invasive surgery is required to treat the thousands of patients requiring Endovascular Aneurysm Repair. Smaller stent grafts allow more patients to be treated (i.e. those with small or highly tortuous arteries). Further design optimisations and materials selections are ongoing but this achievement is already is a great outcome for the project team and Cook Medical Australia.

• Through an additional ARC Linkage grant obtained in 2014, AMPAM is also working with Norske Skog, in association with AnoxKaldnes, to develop wood-PHA composites from pulp and paper waste streams. This partnership has been newly initiated and it is hoped it will lead to novel applications for Australian industry wastes.

• AMPAM researchers, through the Dow Centre for Sustainable Engineering Innovation, have been working with Dow Chemicals to develop novel approaches to high performance carbon fibres derived from polyethylene. This work attracted $150K of funding in 2014, with an additional Linkage application submitted.

• AMPAM researchers Professor Darren Martin, Dr Pratheep Annamalai and Dr Bronwyn Laycock were successful in obtaining an ARC Discovery project on carbon fibres from spinifex nanocellulose, in association with Professor Bronwyn Fox of the Deakin University Carbon Nexus Facility and Professor Eric McFarland of the Dow Centre for Sustainable Engineering Innovation. This work will see the development of a valuable alternative market product for remote communities.
• AMPAM has been collaborating with Manildra Starch, and was awarded a CIEF in 2014 for 70k with a 30k contribution from Manildra, for new biobased adhesives for improved mechanical properties, waterproofing, and reduced energy requirements for corrugated paper products.

• AMPAM has been collaborating with Boeing to develop novel incremental sheet forming (ISF) processes. This collaboration commenced under a PhD contract which has been rolled into a successful ARC Linkage project with an additional partner, QMI Solutions. The main aim is to develop a mechanics-based software system to enable design engineers to setup the ISF machine for a new prototype in minimum time. At present, design for ISF production is essentially a “black art”. In addition to project funding, Boeing has supplied materials and arranged a secondment of a senior engineer to AMPAM. The project was completed successfully and outcomes include the completion and testing of two algorithms for designing optimum intermediate shapes and prediction of forces. The algorithms have been tested on a simple and complex geometry in the first instance, and results have successfully matched Finite Element predictions and tested online using the Amino ISF machine.

• AMPAM has continued collaboration with Boeing in the form of a contract research project to further develop ISF algorithms in the form of user modules as part of Boeing proprietary software. This project has just commenced.

• AMPAM has continued further collaboration with Boeing in the form of a suite of 14 PhD top-up scholarships in the area of advanced forming and manufacturing. Proposed PhD projects have been drafted and the first batch of candidates have been identified for review by UQ and Boeing.

• AMPAM was successful as a major university partner in the new CRC for Rail Manufacturing. Much negotiation and preparation has been performed to initiate CRC trading early in 2015. AMPAM is working closely with industry partner Bombardier to initiate the first research project focussed on the development of novel bearing wear and maintenance modelling and technology.

• AMPAM researchers in the Nanomaterials group have been successful in securing almost $2.4million in competitive ARC Discovery, Linkage and LIEF grants during 2014. These grants will grow AMPAM’s capability in nanomaterials and bolsters UQ’s electron microscopy facilities (DP150100701, DP150100056, DE150101212, LP130100913, LP130101016, LE140100012).

• AMPAM became a partner in the European FP7 project ExoMet in 2013. This is a large project, valued at Euro12.65 million, investigating microstructural refinement of aluminium and magnesium alloys by applying external fields and inoculation. ExoMet is a consortium of 27 companies, universities and research organisations from 11 countries that integrates various scientific and technological disciplines as well as application areas including automotive, aircraft and space. The project targets high-performance aluminium- and magnesium-based materials by exploring novel grain-refining technologies through nanoparticle additions in conjunction with melt treatment by means of external fields (electromagnetic, ultrasonic, mechanical shearing). UQ is the only non-European partner. During 2014 we attended ExoMet’s annual meeting in Europe and collaborated on a number of papers one of which was published in the Journal of Crystal Growth and another at a solidification conference in the UK. Our main collaborator has been Prof Dmitry Eskin at Brunel University an expert in the use of external fields. The expertise we have developed has led to two ARC Linkage applications: one with Nihon Superior was successful in 2014 and the other is currently under review with Cook Medical. (These might be covered elsewhere but it shows the linkages)
• AMPAM began a new collaboration with Oxford University on real-time synchrotron studies of the solidification of Al alloys. The work at Oxford is groundbreaking in terms of being able to observe the nucleation and growth of grains during the initial stages of solidification. This work complements work we have been doing with Kyoto University, Japan, at the Spring8 synchrotron on Al-Si alloys.

• Funding was obtained from the Baosteel-Australia Joint Research Centre to conduct a new project (Project BA13037) investigating influence of hydrogen on steels for auto construction. The project is valued at 250K over three years (2014 $100k, 2015 $150k, 2016 $100k).

• AMPAM researchers, through the CRC for Advanced Composite Structures (CRC-ACS), have investigated new rapid assembly technologies for composite structures in collaboration with end customer Airbus as part of their development program. Research by AMPAM researchers has led to the discovery of a new reaction mechanism between aerospace composites resins and thermoplastics polymers. This breakthrough finding is currently part of a patent application.

• AMPAM researchers, through the CRC for Advanced Composite Structures have developed new compounding techniques for the production of short fibre biocomposites. Production trials commenced with the two potential end users Extrusion Technology International (Brisbane) and Durometer (Sydney). License negotiations have commenced in January 2015 with Agri Fibre Industries (Bundaberg) for the licensing of the compounding and extrusion IP.

• A new probabilistic design framework and a suite of numerical tools for probabilistic composite design have been developed by AMPAM researchers through collaboration in the CRC for Advanced Composite Structures. Upon completion these guidelines will be made available to the Australian composite industry.

• AMPAM researchers of the UQ Composites group have performed over $15,000 worth of consultancy projects for Australian SMEs. They have also secured a competitive $75,000 UQ Collaboration and Innovation Industry Engagement fund for the development of new innovative composite manufacturing technologies with Airbus Helicopters Australia in Brisbane.

• AMPAM continues to work with BAE Systems Australia, Seco Tools Australia and Heat Treatment Australia on a range of manufacturing and sustainment problems.

• AMPAM continues to work with QMI Solutions to strengthen SME Engagement with UQ. A new agreement between QMI Solutions and UQ to facilitate research and technology transfer was signed in 2014.

• An advanced plasma arc melting furnace (PAM) for metal research has been installed within AMPAM at UQ. The project is funded by an ARC-LIEF grant led by Prof M Zhang, UQ and Deakin, UNSW and Monash.
2.2 PROGRESS IN THE AREA OF RESEARCH, EDUCATION AND TRAINING, COLLABORATION AND USER INVOLVEMENT, COMMERCIALISATION AND THE APPLICATION OF RESEARCH RESULTS GENERALLY

The following items details progress achieved by AMPAM in this area:

• AMPAM has continued further collaboration with Boeing in the form of a suite of 14 PhD top-up scholarships in the area of advanced forming and manufacturing. Proposed PhD projects have been drafted and the first batch of candidates have been identified for review by UQ and Boeing.

• AMPAM researchers through an ARC Discovery Project are investigating methane to biopolymer conversion, focussing on manipulation of metabolic pathways to produce materials with good mechanical properties.

• AMPAM researchers through the CHPP ran polyethylene strand trials on twin screw extruder for Gerry Triani (ANSTO), Tamim Darwish (ANSTO) & Arndt Schimmelmann (Indiana University).

• In early 2015, Emeritus Professor St John was awarded the "John Campbell Medal" by the Institute of Cast Metals Engineers in the United Kingdom, recognising his contribution to the science and understanding of metal casting, research and development.

• AMPAM researchers are closer to understanding how hydrogen is stored and released in magnesium based hydrogen storage alloys. By using one of the few ultra-high voltage TEM based facilities available worldwide (at Kyushu University), hydrogen release in relatively thick specimens of commercial relevance was observed. Complimentary work in association with Hydrexia Pty Ltd has characterised the hydriding/dehydriding behaviour using synchrotron powder XRD and in particular the effects of compositional variations in the sample.

• In 2014 AMPAM researchers visited Shanghai University to grown new collaborative research partnerships in solidification processing under external fields. AMPAM researchers have visited Zhengzhou University, Aluminum Corporation of China Limited (Chalco) Zhengzhou Research Institute, Chalco Luoyang Aluminium, Magnesium, and Copper factories in Henan. The visits to Henan enabled the establishment of a new research partnership between UQ, Chalco Zhouzhou Research Institute, and Zhengzhou University, and the details of the partnership are still being determined.

• AMPAM researchers through the CRC-ACS have developed short fibre biocomposites compounding technology, have developed a novel probabilistic design framework and developed open-source numerical tools for biocomposites analysis and design. License negotiations with a Queensland based company (Ari Fibre Industry) are underway.
• AMPAM researchers, through UQ composites, have commenced a development and implementation project with Airbus Helicopter Composites with the aim to increase competitiveness and strengthen manufacturing capabilities at the Brisbane site.

• AMPAM PhD researcher Angelica Legras, supervised by Associate Prof Rowan Truss and Dr Michael Heitzmann, was invited to present at the 2015 JEC conference (largest composite conference in the world) and the 2015 Inverse Gas Chromatography (IGC) symposium in New York. Her pioneering work is a result of a collaboration between the Composite Innovation Centre (Canada), CRC for Advanced Composite Structures and AMPAM.

• AMPAM researchers have been working closely with engineers from White Industries to evaluate the novel 3D printing technology to print sand core for Bronze and steel casting through UQ/QMI Solutions joint manufacturing innovation program. The outcome of this activity is expected to benefit the Australian foundry industries in particular to meet the niche market demand.

• AMPAM researchers have been working with Friction Welding Australia through UQ/QMI Solution joint manufacturing innovation program. The team is evaluating weldments and has provided useful information in understanding the effect of the process parameters on joint quality. A comprehensive report has been sent to the company. The project team is continuing to look for industrial partners with an interest in the opportunity for research to further this technology.

• AMPAM researchers lead by Professor Jin Zou have developed new international and national collaborations on semiconductor nanomaterials research with UCLA, Fudan University, CalTech, National Key Laboratory of Infrared Physics, Beijing University of Technology and the University of Sydney.

• AMPAM researchers played a major role in the Defence Materials Technology Conference annual conference held in Canberra in March 2014. This conference attracted both defence personnel, academia and industry.

• AMPAM PhD Student Angelica Legras visited the Composite Innovation Centre in Manitoba Canada for four months during 2014 to assist in the commissioning of the Inverse Gas Chromatograph in the newly established FibreCITY facilities, one of the world’s foremost centre of excellence for agricultural fibre grading.

• AMPAM, through the School of Mechanical and Mining Engineering and the CRC for Advanced Composite Structures, continues to provide financial support and manufacturing training to the UQ Racing Team. UQ Racing consists of approximately 50 undergraduate students across The University of Queensland who design, manufacture, build and ultimately race a Formula SAE race car at the Formula SAE Australasia (FSAE-A) competition. UQ Racing is an extracurricular project at the University of Queensland that provides students with practical educational opportunities, to gain real world experience in project management, teamwork, financial and resource management, detailed engineering design and hands-on manufacturing in a highly competitive environment. All aspects of UQ Racing are managed by students. UQ Racing engages with over 28 private companies that sponsor the team with materials or manufacturing services including LaserCentral, Penrite Oil Company, Custom Exhaust Specialist (CES), HarneX, Partec Plastics Training Centre, Queensland Raceway, Solidworks, Willowbank Raceway, GFR Industries, Quest Serviced Apartments, Beaurepaires, GLS Engineering, A Grade Anodising, Fulcrum, HARTS Paints, Elmass, Competition Coatings, Pureablu, Pennine Solutions, UAS Pacific, Minibody, LSM Advanced Composites, Prosport Developments, SNAP Printing Brendale, Pete's Canvas and Marine Trimming, Mick's Bike & Car Tyres, Festo and TVGDEV.
2.3 DEVELOPMENT OF ANY AMPAM INTELLECTUAL PROPERTY OF POTENTIAL COMMERCIAL VALUE FROM WHICH UQ MAY DERIVE PROCEEDS OF COMMERCIALISATION

Three of the five agreements provide for reinvestment of proceeds and two agreements provide for proceeds sharing as follows:

- CAST CRC Limited - proceeds reinvested
- Polymer CRC - proceeds reinvested
- DMTC Limited - proceeds reinvested
- ARC Centre of Excellence for Design in Light Metals - proceeds shared on a proportional basis with 40% proceeds reinvested
- CRC for Advanced Composite Structures - IP owned by participants on a project by project basis
- CHPP researchers – PCT submitted on novel carbon fibre composite materials

No relevant IP was created by the ARC Centre of Excellence for Design in Light Metals.

Note that the refunded CRC-ACS has adopted a new approach to IP exploitation rights whereby major investors in IP generation (greater than 30% investment) have royalty free non-exclusive right of use, and the broader Participant base is able to negotiate licence terms for their own field of use. This aims to make an attractive investment environment simultaneously for major end-users and SMEs. This approach also aims to maximise the application of IP into multiple market sectors. CRC-ACS has traditionally focused heavily on the development of Intellectual Capital (IC), incorporating developed skills and tacit knowledge alongside the developed IP. Over time, the IC held within CRC-ACS is intended for transfer to the licensees, with an emphasis on the Participant base and Australian SMEs. The creation of ACS Australia as a spin-off company of CRC-ACS, and being appointed as Utilisation Agent, has the beneficial effect of retaining critical IC in a core of staff intimately involved with the CRC-ACS Projects, and experienced in interaction with the Participant base and the Australian Composites Industry.
2.4 LIST OF ALL UQ PERSONNEL WHO PARTICIPATED IN AMPAM RESEARCH

At UQ there were 140 persons engaged in AMPAM research and commercialisation during 2014 as shown in the table below. This is approximately slightly more than 2013.

<table>
<thead>
<tr>
<th>UQ Personnel engaged in AMPAM research and commercialisation</th>
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<tbody>
<tr>
<td>Aarti Tobin</td>
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<tr>
<td>Andrew Whittaker</td>
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<tr>
<td>Arvind Prasad</td>
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<tr>
<td>Cameron Milne</td>
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<tr>
<td>Chenhao Wang</td>
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<tr>
<td>Cindy September</td>
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<tr>
<td>Daniel Graham</td>
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<tr>
<td>David Mee</td>
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<tr>
<td>David Xie</td>
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<tr>
<td>Emilie Gauthier</td>
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<tr>
<td>Greg Cash</td>
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<tr>
<td>Gui Wang</td>
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<tr>
<td>Hamid Ronagh</td>
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<tr>
<td>James Turner</td>
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<tr>
<td>Jeffrey Venezuela</td>
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<tr>
<td>Jiawen (Simon) Su</td>
</tr>
<tr>
<td>Johannes Reiner</td>
</tr>
<tr>
<td>Jonathan Read</td>
</tr>
<tr>
<td>Jurg Dual</td>
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<tr>
<td>Leonard John Mcinnes</td>
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<tr>
<td>Liqing Huang</td>
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<tr>
<td>Luigi Vandi</td>
</tr>
<tr>
<td>Martin Veidt</td>
</tr>
<tr>
<td>Michael Bermingham</td>
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<tr>
<td>Michael Smart</td>
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<tr>
<td>Ming Li</td>
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</table>
3.0 PROGRESS AGAINST KEY PERFORMANCE INDICATORS

Details regarding KPI progress are given below. Note that many KPIs are not due until after practical completion.

<table>
<thead>
<tr>
<th>KPI</th>
<th>PROGRESS</th>
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<tbody>
<tr>
<td>Governance Arrangements</td>
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<tr>
<td>At least three (3) months prior to practical completion of construction of AMPAM, UQ will establish the following AMPAM governance arrangements:</td>
<td></td>
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<tr>
<td>Complete</td>
<td>Establish the AMPAM Advisory Board, and Strategic Planning Committee.</td>
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<tr>
<td></td>
<td>The members of the AMPAM Advisory Board are: Dr Mark Hodge, CEO DMTC (Defence sector) Dr Samih Nabulsi (Medical Devices sector) Prof David Mee (Research &amp; Education). Mr Gary Christian (CEO QMI Solutions) The Strategic Planning Committee includes: Matt Dargusch (Chair) Martin Veidt (Composites CRC) Peter Halley (Chemical Engineering) Bronwyn Laycock (CRC Polymers) Gary Christian (QMI Solutions)</td>
</tr>
<tr>
<td>Complete</td>
<td>Appoint the AMPAM Director and AMPAM Facility Manager to oversee the management and operation of AMPAM.</td>
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<tr>
<td></td>
<td>Associate Professor Matthew Dargusch and Professor Peter Halley have been appointed AMPAM Directors, after taking over from Professor David StJohn who was interim Director up until late 2013.</td>
</tr>
<tr>
<td>Complete</td>
<td>Appoint Platform Managers for each AMPAM Research platform, including an Education and Technology Transfer Platform Manager responsible for engaging with industry, assessing industry requirements and matching industry needs with AMPAM’s capabilities.</td>
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<tr>
<td></td>
<td>The platform managers are: A/Prof Matt Dargusch: Education and Technology Transfer Platform Manager Prof Peter Halley: Sustainable Manufacturing A/Prof Martin Veidt: Design, Analysis and Modelling Prof David StJohn: Novel &amp; Advanced Materials A/Prof Matt Dargusch: Manufacturing Processing Technology</td>
</tr>
</tbody>
</table>
**Complete**

Appoint a Manager for Innovation and Commercial Development in Engineering, Architecture and Information Technology to:

- assist UQ and AMPAM Participants to identify and implement new R&D projects addressing industry requirements for advanced materials processing and manufacturing;
- facilitate contact between researchers and industry; and
- identify, protect and package innovations for commercialisation.

Howard Leemon, UniQuest, will undertake this role. He is located in the EAIT Faculty and will undertake the roles defined for this KPI. In 2012 Howard was a key player in the establishment of the Nihon Superior Centre for the Manufacture of Electronic Materials.

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**Employment of Professional Staff**

*Capacity and capability of AMPAM to employ a net increase in new research and other professional staff (FTEs).*

**Complete**

Within six (6) months of the Practical Completion Date, create at least six (6) additional full time equivalent positions (there are currently 65 Full Time Equivalent employees working under AMPAM related activities, including 15 postgraduate students) dedicated to working on the UQ Based AMPAM Activities including:

- Four (4) PhD candidates;
- One (1) research fellow; and
- One (1) Professor.

This milestone was achieved in 2012 with a total of 130 FTE employees. This included 4 new students (list) and 1 research fellow (Dr Michael Bermingham). The chair is currently held by Prof. StJohn.

**Complete**

Thereafter, increase the number of research, technical or business development staff employed in AMPAM by 5% per annum to the capacity of the facility up to 105 Full Time Equivalent employees within ten (10) years of the Practical Completion Date.

This milestone was achieved in 2012 with a total of 130 FTE employees.

In 2014 AMPAM continued to engage 140 FTE people which is above the 10 year target of 105.
Education and Skills Development

Capacity and capability of AMPAM to educate and train post-graduate students in research or entrepreneurial skills.

**Complete**

Commence ten (10) PhD and/or Masters Degree students per annum following the Practical Completion Date.

12 new PhD students have commenced at AMPAM in 2014:
- Matthew Gear
- Han Gao
- Xiao-Lei Shi
- Jiawen Su
- Ye Tian
- Cameron Milne
- Chenhao Wang
- Clement Chan
- Syarifah N. S. Muhamad
- Qinglong Liu
- Qiyang Tan
- Ning Mo
- Jeffrey Venezuela

These student join the other AMPAM students who have already commenced their studies:
- Haibo Lui
- Chen Zhou
- Mun Teng Soo
- Lei Yang
- Liqing Huang
- Min Hong
- Zhi Zhang
- Zhiming Liao
- Yichao Zou
- Hongyi Zhan
- Yaowu Zhang
- Johannes Reiner
- Cindy September
- Enrico Hadde
- Zhixue ‘Lawrence’ Liu
- Angelica Legras
- Tristan Shelley
- Mitchell Dunn
- Jianmin Li
- Liliana Montano Herrera
- Emilie Gauthier
- Fuyong Cao
- Yahia Ali
- Stephen Bonner
- Ming Li

There has been six recent PhD completions and five thesis submissions:
- Om Janarthanan
- Guang Zeng
- Yao Xi
- Bing Han
- Wen Sun
- Guang Han
- Xiaogang Liu
- Shijie Jiang
- Qian Liu
- Zhilin Liu
- Yanle Li

**Ongoing**

Develop and implement, in consultation with industry, a comprehensive post-graduate and undergraduate training and technology diffusion programmes.

The postgraduate programs provided by the participating industry-focused centres have been very effective. The successful elements will be...
program within two years of the Practical Completion Date. The undergraduate program is focused on the work experience systems currently required as part of their degree program. The new BE/ME program will provide an excellent opportunity to provide a strong industry perspective within the program.

**Ongoing**
Develop and implement in consultation with industry, a degree program in the field of Advanced Manufacturing.

A/Prof. Matt Dargusch is currently redesigning undergraduate courses to have a significant manufacturing component.

**Complete**
Establish a Chair of Advanced Manufacturing within six (6) months of the Commencement Date.

During 2014 the chair was held by Prof David StJohn. This position is currently being reviewed in light of Prof StJohn’s recent part time status.

**Capacity and capability of AMPAM to integrate manufacturing research with teaching links to TAFE sector, apprenticeship and training providers.**

**Complete**
One training session developed and delivered into tertiary or vocational educational institutions per annum following the Practical Completion Date.

AMPAM organised a 3 day ISF workshop during 2014 for Boeing, QMI and UQ researchers focused on advanced technology and methods in Incremental Sheet Forming.

**Ongoing**
Develop an educational program, in consultation with TAFE Queensland, to provide a seamless pathway from TAFE to the newly established Advanced Manufacturing degree program in the field of Advanced Manufacturing.

Through the CAST CRC, AMPAM has contributed to the development of a new Certificate IV in Engineering (Foundry Technology) in collaboration with the Australian Foundry Institute (AFI)’s Queensland Division, and SkillsTech Australia. AFI is keen to see this extended into levels 5, 6 and, ultimately, 7 of the Australian Qualifications Framework. With the demise of the CAST CRC it is uncertain how this future work will be resourced.

**Ongoing**
Three (3) AMPAM-involved PhD and Masters Degree students working with Queensland manufacturers per annum within one (1) year of the Practical Completion Date increasing to five (5) AMPAM-involved PhD and Masters Degree students working with Queensland manufacturers per annum with five (5) years of the Practical Completion Date.

Bing (Kathy) Han, an AMPAM PhD student sponsored by the DMTC and working with BAE Systems Australia to develop a FEA model to simulate crack propagation in aircraft coatings, has completed her project and been awarded her PhD.

Donna Capararo, an AMPAM PhD student sponsored by the DMTC, is working with BAE Systems Australia to develop a method of monitoring paint degradation on aircraft.
Clement Chan, an AMPAM PhD student sponsored by an ARC Linkage project through Norske Skog and AnoxKlades, is working on novel wood-biopolymer composites.

Angelica Legras, an AMPAM PhD student is working with Brisbane based company Extrusion Technology International. In the collaboration which is part of the CRC-ACS, Angelica is testing the upscaleability of the natural fibre extrusion processes she has developed.

Zhaobing Liu, an AMPAM PhD student sponsored by ARC Linkage Project and CSC scholarship, is working with Boeing and QMI to develop models for incremental sheet forming shape and deformation strain prediction. Yanle Li, an AMPAM PhD student sponsored by ARC Linkage Project and CSC scholarship, is working with Boeing and QMI to develop models for incremental sheet forming contact force prediction. James Fay, M Phil candidate, is working with Australian Aerospace to develop a non-destructive evaluation method to characterise humidity ingress in composite sandwich panels.

Collaboration

*Ability of AMPAM to maintain or increase collaborative programs and links with local, national or international research, education, and commercial partners.*

**Complete**

Within six (6) months of the Practical Completion Date, develop, implement and thereafter maintain a strategy for AMPAM to collaborate with small to medium enterprises to address their requirements for applied R&D.

QMI Solutions, CAST and DMTC have been collaborating with SMEs to address research and technology transfer requirements. Workshops have been held to define AMPAMs offering to SMEs as a precursor to strategy development. A novel use of Business Model Canvas approach to facilitate this task has been undertaken with the support of QMI Solutions. QMI Solutions and AMPAM have established a formal agreement to facilitate SME Engagement.

**Complete**

Within two (2) years from the Practical Completion Date, have entered into two (2) new collaborations with new or existing research partners in Australia.

A collaboration with Deakin University was established, with a successful ARC Discovery on novel spinifex nanocellulose derived carbon fibres being won in 2014.
The opening of two new ARC Research Hubs in 2014 has created new collaborations between Australian research providers including the University of Wollongong and Monash University.

The successful bid of the new Rail Manufacturing CRC has initiated new collaborations with CQU, University of Wollongong and other CRC research and industry partners.

Through the CRC-ACS UQ has established a collaboration with the Aerospace Malaysia Innovation Centre, University Putra Malaysia and MAC. The project titled BIOSHPERE is developing bioadhesives for the aerospace industry. UQ is leading the custodian of the project at the end of the CRC-ACS in June 2015.

**Complete**

Within two (2) years from the Practical Completion Date, have entered into two (2) new collaborations with new or existing industry or business partners including small to medium enterprises in Australia.

A new collaboration with Norske Skog was established through the successful granting of an ARC Linkage (2014-2017) on novel wood biopolymer composites.

A new collaboration with Dow Chemical in the US was established through funding of a project on cost effective carbon fibres from polyethylene.

A new collaboration with NuFarm was established through funding of a project on controlled release formulations from bioderived matrixes.

The successful bid of the new Rail Manufacturing CRC has initiated new collaborations with Bombardier Transportation Australia

In 2014 a new collaboration was established with Whites Industries (Dalby) to evaluate 3D printing sand moulds for bronze and steel casting.

A collaboration with Airbus Helicopter Composites was established by the UQ Composite group. The project will investigate new short cycle time manufacturing processes.

**Future**

Within seven (7) years from the Practical Completion Date, have entered into sixteen (16) new collaborations with new or existing research, industry or business partners including small to medium enterprises in Australia.

This KPI will be addressed in future reports. See previous KPI for an update on this progress.
A new industry sponsored centre has been attracted to AMPAM. The Nihon Superior Centre for Manufacture of Electronic Materials (Director Kaz Nogita) opened in 2012 and will investigate state-of-the-art electronic materials and manufacturing processes including novel solder alloys and soldering techniques. Engagement of Centre directorship has been extended to June 2025.

Three (3) national and international visiting scientists per annum attracted to participate in AMPAM Research within two (2) years of the Practical Completion Date increasing to five (5) national and international visiting scientists per annum attracted to participate in AMPAM Research within five (5) years of the Practical Completion Date.

Dr Christopher Gourlay from Imperial College London visited for three weeks in Sep 2014 to discuss joint research initiatives with NSCMEM.

Dr Kristián Máthis from the Department of Physics of Materials Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic, visited in April 2014 to discuss research with A/Prof. Caceres at AMPAM.

Dr Yanfeng Gao from Nanchang Hangkong University China visited AMPAM for 12months during 2014 and collaborated with AMPAM researchers to study titanium machining technologies.

A/Prof Guoqiang You from the School of Materials Science and Engineering, Chongqing University China visited AMPAM in 2014 to discuss research collaboration.

Prof Damian Schofield from the State University of New York visited AMPAM in July 2014 to research collaboration and deliver a distinguished lecture.

A/Prof. Tim Sercombe from the School of Mechanical and Chemical Engineering, University of Western Australia, visited AMPAM in July 2014 to discuss research collaboration.

Matthias Buderath, Head of Technology - and Technology Domain Management, visited March 6th to discuss future collaborations with the Airbus group.
Research and Development Excellence

*National and international recognition of AMPAM as a centre of excellence in advanced materials processing and manufacturing applied research and development.*

<table>
<thead>
<tr>
<th>Complete</th>
<th>See the publication lists in the Participant annual reports accompanying this report.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete</strong></td>
<td>Ten (10) refereed scientific papers, published in national or international journals or books per annum directly related to advanced manufacturing and applied applications (averaged over each five (5) year period from the Practical Completion Date).</td>
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<table>
<thead>
<tr>
<th>Complete</th>
<th>See the publication lists in the Participant annual reports accompanying this report.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Complete</strong></td>
<td>Fifteen (15) conference papers, articles and industry reports published per annum directly related to advanced manufacturing and applied applications (averaged over each five (5) year period from the Practical Completion Date).</td>
</tr>
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<thead>
<tr>
<th>Commercialisation and Knowledge Transfer</th>
<th>Demonstrate that AMPAM’s R&amp;D program will generate, protect and commercialise new intellectual property.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Method of Producing Polyhydroxyalkanoate Compounded Plastics Having Improved Mechanical Properties: International Application No. PCT/IB2013/061111. Alan Werker, Monica Arcos-Hernandez, Bronwyn Laycock, Steven Pratt, Peter Johansson, Per Magnusson</td>
</tr>
</tbody>
</table>
Demonstrate leadership in the transfer of research innovations into public policy and to the materials engineering industry.

**Complete**
Within two (2) years from the Practical Completion Date, have provided assistance to four (4) Queensland manufacturing firms to enable them to:
- further develop their manufacturing capability of advanced materials;
- supply into larger firms that undertake contract manufacture for other clients; or
- supply into multinational manufacturing firms.

See Participant Annual Reports

AMPAM researchers, through the CRC-ACS have worked with extrusion technology international (Brisbane) to develop short fibre them natural fibre compounding.

**Future**
Within four (4) years from the Practical Completion Date, have provided assistance to eight (8) Queensland manufacturing firms to enable them to:
- further develop their manufacturing capability of advanced materials;
- supply into larger firms that undertake contract manufacture for other clients; or
- supply into multinational manufacturing firms.

This KPI will be addressed in future reports.
See previous KPI for an update on this progress.

**Future**
Within eight (8) years from the Practical Completion Date, have provided assistance to sixteen (16) Queensland manufacturing firms to enable them to:
- further develop their manufacturing capability of advanced materials;
- supply into larger firms that undertake contract manufacture for other clients; or
- supply into multinational manufacturing firms.

This KPI will be addressed in future reports.
See above KPI for an update on this progress.

Demonstrate leadership in the diffusion of applied research innovations through:

**Complete**
Three (3) showcase seminars and one (1) forum planned, developed and delivered in collaboration with the Department and QMI Solutions to a minimum of 120 SMEs throughout Queensland per annum commencing two years from the Practical Completion Date.

The following workshops, forums and symposia were held over the current and previous reporting periods:

3-day Incremental Sheet Forming Workshop held in the Advanced Engineering Building UQ Aug 18-20 2014.
AMPAM researcher Prof Jin Zou organised the 8th International Conference on Advanced Materials Processing held on the Gold Coast, 27-30th July 2014

CRCPolymers workshop: Driving productivity growth across the food supply chain, Brisbane March 31 2014 (B. Laycock presenter/panel).

AMPAM researcher Dr Laycock presented and served on the expert panel at the “Agricultural Plastics Innovation Clinic” organised by the Queensland Government and the Australian Institute for Commercialisation (AIC) on 12 June 2014 at Home Hill, QLD. The forum addressed fundamental issues including the development of environmentally friendly, economically viable solutions to manage agricultural plastic waste. The forum was attended by growers, industry experts and research leaders.

CRC Polymers Annual Meeting, Melbourne July 29 2014.

15th Australasian Polymer Summer School, University of Western Sydney Village, Parramatta North Campus, New South Wales from 4-6 February 2014.

16th Australasian Polymer Summer School February 3-5 2015, at Monash University, Clayton.

2014 DMTC Annual Conference was held in March (26-27th) 2014, Canberra. Attendees included SMEs Australia wide working in the defence industry.

AMPAM Co-director A/Prof Dargusch presented a seminar at the AFI conference in the Gold Coast. The event attracted many Queensland SME’s and was reported in the Metal Casting Technologies Asia Pacific magazine.

Dr Michael Heitzmann presented a seminar on Composite materials for process engineering applications. Joint Chemical Engineering Committee Seminar, Engineers Australia, Brisbane 22nd July 2014.
Chemeca 2013 Sep30-Oct2 2013 Brisbane
(P.Halley Technical Committee)

CRCPolymers workshop Water and Food security, Melbourne, October 11 2013 (P.Halley presenter/panel).

10th Composites Australia and CRC-ACS Conference, 4 – 5 March 2013 in Melbourne

CRC-ACS Annual Meeting, 28 Feb. – 1 Mar 2013

International Symposium on BioPolymers (ISBP2012), Cairns October 7-10 2012 (P.Halley, R.Truss, B.Laycock technical committee).

The First International Conference on Metallic Materials and Processing, held 8-11 July 2012, Gold Coast, Australia. Sponsored by DMTC.

14th Australasian Polymer Summer School, held 4-7th Dec 2012, Flinders University.


Technology Seminar: Practical Composites Design & Analysis was delivered by CRC-ACS to Engineering Australia and Composites Australia Members. Seminars were held in Melbourne, Brisbane and Sydney during 2012.

9th Composites Australia and CRC-ACS Conference, 15 – 16 March 2012 in Blue Mountains.

CRC-ACS Annual Meeting, 13 – 14 March 2012

Powder Processing, Consolidation and Metallurgy of Titanium, held 4-7th Dec 2011, UQ.


AMPAM workshop, held 11th May 2011 Eight Mile Plains.
Complete
One (1) showcase seminar delivered in South East Queensland per annum commencing two (2) years from the Practical Completion Date.

Manufacturing Innovations in Titanium Processing, held 10th Jun 2010, Eight Mile Plains.

One-day Titanium manufacturing workshop, held at UQ 26 Aug 2010.

8th Composites Australia and CRC-ACS Conference, 16-18 March 2011, Sanctuary Cove.


CRC Polymers Annual Meeting, Melbourne Sep 5 2011.

CRC Polymers – Polymer summer school, UQ Brisbane Dec 6-9 2011.

CRC Polymers, Smart Surfaces seminar series (Melbourne, Sydney, Perth, Adelaide, Brisbane) 2011.

3-day Incremental Sheet Forming Workshop held in the Advanced Engineering Building UQ Aug 18-20 2014.

CRCPolymers workshop: Driving productivity growth across the food supply chain, Brisbane March 31 2014 (B. Laycock presenter/panel).

Technology Seminar: Practical Composites Design & Analysis was delivered by CRC-ACS to Engineering Australia and Composites Australia Members. Seminars were held in Melbourne, Brisbane and Sydney during 2012.


AMPAM workshop, held 11th May 2011 Eight Mile Plains.

Manufacturing Innovations in Titanium Processing, held 10th Jun 2010, Eight Mile Plains.

One-day Titanium manufacturing workshop, held at UQ 26 Aug 2010.
CRC Polymers, Smart Surfaces seminar series (Melbourne, Sydney, Perth, Adelaide, Brisbane) 2011.

**Future**
Two (2) showcase seminars developed and delivered beyond South East Queensland per annum commencing two (2) years from the Practical Completion Date.

This KPI will be addressed in future reports.

**Complete**
One (1) forum conducted to identify and address a range of industry requirements and existing and emerging opportunities and challenges per annum commencing two (2) years from the Practical Completion Date.

AMPAM, through the DMTC held a ‘Future Directions for the Titanium Manufacturing Industry in Australia’ workshop at QMI Solutions on 10 December 2012. The workshop was conducted to explore future opportunities for the manufacturing industry in titanium related technologies and businesses involved in, or looking to get involved in, titanium manufacturing were invited to attend. Attendees included representatives from federal and state governments, defence primes and SMEs.

**Future**
Within three (3) years of the Practical Completion Date, evidence through the provision of three (3) case studies that AMPAM’s applied research findings have been adopted by Queensland firms resulting in increased business opportunities secured, efficiency savings realised and/or increased capital investment.

This KPI will be addressed in future reports.

**Investment in Research**
*Ability to attract external funding for AMPAM Research from competitive research grants or other sources such as consultation or revenue from commercialisation of intellectual property or philanthropists.*

**Complete**
By the Practical Completion Date, the Strategic Planning Committee to develop a strategy for maintaining investment and supporting the AMPAM Participants.

AMPAM has adopted a strategy of building strong linkages between industry and UQ in order to prepare proposals for major funding schemes such as the ARC ITRH scheme and the CRC program. In response to this strategy, AMPAM participated in two successful proposals to the ARC ITRH scheme in 2013.

**Complete**
Secure $2 million per annum of external funding for AMPAM Research for the five (5) year period from the Commencement Date.

All participants have met their contributions to satisfy this KPI. CRC Polymers was successful in its extension bid (from 2012 to 2017) for $15M, starting July 2012.
For the balance of the term of this Agreement, maintain external funding for AMPAM Research at not less than $3 million per annum.

AMPAM has already exceeded this KPI target with the total income from the participating centres being ~$23,798,445.

In 2014 the Assistant Minister for Defence announced the extension of the DMTC for 3 years from mid 2015-2018. So far the DMTC has contributed over $4,000,000 to AMPAM from 2008-2014.

In 2014 two ARC IRT were launched (ARC Research Hub for Australian Steel Manufacturing & ARC Research Hub for Transforming Australia’s Manufacturing Industry through High Value Additive Manufacturing).

AMPAM to inform and engage the community in the activities conducted at AMPAM, highlighting AMPAM Research, communicate to the community the importance of the research industry to Queensland’s future, and acknowledge the contribution by the Queensland Government, commencing two (2) years from the Practical Completion Date.

Dr Paul Luckman is AMPAM’s representative on the QSCWG.

AMPAM aims to participate in QSCWG activities that relate to the promotion of advanced materials engineering and R&D.

Four (4) feature articles per annum to appear in related trade and business publications on the importance and relevance of AMPAM Research.

AMPAM Co-director A/Prof Dargusch presented a seminar at the AFI conference in the Gold Coast. The event attracted many Queensland SME’s and was reported in the Metal Casting Technologies Asia Pacific magazine.

AMPAM researchers have published two articles in the Journal of the Technical Association of the Australian and New Zealand Pulp and Paper Industry (APPITA). Appita is the not-for-profit association serving the Australian and New Zealand pulp and paper industry. Appita’s mission is to facilitate the interchange of information for the industry, across the whole supply chain from forests through to end uses of paper products:


AMPAM research on low cost titanium manufacturing featured in a media story which highlighted the strong collaboration between UQ and local and international manufacturing industry (“QLD to shoot down cost of manufacturing titanium” The Courier-Mail January 31, 2014.

**Complete**

Four (4) guided tours of AMPAM, industry visits or school visits to lift community and industry awareness of AMPAM Research and promote AMPAM’s relevance to the community, industry and the State’s economic development.

AMPAM Researchers presented demonstrations to High school students to make them aware of AMPAM research and engineering at the “Women in Engineering Day” held in Sept 2014. This interactive forum exposed the students to new materials and manufacturing research currently happening in AMPAM.

AMPAM Researcher, Jonathan Read, has been coordinating and delivering scientific demonstrations to high school groups that visited AMPAM. Throughout 2014 three schools visits were held.

Since the opening of the AEB, a number of guided tours of the new facilities have taken place with visits from Airbus, Boeing, the Royal Australian Air Force, Cook Medical Australia, Griffith University, DMTC partners, Crimsafe, Duromer, Airbus Helicopter Pacific, Hains Timber and a number of SMEs including Wilson Engineering, White Orthodontics and Expektra Pty. Ltd.

**Complete**

Establishment of AMPAM website as a general public communication vehicle to provide updates on AMPAM Research and promotional activities, within one (1) year from the Practical Completion Date.

The AMPAM website has been established: www.uq.edu.au/ampam/
4.0

INFORMATION DESCRIBED IN CLAUSE 5 OF THE PROCEEDS OF COMMERCIALISATION AGREEMENT

There were no Commercialisation activities undertaken during the 2014 period.

5.0

EVIDENCE THAT UQ HAS MADE THE UQ CONTRIBUTIONS DUE AND OWING AS AT 31 DECEMBER OF THE PRECEDING YEAR

The contributions from UQ were received and supporting documents for 2014 are supplied to DSITIA with this report.

6.0

EVIDENCE OF THE AMPAM PARTICIPANTS’ CONTRIBUTION UQ HAS RECEIVED AS AT 31 DECEMBER OF THE PRECEDING YEAR AND THE PROGRESS TOWARDS REACHING THE AMPAM PARTICIPANTS’ CONTRIBUTION LEVELS IN ACCORDANCE WITH ITEM 3 OF SCHEDULE A AS AT THE DATE OF THE ANNUAL REPORT

AMPAM’s participants’ contributions have exceeded levels outlined in the agreement and relevant supporting documentation was attached with previous reports.
7.0 DETAILED INFORMATION ON THE COLLABORATIVE USE OF AMPAM

7.1 AN OUTLINE OF AMPAM RESEARCH AND THE UQ BASED AMPAM ACTIVITIES CONDUCTED BY UQ BY ITSELF AND IN COLLABORATION WITH AMPAM PARTICIPANTS DURING THE PREVIOUS YEAR AND PROPOSED FOR THE FORTHCOMING YEAR

During 2014, AMPAM conducted collaborative research activities with SMEs and research institutions including:

- A program of machining research to advance and deliver technology solutions to improve Australian manufacturing capabilities. This has resulted in both research advances and process improvements for industry partners. Some highlights of this research include a machining best practice process that has reduced component manufacturing time for BAE Systems, Seco Tools, Sutton Tools, Airbus; advanced coolant technology developments; machining vibration management and reduction strategies; machining process modelling; laser assisted machining.

- A program of advanced forming mechanics research and technology development in collaboration with Boeing, including the process development and modelling of incremental sheet forming. The project commenced in January 2011 with the Partner Organisations (Boeing Research and Technology Australia BRTA and QMI Solutions). Major outcomes in 2014 included -

  1. Experimental measurement and analytical prediction of contact forces in ISF for benchmark geometry. The algorithm will be used to predict and avert failure in the ISF process and possibly be incorporated into an ISF control strategy.
  2. Completion of benchmark experimental validation and analytical ISF deformation path optimisation investigation based on material flow. The optimum intermediate shape strategy for maximum formability in ISF was identified both experimentally and analytically on a complex shape.
  3. Further design and development of an instrumented tool for ISF contact force measurement.
  4. Completion and testing of two ISF algorithms for optimal multipass design and force estimation.
  5. Development of online modules for ISF force and residual thickness estimation as part of Boeing proprietary software.

- A program of fundamental hypersonics research in collaboration with BAE Systems Australia. This has resulted in the development of new advanced material systems for hypersonic vehicle leading edges and scramjet combustors.
• A program of developing new and more effective grain refining technology for continuous steel casting with collaboration of Baosteel. The research outcomes will lead to significant improvement of quality of steel products and impact on steel metallurgy worldwide.

• A basic program of materials and polymer flow research and development including polymer formulation and blending; rheology; flow simulation; polymer properties; and lifetime modelling. Systems we are currently examining include bio-based polymers, natural composites, degradable polyethylene, nanocomposites, carbon fibres, thermoset coatings, swallowing fluids and foods and supercritical polymer processing for aerospace, agricultural, biomedical, food and high value industrial plastics applications.

• The research, development and commercialisation of sustainable and degradable polymer materials for agriculture, food processing and industrial applications continued with partner companies Plantic (ARC Linkage), AnoxKaldnes and VWSA (ARC Linkage), Norske Skog (ARC Linkage) and Integrated Packaging (CRC Polymers), and new research with Warwick University and University of Alabama (ARC Discovery) and Deakin University (ARC Discovery). Specifically the CRC Polymers project focuses on sustainable agricultural film to enhance crop growth and save water; the ARC Linkage project with Plantic focuses on thin biobased film for packaging, the ARC Linkage with AnoxKaldnes focuses on novel biopolymers from bacteria, ARC Linkage project with Norske Skog focuses on wood polymer composites, ARC Discovery project with Warwick and Alabama focuses on new biobased polymer nanocomposites with enhanced processing, properties and value, and the ARC Discovery project with Deakin involves conversion of spinifex derived nanocellulose to carbon fibre.

• A comprehensive program of fundamental and collaborative industrial research in the area of metal casting and solidification. This research includes new alloy development for structural, medical and energy storage applications (aluminium, magnesium, titanium, zirconium, cobalt and ferrous alloys); new grain refiners and eutectic modifier developments; melt processing and quality control (e.g. dross, porosity, hot tearing and other defect minimisation); casting process developments (e.g. high pressure casting, gravity sand casting; vacuum arc melting); joining technology developments (new collaborative lead-free solder alloy developments with Nihon Superior, laser welding with Cook Medical).

• A program of corrosion research activities. This includes but is not limited to new surface engineering process developments (packed powder diffusion coating, surface nanocrystallization, anodizing and kinetic metallization); new corrosion resistant alloy developments; biodegradable materials for medical applications. Funding was gained for a project on the influence of hydrogen on steels for auto construction from the Baosteel-Australia Joint Research and Development Centre. Research collaboration with Alstom Switzerland is studying the influence of hydrogen for steels in the hydrogen. Publications have resulted from international collaborations with Alstom (Switzerland), Prof Uggowitzer, from ETH Zurich (Swiss Federal Institute of Technology Zurich) and Prof Kim Verbeken Univ of Ghent, Dr D.P. Lu Jiangxi Academy of Science Nanchang, Prof E Quandt University Kiel and Prof MC Zhao from Central South University, China.

• A program of joining technology research including adhesive bonding, self-piercing riveting, soldering, aluminium brazing, diffusion bonding and laser and conventional welding. These processes are used to join a range of metallic, non-metallic, composite and dissimilar materials for a variety of applications including biomedical, electrical, structural and functional. Current partners include Nihon Superior, Cook Medical and Henrob. As part of this program we interface with other research institutions including Osaka, Kyushu universities and the Australian Universities.
• A program of net shape manufacturing research including powder processing and metallurgy and design of low cost high performance powder metallurgy titanium alloys. Current primary research activities include powder metallurgy of (i) titanium and its alloys with the assistance of density functional theory (DFT) and molecular dynamics (MD) modelling; (ii) aluminium and its alloys with the assistance of computational fluid dynamics (CFD) modelling; (iii) amorphous alloys (Al-based and Ti-based); (iv) porous metallic materials (metal foams); and (vi) metal-ceramic hybrids and/or composites.

• A program of composite materials research particularly in developing non-destructive inspection and testing methodologies for evaluating the quality of composite aircraft structures. This has resulted in new technology developments in imaging laminar damage using guided waves ultrasonic measurement techniques.

• A program in developing a sessile drop test as pre-bond inspection tool suitable for a maintenance workshop in the aviation industry.

• A program in developing a new thermoplastic functional surface to replace the existing primer coating on composite structures.

• A program of composite materials research in developing rapid assembly methodologies for composite aircraft components. This has resulted in two technologies being selected by Airbus to be added to their development process.

• A program in developing new guidelines and technologies for onshore and offshore pipeline composite repairs and reinforcements. This has resulted in Petronas Research adding the techniques to their development program.

• A program of composite materials research in developing composite materials which are partially or fully sourced from renewable resources and the development of relevant design standards.

• A program in developing a non-destructive evaluation technique to characterise humidity ingress in honeycomb sandwich composites.

• A program in developing a novel finite element simulation tool to investigate the onset and evolution of damage in aircraft coatings.

• A program of medical device manufacturing with new materials and new device designs in partnership with Cook Medical Australia.

• A new research collaboration with Shandong Academy of Sciences and a Queensland-Shandong Joint Research Centre on Metallic Materials (QSRC-Metals Centre) was established in 2014. The objective of the QSRC-Metals Centre is to effectively promote the development of metal products and manufacturing processes in Shandong Province, and therefore to fulfil increasing demanding for new technologies associated with the rapid growth of Shandong companies through collaborative research. The establishment of the joint centre can also further improve the UQ’s research capability in the areas of metals and manufacturing.

Further details are available in the attached participating Centre Annual Reports.
In 2015, research at UQ will continue in the areas discussed above; however, some new emerging collaboration and research opportunities may include:

- The opening of the new ARC Industrial Transformation Research Hub Transforming Australia's Manufacturing Industry through High Value Additive Manufacturing will create new collaborations with national and international industry partners and research institutions. The project seeks to use state-of-the-art metallic 3D printing technologies to manufacture a complete aerospace engine. It will allow AMPAM researchers to build new links with partners from the aerospace industry and research providers including Safran-Microturbo SAS, A.W. Bell, Chassis Brakes International, International Seal Company Australia, Metallica Minerals Limited, Kinetic Engineering Services, Amaero Engineering, Monash University and Deakin University.

- The new DMTC program will be commencing with strong focus on light weighting and sustainment technologies.

- An ARC linkage project will see AMPAM researchers collaborating with RMIT, CSIRO and Magontec to improve the performance of magnesium alloys. The AMPAM contribution to this project will particularly focus on controlling the eutectic morphology in a range of rare-earth containing magnesium alloys with a view to optimising strength-ductility-cost combinations.

- In late 2014 an ARC Linkage project (LP140100485) on developing mechanically strong joints for lead-free soldering and aluminium brazing commenced with Nihon Superior as the industry partner. This project will accelerate in 2015 with the commencement of a PhD student who will be working on high-performance brazed alloy development. The application of external fields such as ultrasonic and electromagnetic fields will be integral to this project.

- The AMPAM contribution to the ARC research Hub for Australian Steel Manufacturing with BlueScope steel will continue. This will include several synchrotron experiments aimed at characterising material behaviour in commercial processing operations.

- NSCMEM will concentrate on its core projects related to solder alloy development. New projects will include low temperature liquid metal joining, novel high strength solder alloys and transient liquid bonding. Work in association with Hydrexia and hydrogen storage alloys will continue.

- A new ARC Discovery project will investigate the potential of nonlinear vibro-ultrasonic nondestructive evaluation techniques to detect and quantify laminar damage in advanced composite materials and structures made by additive manufacturing.

- A new project with the Volvo Group Australia Oceania will investigate the design of a flexible spare wheel carrier that is proposed to be commercially marketable for all trucks of the Volvo group.

- A new project with Airbus Helicopters Australia Pacific will investigate the impact behaviour of fibre-reinforced composite shell structures through experimental testing and numerical simulation.

- A new ARC Discovery project on novel biomimetic peptide based conducting nanowires for sensing applications will be starting in 2015, with the objective being to create cost-effective, non-toxic conducting peptide fibrils for use in water or physiological environments. These peptides are modelled on natural conductive tails in bacteria that are constructed from proteins and that have metal-like conductivity. The electrical signals in these nanowires are carried through aromatic groups in the peptides and/or attached cytochromes. We have already shown that peptides can, by design, self-assemble into long thermostable fibrils that support cell growth and development.
A new ARC Discovery project on biobased carbon fibres incorporating novel spinifex-derived nanocellulose will be starting in 2015. Spinifex grasses cover ~30% of our Australian continent, in the driest regions. We have found that, presumably because of this harsh environment, they are uniquely easy to break down into ultra-long, thin cellulose nanofibrils. We will take advantage of this trait to produce high strength, sustainable carbon fibre materials. Through the use of novel catalysts and advanced processing techniques, we will deliver cost-effective production, making bioderived carbon fibres a practical reality. The use of the world’s first university based carbon fibre research facility capable of producing high quality fibre (CarbonNexus) will ensure the product is industrially relevant, with real potential to capture a share of the $14B carbon fibre composite market.

A new collaboration is starting in 2015 with NuFarm technologies, developing novel biobased, biodegradable controlled release formulations for agricultural applications. This project will capitalise on the expertise AMPAM researchers have developed in biopolymer processing.
## 7.2 A LIST OF ENTITIES USING AMPAM OTHER THAN UQ OR AMPAM PARTICIPANTS DURING THE PREVIOUS YEAR AND PROPOSED FOR THE FORTHCOMING YEAR

Entities involved in conduction research with AMPAM in the previous year (2014):

<table>
<thead>
<tr>
<th>Nestle</th>
<th>Nyrstar</th>
<th>CUC</th>
<th>Henrob Australia</th>
<th>RMIT University</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAECO</td>
<td>MSC</td>
<td>Veolia</td>
<td>Baosteel</td>
<td>Lockheed Martin</td>
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<tr>
<td>RSL care</td>
<td>Lockheed</td>
<td>AnoxKaldnes</td>
<td>ACS Australia</td>
<td>Alstom Laboratory</td>
</tr>
<tr>
<td>Piber</td>
<td>Pacific ESI</td>
<td>NuFarm</td>
<td>Ampal Inc</td>
<td>Airbus</td>
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<tr>
<td>Lovett Engineering</td>
<td>Orica</td>
<td>Rheology Solutions</td>
<td>EADS Cassidian</td>
<td>USP</td>
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<tr>
<td>Boeing</td>
<td>CSIRO</td>
<td>Bradken</td>
<td>T-Mag</td>
<td>o.d.t. Engineering</td>
</tr>
<tr>
<td>Bishop</td>
<td>PLASMATE</td>
<td>Monash University</td>
<td>Deakin University</td>
<td>Nihon Superior</td>
</tr>
<tr>
<td>Rio Tinto Alcan</td>
<td>Queens University</td>
<td>Seco Tools Australia</td>
<td>Norske Skog</td>
<td>Millatec Engineering</td>
</tr>
<tr>
<td>EGR</td>
<td>BlueScope Steel</td>
<td>Sutton Tools Australia</td>
<td>Henkel Australia</td>
<td>Whites Industries</td>
</tr>
<tr>
<td>University of Alabama</td>
<td>Central QLD University</td>
<td>MartinFerra Engineering</td>
<td>Heat Treatment Australia</td>
<td>Newmont Mining</td>
</tr>
<tr>
<td>Plantaic Technologies Ltd</td>
<td>Northwest Institute of Non-ferrous Metals (NIN)</td>
<td>Cook Medical Australia</td>
<td>BAE Systems Australia</td>
<td>Boeing Research and Technology</td>
</tr>
<tr>
<td>Australian Foundry Institute (QLD Division)</td>
<td>Grandfield Technology</td>
<td>Central South University China</td>
<td>Swinburne University of Technology</td>
<td>Integrated Packaging</td>
</tr>
<tr>
<td>ETH Zurich (Swiss Federal Institute of Technology Zurich)</td>
<td>Defence Science and Technology Organisation (DSTO)</td>
<td>Advanced Magnesium Limited (now known as Magontec as of 20 November 2011)</td>
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</tbody>
</table>
Entities proposing to conduct research with AMPAM in the forthcoming year (2015):

<table>
<thead>
<tr>
<th>Company</th>
<th>University/Institution</th>
<th>Company</th>
<th>University/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duromer</td>
<td>Airbus</td>
<td>CUC</td>
<td>Lovett Engineering</td>
</tr>
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<td>Deutsches Zentrum für Luft- und Raumfahrt e.V.</td>
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APPENDIX 1
PARTICIPANT ANNUAL REPORTS

All but one of the Participant Annual Reports are provided as separate pdf documents where the UQ related projects and activities are highlighted in yellow. As the CRC Polymers do not publish an annual report, a report on the CRC Polymers UQ/AMPAM related activities is provided as Appendix 2.
APPENDIX 2
CRC Polymers report for AMPAM Annual Report

1. 2014 General Report

The CRC for Polymers (CRC-P) began its extension in 2012 (2012-2017; CRC Program funding of $14.5 million over 5 years). The CRC-P is conducting the following research programs:

HEALTH THERAPIES AND DELIVERY: this program is seeking to improve health outcomes by developing products that require polymer technologies for therapies and their delivery in human and animal health applications. The research involves understanding the interactions between polymers and biological materials, and tailoring the architecture and composition of synthetic polymers and biopolymers for use in biological applications.

WATER AND FOOD SECURITY: this program is developing polymer technologies which aim to assist Australian farmers meet the growing global demand for food by overcoming water scarcity and improving crop yields. The collaborative research involves expertise in polymer chemistry, water studies, microbiology, agronomy and soil science.

POLYMER SOLAR CELLS: this program is developing materials and technologies for the production of commercially viable flexible solar cells. These improved materials and technologies will not only provide long term protection against the ingress of water and oxygen, and the harsh Australian environment, for the current generation of flexible solar cells, but will also be used for the development of a next generation commercially viable low-cost polymer-based solar cell.

2. 2014 Achievements in CRC Polymers project involving UQ

POLYOLEFIN-BIOPOLYMER FILMS FOR MORE SUSTAINABLE AGRICULTURAL PRODUCTION (CRC-P 2.3)

Partners: UQ, QUT, Integrated Packaging, CSIRO, ANSTO, Greening Australia, Rice Research Australia. Both oxodegradable and generation 2 green oxo-biodegradable films were produced at large scale and field trials were conducted in 2014 in a range of locations and crops in Australia and overseas. Commercial sales of an oxodegradable formulation were made and the oxo-biodegradable films have been showing very encouraging early results in terms of below ground degradation performance.
A MANUFACTURING PROCESS FOR PRODUCING FLEXIBLE POLYMER-BASED DYE SENSITISED SOLAR CELLS (CRC-P 3.2 new project)

Partners: UOW, UQ, University of Newcastle, ANSTO, UNSW
The targeted output from this project is a commercially viable low-cost process for the production of polymer-based solar cells where a highly conductive, metal foil-polymer film laminate electrode, developed by the CRC-P, has the competitive advantage of allowing production of low-cost, large surface area solar cells. In 2014 the combination of novel nanomaterials, polymers and assembly has been used to develop new prototype cells to improve cost-effective production and high device efficiency.

Progress has been made towards developing a viable process to produce a prototype photovoltaic cell based on the design protected by a CRC-P patent application, but further development is required to meet key performance targets. One method involved fabricating a solar cell using certain perovskites which are highly efficient light absorber and charge transfer materials, thereby allowing the fabrication of thin film solar cells.

As part of the fundamental research being conducted within the polymer solar cell program, the component options for perovskite-based solid-state solar cells have been evaluated and the best combinations have been selected. The developed perovskite and hole transport materials will also be used to explore an alternative way to fabricate the CRC-P designed solar cell.

POLYMER FILM-BASED ENCAPSULANTS FOR USE IN STEEL-ROOF-INTEGRATED POLYMER SOLAR CELLS (CRC-P 3.3 new project)

Partners: UOW, UQ, University of Newcastle, ANSTO, UNSW, BlueScope Steel
This project involved the use of polymer film-based composite structures and sealants, with exceptional water and oxygen barrier properties, and extreme resistance to photochemical and thermal degradation, were prepared for the encapsulation and protection of flexible solar cells. This research project was discontinued in 2014.

3. Publications

JOURNALS


CONFERENCE PAPERS


CRC-P TECHNICAL REPORTS


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