MATERIALS AUSTRALIA

Alloy Steels Welding / Joining

VOLUME 47 | NO 2
ISSN 1037-7107
JUNE 2014

Materials Australia

Official Publication of the Institute of Materials Engineering Australasia Limited Trading as Materials Australia | A Technical Society of Engineers Australia **www.materialsaustralia.com.au**

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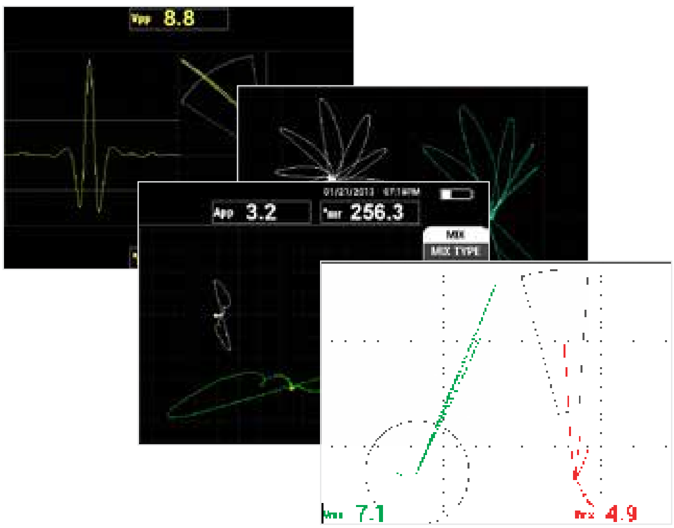

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From the President

Having just returned from the Materials Innovations in Surface Engineering Conference 2013, I would like to take the opportunity to congratulate the organising committee on a fantastic event. The committee consisted of: Chairman Paul Howard, Secretary Catherine Whitby, Technical Drew Evans, Sponsorship Scott Abbott, Marketing Hussein Hamka and the paper review committee as well. Attendance was good, with 60 participants over the two day conference representing both international and domestic universities, and different industries including defence.

I hope this issue of Materials Australia Magazine finds you well. Changes are afoot with your institute!

You may notice that it is June already and this is the first MA Magazine for 2014! Fiona Obaidini has resigned from being the Editor of the MA Magazine. Fiona has made a massive and very positive difference in the Magazine over her 5 plus years with us, both in the way it looks and the quality of the content. On our behalf, and that of all our members, the National Executive wishes her all the very best in her new endeavours.

Paul Howard, the National Treasurer, and Tanya Smith, our Executive Manager, have succeeded in effectively reducing the overheads of the Head Office. As members of the Institute you should not feel any differences in your interactions with our Head Office going forward. As part of that revamp, the website is going to be updated. The website will maintain all its current functionality for the CMatP logging and the renewal of memberships and it should also offer us more flexibility and functionality into the future as well. We will let you know when the changes are ready to go live. The website and other changes are all designed to give our branches, and our members, assistance to organise training, seminars, conferences, and networking functions at the minimum cost and maximum value.

I was fortunate enough to represent Materials Australia at the TMS2014 meeting in February in San Diego, USA as I was going to be in that part of the world with my regular job. I have never been to such a large and comprehensive materials related conference with over 4000 speakers and delegates. There were so many streams it was difficult to know which to attend and all the presentations I attended were extremely informative. I was also invited as the President of Materials Australia to the Presidents Dinner on the first evening to meet with the organising committee and other society Presidents from around the globe. A wonderful experience.

While talking about conferences, I would like to introduce the upcoming conference CAMS2014. This is the third biennial Combined Advanced Materials Societies conference incorporating both Austceram and the Materials conferences. It will be held at the University of Sydney, NSW from the 26-28th November 2014. Request for abstracts is currently open and further information is available later in this magazine or on the website: www.cams2014.com.au. The conference will only be as good as the support it gets from our members, so please let's all assist the organising committee and get the word out to your networks about this conference and it should a fantastic success. I look forward to seeing you there.

Finally, for Materials Australia to keep going, to be viable and to be relevant as an institute into the future, we still NEED you to be involved. Please support your branch functions, seminars, networking events and over the rest of this year as without our member's interest, support and assistance we will become unfeasible.

Cathy Hewett
National President

As always, any feedback, comments, questions, queries AND offers of help will all be accepted gratefully at chewett@bradken.com or via Tanya at tanya@materialsaustralia.com.au

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PUBLISHED BY
Institute of Materials Engineering Australasia Ltd.
Trading as Materials Australia
ACN: 004 249 183
ABN: 40 004 249 183

Cover Image
From feature article on page 28.

Robotic welding is automating the Australian fabrication and manufacturing industries.

Photo courtesy The Lincoln Electric Company (Australia) Pty Ltd and provided by the WTIA.

Letters to the editor; magazine@materialsaustralia.com.au

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CAMS 2014
call for abstracts

The 3rd biennial conference of the Combined Australian Materials Societies, incorporating Materials and Austceram

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Please submit abstracts online by Wednesday 15 June 2014.

We invite prospective authors to submit a brief abstract, up to 400 words under any of these themes. All abstracts must be submitted online, using the Word template provided.

CAMS 2014
November 26–28
Charles Perkins Centre
University of Sydney
www.cams2014.com.au

More information: Caryn Morgan
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caryn@cmaevents.com.au
+61 2 9810 2701

Themes

- Advances in materials characterisation
- Advances in steel technology
- Advanced manufacturing
- Biomaterials
- Cements & geopolymers
- Composites in roadmaking & bridge building
- Ferroelectrics
- Light metals design
- Materials for energy generation, conversion & storage
- Materials simulation & modelling
- Metal casting & thermomechanical processing
- Microstructure & properties of composites
- Nanostructured & nanoscale materials
- Nuclear waste forms & fuels
- Particulate packing & flow
- Raw materials processing
- Refractories
- Smart building materials
- Smart polymers
- Solar energy conversion
- Surfaces & interfaces
- Thin films & coatings
- Utilisation of waste materials
- Wear-resistant materials

Co-chairs
Julie Cairney
Charles C. Sorrell

Technical chair
Simon Ringer

www.cams2014.com.au

Victoria Branch Report

The Victorian branch AGM and annual Gifkin's Lecture were held on 3 April 2014 at Monash University. Nominations for the Victorian Branch Committee included most of the current committee members renominating, and three new nominations. Office roles will be finalised at the next branch committee meeting.

The AGM also provided an opportunity for award recipients to be congratulated and presented with their prizes. Ms Genevieve Hart was awarded the IMEA prize for the best final year project in a materials course (a joint winner with Mr Konstantinos Tsanaktsidis, who could not be present) and Mr Wayne Cheung was awarded the Ian Polmear Award for the best 2nd year student in a materials course.

The Gifkin's Lecture was presented by Dr. Malcolm Couper, an eminent researcher in the field of aluminium and its alloys, who is currently an Adjunct Professor with Monash University. This year's lecture was titled, "Metallurgical Grade Silicon – The starting point for aluminium alloys, semi-conductors & photovoltaics". Approximately 40 members attended the event and were treated to Malcolm's relaxed and informative presentation that included everything from finding appropriate sources for metallurgical silicon and quality control, to silicon economics! The questions that followed demonstrated the broad interests

Mr Hart accepting the award for Genevieve (left) and Wayne Cheung receiving his award (right) - from Vic branch President, Rob O'Donnell.

of the audience in the uses for silicon and the decision-making requirements of industry when sourcing reliable supplies of this interesting commodity.

The committee is working hard to arrange several site visits in the coming months, along with the regular events hosted by the Victorian branch, so members are encouraged to watch the website for details.

Dr. Malcolm Couper, in action presenting this year's Gifkin's Lecture.

West Australian Branch Technical Meeting

14 April 2014 - GE Oil & Gas 'Global Services' Centre

Bob Crielly (Materials Engineering Manager), Duncan Wilmot (Lead Materials Engineer Michael Lison-Pick and Matthew Jermyn (Materials Engineer)

The GE Oil & Gas 'Global Services' centre in Jandakot is new, multi-million dollar state of the art facility, purpose built for the overhaul and repair of GE gas turbine engines, primarily used in LNG and power generation applications. The facility performs inspection and repair of components in the Hot Gas Path, including combustion liners, transition pieces, power nozzles and turbine rotors. The workshop contains the equipment necessary to perform non-destructive testing, welding and brazing, vacuum heat treatment, machining and balancing, as well as a fully automated plasma and HVOF coating cell to apply wear and thermal barrier coatings.

The Materials Engineering department at Jandakot provides direct support to Global Services (gas turbines/turbo-machinery) as well as Drilling and Surface (offshore drilling and production) and Subsea Services (subsea oil and gas production equipment).

The tour of the facility started with an introduction to turbine technology and an explanation of the major differences between the three main families of turbines: heavy duty (the focus for the Jandakot facility), aeronautical and aero-derivative. Heavy duty turbines are characteristically large and heavy, and able to handle a variety of fuels. They are slow to start up, run for relatively long intervals between starts, and have long service intervals. Aeronautical turbines are the opposite in almost every way. Aero-derivative turbines are generally more flexible with fuel and are the type of turbine that can be used as 'a powerplant on the back of truck', often for back-up power generation.

The materials requirements for turbine components are governed by the thermodynamic efficiency imperative to operate with the highest possible combustion temperatures. The highest temperatures are found in the Hot Gas Path from the combustion stage to first stage stator and rotor. The group learned that heavy duty turbine terminology refers to 'nozzles and buckets', whereas the corresponding aeronautical turbine terms are 'vanes and blades'. This difference in terminology reflects differences in characteristic differences in curvature.

Materials for components in the Hot Gas path are generally in the class of nickel and cobalt superalloys (which date from the 1960s). Through the course of decades of development these alloys are now used in combination with thermal barrier coatings and are gas-cooled with film and closed-loop cooling systems. It requires extremely sophisticated manufacturing technology to grow single crystal turbine blades with complex internal gas pathways, but the result is that these components can operate well above the melting point of their alloy substrates (around 1000°C), with combustion temperatures now reaching around 1600°C.

As explained on the tour of the facility, the Jandakot operation is still working up to full capacity, and has started operation with refurbishment and repair of combustion liners and transition pipes, which are the components requiring the most frequent servicing. After cleaning and inspection, the first metallurgical operation is solution heat treating under vacuum at around 1250°C. The two furnaces (with 1 cubic metre working volumes) are also used for precipitation hardening and eventually, vacuum brazing. Other current operations include welding and 8-axis robotic HVOF thermal barrier coating.

Every service offered in turbine repair has to be exhaustively qualified before being made available on a production basis. Qualification is not generic (e.g. 'welding') but extends to each specific operation, and to the actual components being serviced. Being qualified to repair a GE 'Frame 5' first stage nozzle does not imply qualification for nozzles for 'Frame 9' turbines. Qualification of operations at the Jadakot facility is proceeding through static components, and will then extend to rotating components. Equipment for static balancing of rotors will soon be installed.

The visit provided a unique opportunity for the 24 members and guests to get an intimate view of a new facility in the process of building up to full capacity. The generosity of GE Oil & Gas in making the plant available for inspection after hours, and in providing an unexpectedly substantial meal in the facility canteen, was most appreciated.

New South Wales Branch Report
AXT Demo Lab Open Day

By Dr. Cameron Chai, AXT Marketing Communications Executive

The AXT Demo Lab Open Day took place on March 19 and was attended by a large crowd of eager guests from Materials Australia (MA), the Australian Microbeam Analysis Society (AMAS), the Australian Microscopy and Microanalysis Society (AMMS) and the Australian Ceramic Society (ACS).

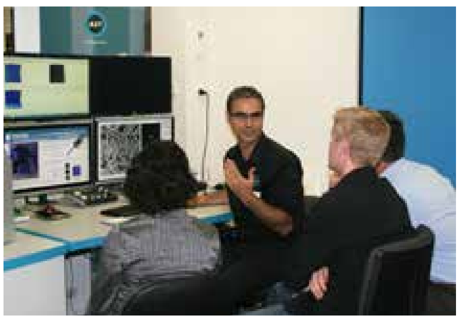
The event commenced with a light lunch in the AXT conference room that allowed the attendees to mingle and socialise in a relaxed atmosphere. Richard Trett, AXT's Managing Director then gave a brief introduction to AXT and allowed all the guests to introduce themselves.

Due to the number of attendees, they were separated into groups to cover the instruments and technologies on show in the demo lab as follows:

1. Sample preparation and analysis
2. Imaging and microscopy

A third group was given a presentation on micro computer tomography (micro CT) and its application to materials analysis and inspection. This was based around the Rigaku nano3DX x-ray microscope, a new product that was only released in February this year at ACMM23/ICONN2014.

Having spoken to many of the attendees throughout the event, they were impressed by the depth and variety of equipment that we have available in our Demo Lab. They were also impressed by the capabilities of the instruments. For example, the safety features of the Spex automated sample press and Katanax automated fusion bead machine, which is especially relevant in today's OH&S environment; the analytical power and compact size of Rigaku's EDXRF and benchtop XRD instruments; the detection limits and speed of the WDXRF instruments; and the flexibility, versatility and imaging quality of the Hirox 3D digital microscope and TESCAN LYRA FIB-SEM.



CMatP Profile: Jessica Down

Where do you work and describe your job.

I work for Wood Group Integrity Management (WGIM) as a materials engineer in Perth, Western Australia. A Wood Group Kenny company, WGIM specialises in materials engineering and asset integrity management.

I started with WGIM in 2010. My current role involves providing materials support during the fabrication phase of upstream subsea developments. The role is quite diverse and includes technical support for forging, welding, coating, non-destructive testing and material preservation for line pipe and subsea equipment.

Outside of my job, I have also recently joined the Materials Australia (Western Australia Branch) Council.

What inspired you to choose a career in materials science and engineering?

Unfortunately, I cannot say that as a six year old I dreamed of becoming a materials engineer. At that age, I had more interest in becoming a super hero than an engineer. It wasn't until my final year of high school that my mum suggested a career in engineering.

I had always enjoyed science at school, and with that suggestion, I chose to study mechanical engineering at the University of Western Australia.

It was a subject at university, Introduction to Materials Science and Engineering, which gave me my first encounter with materials engineering. From that point, I was hooked. I found myself gravitating towards the materials science units within my degree. It wasn't until I had the opportunity to work in the Bioengineering Division at the Royal Perth Hospital that I decided I wanted to pursue a career in the industry.

I joined the Bioengineering Division at Royal Perth Hospital straight out of university and worked in the metallography lab. There I conducted material testing, investigations and failure analysis of biomedical implants. I found it fascinating to see how the advancements in materials allowed for the development of medical implants. I realised then, regardless of the industry, I wanted a career as a materials engineer.

As offshore developments venture into deeper waters with more corrosive production fluids, materials engineering has a challenging role to play across the design, fabrication, installation and operational phases of these subsea assets.

Who or what has influenced you most professionally?

I would have to say the whole Materials Engineering Team on the project I am currently working, but more specifically, the two lead materials engineers James and Mike. As a 'green' materials engineer, making the move from a small research laboratory into the world of oil and gas just four years ago, I remember being fairly apprehensive. Fortunately, on my first day I was introduced into the project Materials Team; a dynamic group of engineers from WGIM. The energetic and collaborative team environment was contagious.

Both James and Mike in particular were, and still are, great mentors, providing valuable guidance throughout my transition into the upstream oil and gas industry. Both were patient teachers, imparting their knowledge and experience and empowering me to put my technical knowledge into practice. They also gave me the opportunity to support works on site at coating and fabrication facilities. This gave me a practical appreciation for the work being undertaken on the project.

Which has been the most challenging job/ project you've worked on to date and why?

I would have to say that the project I am currently working on has been the most challenging so far, for a couple of reasons. Firstly, it is the first subsea development I have ever worked on. It was a big change, both in content and nature, from my previous work at the Royal Perth Hospital. When I started, everything was new. This made the learning curve on the job exciting but challenging.

Secondly, moving into the oil and gas industry, I noticed that there was a much heavier commercial aspect associated with engineering. The commercial aspect was not something that I had encountered previously. Learning how to provide the best technical support, in the context of such a large complex project with multiple interfaces and stakeholders, was certainly challenging.

What does being a CMP mean to you?

As a young engineer, I think it is important to have a plan for continued development. I have recently obtained my CMatP status, which not only gives me recognition

CMatP Profile: Jessica Down

throughout the industry; it also actively encourages ongoing development.

What gives you the most satisfaction at work?

I would have to say I get a lot of satisfaction from building on my experience, growing my skills and knowledge. Every time I have the opportunity to work in an area that I may not be familiar with, or when I am able to get out on site and see how things are done I find it extremely rewarding.

There have been countless times during my career when I have thought, "If only I had another ten years experience". Obviously there is no quick solution to gaining this experience, so when I do learn something or experience something new, it is definitely a satisfying moment.

What is the best piece of advice you have ever received?

I think it would have to be something my parents told me: make sure you love what you do, otherwise there is not much point doing it. Quite blunt but very true. Most decisions I have made in my career, and in my life, have always come back to this.

What are you optimistic about?

I am optimistic about the involvement of materials engineering in the future of oil and gas developments. As offshore developments venture into deeper waters with more corrosive production fluids, materials engineering has a challenging role to play across the design, fabrication, installation and operational phases of these subsea assets. I look forward to being a part of the industry as it progresses.

What have been your greatest professional and personal achievements?

I was given the task of looking after the preservation of approximately 73,000 joints of line pipe at a coating facility in Malaysia for an upstream subsea development. This was quite a challenging task, which involved the development of a preservation and inspection plan. This plan was implemented on site to ensure there was no degradation to the line pipe coating, or excessive corrosion of the steel whilst it was in storage, for up to two years. For my part in the project, I received an internal recognition award and was also selected to present a paper on preservation of line pipe at the annual WGIM Global Technical Conference in 2012 in London. This was the first conference at which I had ever presented and I came away with an award for best presenter at the conference.

What are the top three things on your "bucket list"?

Now this is a difficult question! I have been trying to learn to speak Italian for the past few years, so I think that needs to go in at number one.

Number two on my bucket list would be to go on a road trip around Australia. Even as a little kid, I always loved driving holidays. There are many parts of Australia I have not had the chance to visit yet.

Finally, I would have to say that I would love to go to an AFL grand final - hopefully with the West Coast Eagles winning!

Our Certified Materials Professionals (CMatPs)

The following members of Materials Australia have been certified by the Certification Panel of Materials Australia as Certified Materials Professionals.

They can now use the post nominal 'CMatP' after their name. These individuals have demonstrated the required level of qualification and experience to obtain this status. They are also required to regularly maintain their professional standing through ongoing education and commitment to the materials community.

We now have over one hundred Certified Materials Professionals who are being called upon to lead activities within Materials Australia, these include heading special interest group networks, representation on Standards Australia Committees, and representing Materials Australia at international conferences and society meetings.

To become a CMatP visit our website:
www.materialsaustralia.com.au

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Mr Ian Brown	CMatP	SA
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Prof Liu Yinong	CMatP	WA
Dr Shengjun Zhou	CMatP	QLD
Prof. Jin Zou	CMatP	QLD

A drink for harmony:
The Visionary New Home for Olympus in Australia

Source: Relate Technical Communications 2014

The operational headquarters for Olympus in Australia is located in a state-of-the-art facility in Melbourne that incorporates a fully operational Customer Experience Centre, comprehensive training facilities and the company's National Service Centre.

At the recent dedication of the new building, the celebrations included a traditional Japanese ceremony called "kagami-biraki." In his speech to mark the occasion, Mr Dean Driscoll, Clinical Resources Manager for Olympus in Australia said, "For those of you who are new to the Japanese tradition of 'christening' a new building, kagami-biraki is a ceremony performed at celebratory events in which the lid of a sake barrel is broken open with a wooden mallet and the sake served to everyone present." The purpose of the ceremony is to encourage harmony, health and good fortune and, on his first visit to Australia as Chairman of Olympus Group, Mr Yasuyuki Kimoto participated in the opening.

Driscoll added, "Sake enjoys a history of more than 2000 years and has been revered and treated as sacred, being offered to the gods to grant good health and fortune on momentous occasions such as ours here tonight."

Guests at the opening were given a tour of the new facility, where customers will be able to experience the complete range of Olympus products in the various rooms dedicated to each of the company's portfolios. Industrial Business Division customers will have hands-on access to products utilised in non-destructive testing, remote visual inspection, materials analysis by X-Ray fluorescence and high-speed imaging. Similar demonstration and training areas are available to digital photography and microscopy customers.

One of the guests at the opening was Australian Institute for Non-Destructive Testing (AINDT) CEO, Mr Les Dick. AINDT is the peak industry body for NDT and Condition Monitoring and many of its members are serviced by Olympus."The building is stunning and demonstrates a commitment to the company's customers, many of which are members of AINDT," Mr Dick said. "In the past AINDT has collaborated with Olympus to present specialised training seminars and we look forward to bringing our members to this new facility and allowing them to gain hands-on experience of the latest technology."

For industrial customers, the latest hand-held X-ray Fluorescence (XRF) analyser models were on display at the opening. In addition, the GoldXpert—a stylish and functional bench-top precious metals analyser—was demonstrated. The unit was designed to be compact and attractive, ideal for use on a showroom floor. It provides carat and compositional analysis results with one push of a button. One guest at the opening volunteered his wedding ring to be analysed and was relieved to find that it was the 18 karat gold he expected.

An XRF analyser uses a controlled beam of radiation to excite the electrons in a sample causing the elements to 'fluoresce'. Each element fluoresces at a specific energy level, which can be identified as a characteristic peak.

For medical imaging customers, the Olympus headquarters building has multiple training rooms, including a fully equipped operating theatre and an endoscopy room. All the medical systems are integrated

The headquarters building for Olympus in Australia and New Zealand.

utilising the latest control software which allows direct and remote control and monitoring of any piece of equipment.

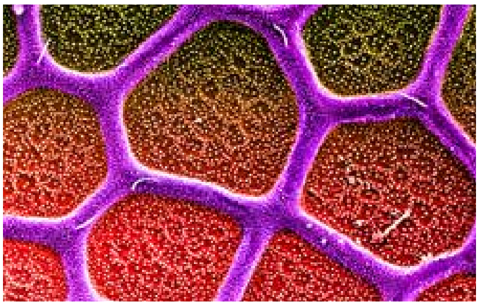
On the floor below the Customer Experience Centre is the National Service Centre, where clean-room conditions have been established to disinfect, assess, repair and quality control the maintenance and upgrade of all instruments including medical imaging equipment such as endoscopes and other medical devices.

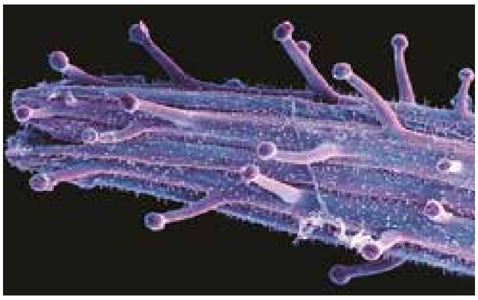
The latest instrumentation models are also some of the most affordable. Innovations in a wide range of areas have enabled Olympus to create sophisticated equipment that can now be available to smaller companies. The company is committed to the development of new technologies, products, and services that offer the best solutions to the needs of its customers.

Inside the National Service Centre located in the Olympus ANZ headquarters.

The University of Western Sydney:
A Leading Research Institute

Author: Sally Wood





With more than 40,000 students, 1,500 academic staff and a history stretching back to 1891, the University of Western Sydney is a confirmed leader within Australia's research industry.

The excellence and depth of the University's research was recognised in the most recent national research report card (Excellence in Research for Australia 2012). More than 70% of the University's assessed research was ranked at world-class level or higher, securing UWS a place in the Top 20 List of Australian research universities.

In 2013, the University successfully obtained over $5.8 million in grants from the prestigious Australian Research Council (the Australian government's main agency for allocating research funding to academics and researchers at Australian universities) for 18 Discovery Projects. These grants, and the resultant Discovery Projects, further cemented the University's place among the top Australian research universities.

The University continues to expand its research capabilities, including the inauguration of the Hawkesbury Institute for the Environment in 2012. Funded by a $40 million grant from the Australian Government Education Investment Fund, the Hawkesbury Institute houses some of the largest, most complex global facilities for researching the effects of climate change.

World Class Research through Industry Collaboration

The University of Western Sydney encourages collaboration with industry partners to facilitate innovative research and problem solving. The University currently has more than 350 partnering organisations, with more than 80% of research directed towards fulfilling economic and social needs, particularly those of organisations across Sydney.

With a variety of research models available, the University can facilitate the joint development of a research program or project, contracted research and research training opportunities.

Academics and specialists are also available for consultancy services to external organisations including industry, government agencies and educational institutions. Consultancy engagements can include anything from training and education to contract research, expert opinion, analysis and testing services, and product and process development. Projects vary from as short as a couple of days, to as long as a couple of years.

The University's state-of-the-art instrumentation ensures that organisations and industry bodies remain on the cutting edge of research across a broad variety of fields. In-depth research programs, and collaboration on high-end technical analyses, can be leveraged to raise the profile, and increase the bottom-line, of organisations and industry bodies alike.

Synergy between university research staff and external organisations is frequently achieved through joint commercialisation projects for new technologies and research innovations. These projects frequently lead to the establishment of commercial ventures, collaborative partnerships and spin-off companies.

Centralised Research Facilities

With a vast array of specialist research facilities and a wide range of high-end scientific equipment, the University actively supports Australia's industrial and commercial sectors. These research facilities offer comprehensive commercial services, ranging from supervised access and fee-for-service, to collaborative work.

The university's capabilities for characterisation, imaging and microanalysis are unique, offering new insights into the development of new materials and pharmaceuticals, in chemical and forensic analysis, and in plant and animal samples.

Advanced Materials Characterisation Facility

The Advanced Materials Characterisation Facility, run by Research Manager Dr Richard Wuhrer, has a suite of state-of-the-art instruments for biological and material characterisation. Some of these instruments include:

- Scanning Electron Microscopes for use in imaging and analysis
- Microanalysis Instrumentation used to determine material composition
- X-Ray Diffraction Instrumentation used to determine phases present
- Atomic Force Microscopy for atomic resolution imaging
- Electron Microprobe used for trace elemental analysis
- Surface Area and Pore Size Analysis (Micromeritics ASAP2020)
- Thermal Characterisation Instrumentation (TGA-DSC-IR)
- Infrared and Raman Instrumentation which are used to determine the chemical or biochemical components of materials and biological samples.

Biomedical Magnetic Resonance Facility

Professor William S. Price, Dr Bahman Ghadirian, Dr Tim Stait-Gardner and Dr Allan Torres lead the Biomedical Magnetic Resonance Facility. This facility is equipped with state-of-the-art equipment for nuclear magnetic resonance (NMR) diffusometry and high-resolution magnetic resonance imaging (MRI) as well as conventional NMR experiments. In vivo MRI experiments and high-resolution magic angle spinning (HR MAS) are also possible. NMR contains numerous sub-disciplines including MRI, traditionally used in clinical medicine. The University team is encouraging the use of NMR and very high resolution MRI by industry, government agencies and research organisations in such diverse fields as materials, cancer research, entomology, neuroscience, rheology, molecular association, nanotechnology, plant science, well-logging, electrochemistry and surfactants. The University is also a node of the National Imaging Facility.

Confocal Bio-Imaging Facility

The Confocal Bio-Imaging Facility, run by Dr Anya Salih, has an advanced bio-imaging facility with state-of-the art confocal and multi-photon microscopes. By analysing fluorescence emitted from a sample, confocal imaging unites the power of optical microscopy, biology, biophysics and advanced computational methods. Through confocal images, we are able to: visualize the three-dimensional structure of cells; decipher how genes, molecules and proteins work and interact in living cells and organisms; and how see how these organisms are affected by changing environmental, physiological and disease conditions.

Mass Spectrometry Facility

The high-tech Mass Spectrometry Facility is available to staff, students and industry. Run by Dr David Harman, the facility offers access to advanced Mass Spectrometry, either direct sample analysis (infusion of samples in solution) or coupled with ultra high performance liquid chromatography (nanoflow or conventional). The instrumentation available includes a nanoUPLC coupled to a Xevo QToF, and a UPLC coupled to a Xevo Triple Quadrupole. This state-of-art equipment can be used for applications such proteomics, metabolomics, lipidomics, small molecule (drug/vitamin) quantitation and molecular weight determinations.

Next Generation Genome Sequencing Facility

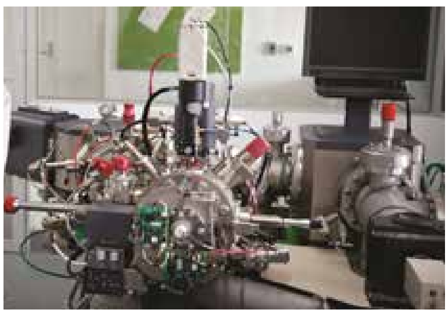
Located at the University's Hawkesbury Institute for the Environment, the Next Generation Genome Sequencing Facility is run by Dr Carline Janitz. The facility offers cutting edge next-generation sequencing services using Illumina HiSeq1500 and MiSeq platforms. The facility offers a broad range of applications in genomics, trancriptomics and epigenomics including:

- Whole genome de novo sequencing, resequencing
- Targeted re-sequencing using Agilent, Roche and Illumina platforms
- Transcriptome sequencing including the standard RNA-Seq using polyA selection and strand-specific RNA-Seq
- Small RNA discovery and analysis
- Chromatin immunoprecipitation sequencing (ChiP-Seq)

Secondary Ion Mass Spectrometry Facility

Managed by Dr Rong Liu, the Secondary Ion Mass Spectrometry (SIMS) Facility has recently under gone a substantial upgrade and is the only dynamic SIMS instrument located on the east coast of Australia. The Cameca IMS 5fE7 ion microprobe is a highly specialised surface analysis tool for high resolution depth profiling as well as surface analysis and ion imaging. The SIMS has many fields of applications, including semiconductor devices, energy conversion components, materials science, geology and biological materials that can sustain ultra high vacuum.

The modern research facilities of the University of Western Sydney are located across the university's seven campuses in Sydney's Greater West, all of which are conveniently accessible by car or public transport. For further information, visit: www.uws.edu.au/innovation/centralised_research_facilities. Or, contact USW Innovation: Victoria Hirst on v.hirst@uws.edu.au or 02 9685 9742



Author: Sally Wood

RMIT Researchers Develop New Antibacterial Fabric

RMIT researchers have developed a new antibacterial fabric that can kill a range of infectious bacteria, such as E coli, within 10 minutes. The discovery could significantly reduce the risk of deadly hospital-acquired infections and revolutionise the way the medical industry deals with infection control. Antibacterial fabrics do not allow nasty disease-causing bacteria to stick to and grow on their surface – creating an infection free environment.

Graphene Photonics Promises Fast-Speed, Low-Cost Communications

Researchers at Swinburne University have developed a high-quality continuous graphene oxide thin film that shows potential for ultrafast telecommunications. Associate Professor Baohua Jia created a micrometre thin film with record-breaking optical nonlinearity suitable for integrated photonic devices used in all-optical communications, biomedicine and photonic computing. Derived from carbon and 100% recyclable, graphene has many useful properties, including electrical conductivity.

Commercial and Government Infrastructure to Employee 4,000+ Engineers

The oversupply of engineers in Australia has grown from a surplus of 3,700 people in the December 2013 quarter, to a surplus of 4,100 people in the March 2014 quarter. However, according to the Clarius Skills Indicator (which measures the supply and demand of skilled labour in Australia, based on ABS and Department of Employment data) this surplus is expected to tighten amid renewed optimism in commercial construction and government infrastructure.

Society of Automotive Engineers Initiates Engineering Skills Program

The closure of Australian automotive manufacturing and engineering design centres looks set to result in a massive skills drain. Over 2,000 highly qualified engineers are being made redundant, and seeking employment overseas. The Society of Automotive Engineers has requested funding from Minister Hodgett (Victorian Minister for Manufacturing) for a program to support the transition of professional engineers and technicians into other industries within Australia.

Australian Software Platform to Revolutionise Property Market

Australia's CIM Environmental Group has developed a world first software platform that has the ability to save building owners millions of dollars each year by reducing energy costs and carbon emissions while improving conditions for tenants. The ACE Platform receives and analyses mass quantities of data from the Heating, Ventilation and Air Conditioning (HVAC) units of buildings, instantaneously detecting faults and inefficiencies.

Mechatronics students Michel Fathallah and Alex Bunting in Raymond Kirby Robotics Laboratory.

Infotech Enterprises Rebrands as Cyient Limited

Infotech Enterprises has changed its name to Cyient Limited, positioning the Hyderabad-based firm as a "distinctively unique global" company. Founded in 1991, the company has become a global leader in engineering, reporting a 17.8% revenue increase in 2013-2014. With more than 12,000 employees across a global network of 38 locations, Cyient boasts clients across the aerospace, manufacturing, transportation, utilities and communications sectors.

Japanese University Broadens Synthesizing Optically Active Compounds

Kanazawa University in Japan has highlighted the importance of chiral compounds in chemical manufacturing. Researcher Yutaka Ukaji has developed a method for desymmetrising compounds to produce new chiral molecules. The process allows 99% selectivity in the chemicals produced. The property of chirality is defined by the existence of distinct mirror image geometric arrangements of the constituent parts of a molecule, known as stereoisomers.

Nanotronics Imaging Adds Two Technology Visionaries to its Team

Leading software company, Nanotronics Imaging, has added two key people to its team. Nicolas Heron (previously at ImaCor Inc.) has joined as Chief Technology Officer. Paul Roossin (previously at The Rockefeller University and IBM) was appointed as the Science Director. Nanotronics Imaging is developing nanotechnology that will revolutionize a wide range of industries, from silicon chips and computer hardware to medical diagnostics and energy storage.

New Mechatronics Lab Animates Learning at the University of Sydney

A state-of-the-art mechatronics laboratory opened at the University of Sydney in early May. Outfitted with the latest robotic and microcontroller-based hardware and software, the centrepiece of the new Raymond Kirby Robotic Laboratory is a Baxter humanoid robot - one of the first of its kind in Australia. Unlike current industrial robots, Baxter is designed to be intrinsically safe when working with people, using sonar sensors and cameras to monitor the space around itself.

PRODUCT LAUNCHES

Schwarze-Robitec Launches Time-Optimized Machine Control

A leading expert in the field of tube bending machines, Schwarze-Robitec has launched a brand new machine control. The new control keeps auxiliary process time to a minimum. The bending machine manufacturer has broken down the original sequence of the bending process and arranged the individual steps synchronously. An integrated diagnostic and maintenance tool that minimizes downtimes supplements the new, effort-saving control software.

The new, easy-to-operate machine control from Schwarze-Robitec.

Quadran Launches New 365 UV-A Inspection Lamp

Spectronics Corporation has unveiled a new dual-intensity UV-A lamp that delivers the best of both worlds for NDT (Non Destructive Testing). The new QUADRAN 365 Series lamps feature a high-intensity and a standard-intensity UV-A output setting, plus a convenient high-and-low white light brightness setting. This allows the NDT practitioner to easily adjust the UV-A intensity for fluorescent inspection and the white light for flaw location.

Quadran's new dual-intensity UV-A lamp.

The WeldCheck Eddy Current instrument from Ether NDE.

WeldCheck Eddy Current Instrument Gains Momentum

The WeldCheck Eddy Current instrument (manufactured by Ether NDE) has made a big impression across the nation. Showcased in the NDT area of the Australasian Oil and Gas Exhibition & Conference in February 2014, the WeldCheck has being selling rapidly over the last few months. The instrument has a large, easy-to-read screen, and a rugged casing. Its simple flip functionality means that both right and left-handed operators can use it.

Brucker Elemental Launches Second Generation XRF Analyser

Brucker Elemental has launched their second generation S1 TITAN™ handheld XRF analyser. With much uncertainty about the quality of imported alloys in today's market, the XRF analyser quickly and accurately analyses elemental composition and identifies the alloys of samples. Enhancements include weatherproof housing, an integrated camera and enhanced SharpBeam™ technology improves precision measurement and reduces power requirements.

Second Generation S1 TITAN™ handheld XRF analyser from Brucker Elemental.

Aerotech X-Y Ball Screw Stage.

New Aerotech PlanarSL Delivers Geometric Performance and Accuracy

Aerotech has developed an X-Y ball-screw stage for high precision applications, from surface metrology to automation. The low-profile mechanical bearing stage combines two axes of motion in a compact package. Its precision-ground and preloaded ball screw is designed to drive directly through the centres of friction and stiffness, resulting in superior geometric performance and accuracy. High-precision linear motion guide bearings provide sound straightness and flatness.

Rapid inspection and characterisation of alloys using low cost desktop electron microscopy

Source: ATA Scientific Pty Ltd

The properties of many engineering materials are mostly governed by a combination of their composition, morphology and distribution of key microstructural features. These features can be observed with a range of imaging techniques, each with their own strengths and weaknesses. Conventional optical microscopy offers robust and affordable analysis with high sample throughput. However the maximum magnification and depth of focus is limited. Light microscopes can show a useful magnification only up to 1000-2000 times. This is a physical limit imposed by the wavelength of the light. As demand for magnifications beyond the optical range (>1000x) increase, new technologies are required to investigate smaller features of interest.

Scanning Electron Microscopy

Scanning Electron Microscopy (SEM) is best suited when more detail is required such as higher three dimensional magnification. While SEM offers higher magnification and depth of focus, it too can be seen as less favourable. Given these instruments are extremely expensive, they often require more space and more experienced staff to operate them.

Still, viewing three dimensional images of microscopic areas only solves half the problem in an analysis. It is often necessary to also identify the different elements associated with a specimen. Integrating electron imaging (SEM) with X-ray analysis is a very powerful combination for understanding the composition and structure of materials.

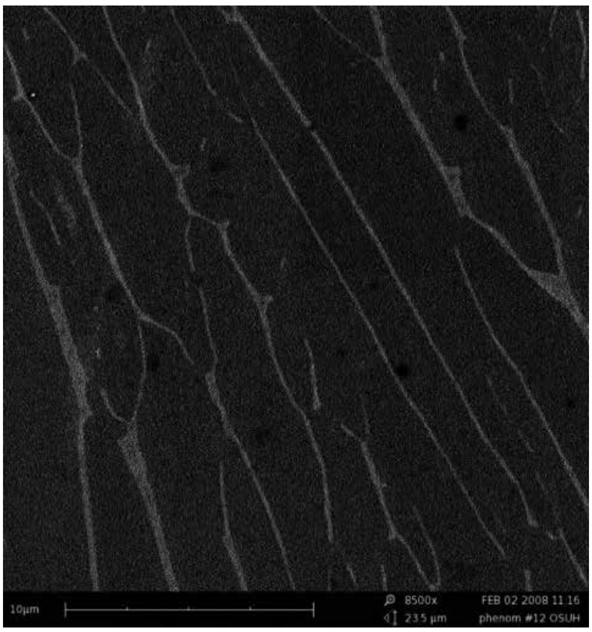
For example, X-ray analysis can be important when monitoring a production process that needs to create a consistent material mix such as the fabrication of alloys and ceramics. SEM imaging of a sample from production can reveal contamination with an unknown substance or the inclusion of unknown particles. With integrated X-ray analysis these particles can be examined and their composition and potential origin easily revealed.

Phenom Desktop SEM

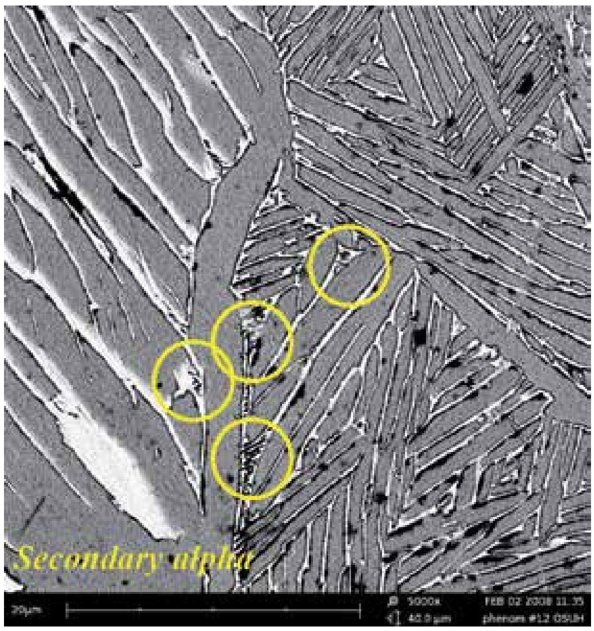
The Phenom™ desktop SEM is a user friendly tool that bridges the gap between the optical microscope and ultra high resolution microscopes. This desktop SEM exceeds the resolution of optical microscopes (30 nm v. 200 nm, respectively) and eliminates the expense, delay (images within 30sec) and difficulty associated with operating a traditional SEM. With the Phenom integrated X-ray analysis system, sample structures can be physically examined and their elemental composition determined. Rapid examination of common engineering alloys (e.g. Al, Ti, Fe and Ni) can be performed in areas such as routine metallurgical analysis, quality control, failure analysis, and research studies.

Metallurgical Inspection with Phenom SEM

Metallography provides information about an alloy linking its composition and processing to its properties and performance. For example, in titanium alloys the yield strength has been shown to be related to the thickness of the α-laths. Precise measurement of the α-laths is important for input into emerging models that are capable of predicting alloy properties. Figure 1 shows the α-laths (darker phase) as well as the β-ribs (lighter phase) between the laths of β-processed Ti-6-4. Using established measuring techniques it is possible to calculate the



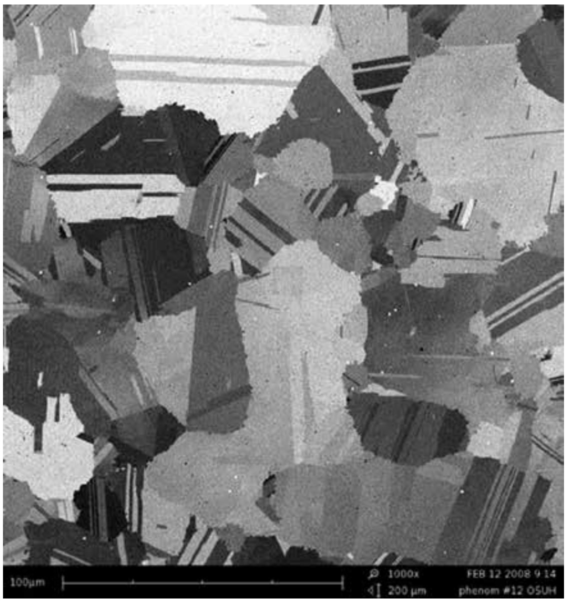
BSE Mode of β-processed Ti-6.4 (Figure 1).



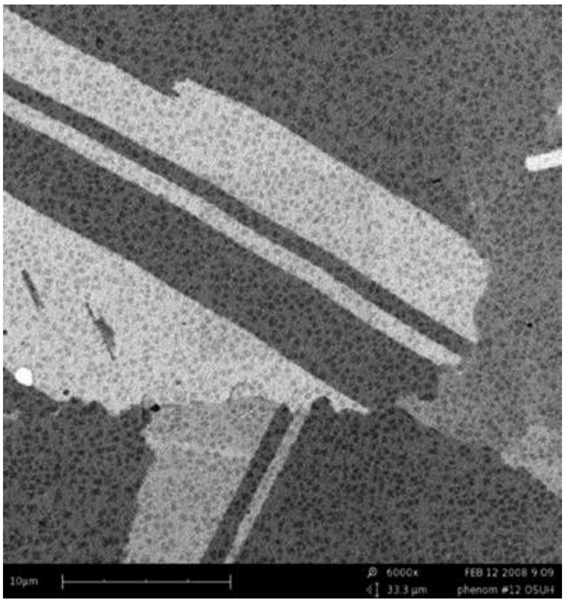
BSE Mode of β-processed Ti-6.4 (Figure 2).

Intermetallics and porosity of an automotive Al alloy (Figure 3).

Intermetallics and porosity of an automotive Al alloy (Figure 4).



Nickel-base superalloy (Figure 5).



Nickel-base superalloy (Figure 6).

average thickness of these laths with an uncertainty of approximately 50 – 100 nm, which is less than the resolution limit afforded by conventional optical microscopes (i.e. 200 nm). Often in titanium alloys there is a second nucleation event that will result in the formation of sub-micron sized α-laths (e.g., secondary alpha) as shown in Figure 2. This characteristic can often strengthen the alloy. It is extremely challenging to image such fine features using an optical microscope, or even to confirm their presence. However, they are readily observed when using the Phenom.

Additional microstructure observations of a cast aluminum alloy are shown in Figure 3 and Figure 4. The size and distribution of the intermetallic phases (lighter phases) and shrinkage porosity impacts the alloy properties. Figure 3 illustrates an important feature of the Phenom – the ability to gather topological information (e.g. details of the shrinkage porosity) due to the intrinsic depth of focus, while concurrently collecting information about the distribution of phases within the microstructure indicated by contrast variations in the image. Ni-based superalloys, shown in Figure 5 and Figure 6, are an excellent example of an "engineered" alloy, and the current state-of-the-art alloys are the product of decades of development. The alloy, consisting of a disordered gamma matrix and ordered gamma-prime, exhibits a very attractive combination of strength and creep-resistance, enabling it to be used as the material of choice for certain regions of a gas-turbine engine (jet engine). The gamma prime is typically enriched in Al, giving it a darker appearance in BSE mode as shown in Figure 6.

The Phenom desktop SEM is affordable, easy to operate and offers direct access to the high-resolution and high-quality imaging and elemental analysis of micron and submicron structures necessary in a large variety of applications.

For more information visit www.phenom-world.com or local sales agent www.atascientific.com.au.

Reference: Phenom application note: Metallurgical inspection using the Phenom™

Development of Sputtered Films for Solar-Hydrogen Production at UWS Hawkesbury

Source: J. Holik[1], M. Bello Lamo[2], R. Ding[3], J.J. Lee[3], S. Li[3], D. Wang[3], R. Wuhrer[4] and L.R. Sheppard[1*]

The development of sustainable and environmentally friendly alternative fuel is an important activity for addressing climate change and long term energy security. At the University of Western Sydney, the Solar Energy Technologies Research Group is pursuing the generation of hydrogen fuel from the photoelectrochemical splitting of water. This process is driven by sunlight and involves two electrodes immersed in an aqueous solution. At least one of these electrodes is photosensitive and capable of employing solar energy to drive the redox reactions that lead to water electrolysis. Identified as a photo-electrode, intense research is being undertaken around the world to develop photo-electrode materials that exhibit the requisite host of functional properties required for high performance solar driven water splitting [1].

At present, most research attention is being placed upon titanium dioxide (TiO_2) or derivatives thereof, as the most promising photo-electrode material. This is due to its low cost, high abundance (especially in Australia) and high corrosion resistance [1]. However, TiO_2 suffers from poor photosensitivity due to a large band gap energy; 3.2 eV for anatase, and 3 eV for rutile [1]. This limits the absorption of incident photons to only the UV fraction of the solar spectrum which accounts for ~5% [2]. As a result, the reported energy conversion efficiencies of TiO_2-based photo-electrodes are in the vicinity of 1%. In order to access the more abundant visible portion of the solar spectrum, which accounts for ~30%, the band gap energy would need to be reduced towards the practical limit of 1.5 eV [1].

Many successful efforts have been made to reduce the band gap of TiO_2 and increase visible light sensitivity [3]. However, the translation of this success towards actual performance improvement is very limited. One particular reason for this relates to the use of dopants for band gap reduction and the simultaneous introduction of recombination centres. Consequently, gains achieved through increased absorption of solar energy are curtailed by a reduced ability to convert this energy into hydrogen fuel.

A strategy being employed to address this particular challenge involves the development of doped TiO_2 thin films that exhibit a graded semiconductivity. This configuration establishes a continuous electrical potential gradient across the thickness of the film that assists with the inhibition of charge carrier recombination. Using the UWS Reactive Magnetron Sputtering Facility at UWS Hawkesbury, a deposition process is being developed that will enable doped TiO_2 thin films to be deposited in such a manner. However, it is important that the resultant films exhibit high crystallinity and are of the rutile TiO_2 polymorph. Deposition must also take place at low temperature in order to inhibit deleterious mass transport processes.

The initial phase of this project is aimed at addressing the deposition of undoped rutile thin films of high crystallinity without substrate heating. With a goal to increase the bombardment energy of sputtered ions, this investigation is specifically targeting changes to the substrate-to-target distance and substrate bias. The deposition conditions were otherwise constantly maintained and are summarized in Table 1. In order to simultaneously investigate different substrate-to-target distances, four copper pillars of heights 15, 30, 44 and 60 mm were used to fix n-type silicon substrates (oriented < 1 0 0 >) at different distances from the titanium target (see Figure 1). The resulting substrate-to-target distances are summarised in Table 1. The pillars were located at identical radii to ensure that each substrate is exposed to the peak deposition region below the target for an equal sum of time during deposition. As a consequence of this configuration, a very low frequency pulsing of the deposition flux has been introduced. Film uniformity was also disturbed due to the confocal arrangement of the sources in this sputtering system (AJA Orion 5, AJA International, Scituate, USA). This was most exaggerated for the tallest pillar (shortest substrate-to-target distance). Radio frequency (RF: 13.56 MHz) bias voltages of 0V, -50 V, -100 V and -157V were applied to the substrate to investigate its affect on film crystallinity at different substrate-to-target distances.

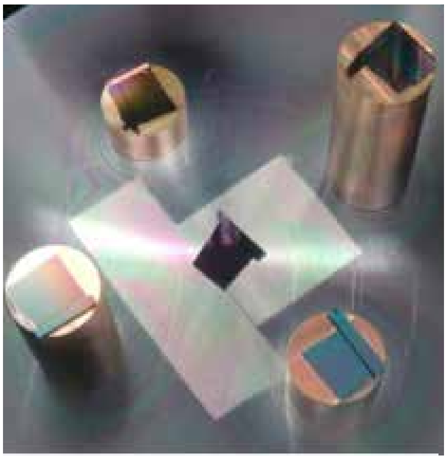


Figure 1. Arrangement of copper pillars to achieve different substrate-to-target distances.

Initial results from X-ray diffraction analysis was performed on a Panalytical Empyrean thin film x-ray diffractometer using a 1° glancing angle, Cu KĐ radiation and a 2Đ range of 20-80 degrees). This analysis has revealed that the applied substrate bias rather than the substrate-to-target distance has the most influential affect on both the degree of crystallinity and phase orientations present. At 0V of applied substrate bias, amorphous films were obtained irrespectively of the substrate-to-target distance. However, once bias was applied at -50V or greater, all films displayed a high degree of crystallinity and were found to be predominantly rutile. The films were also observed to display texturing that was sensitive to the applied bias voltage. At -50 V, the films displayed clear preferred orientation towards rutile (110), but this broke down to become a mixture of rutile (101), (111) and (211) orientations when the substrate bias was increased to -157 V.

The effect of substrate-to-target distance on film crystallinity and structure appears to be subtle in comparison to the effect of applied substrate bias. No clear changes to film structure were observed due to apparent changes in deposition energy at any applied substrate bias. It can thus be concluded that over the studied substrate-to-target range, the additional deposition energy gained from locating the substrates closer to the target is negligible compared to what is gained from applying substrate bias.

From images obtained using scanning electron microscopy (SEM, JEOL 7001F field emission gun, 15 kV accelerating voltage, 5-10 mm working distance), the different combinations of substrate-to-target distance and bias voltage revealed a spectrum of surface topographies. At low voltages and long substrate-to-target distances, films were observed to consist of 20-30 nm diameter clusters (see Figure 2). While maintaining the same substrate-to-target distance, increasing the substrate bias voltage yielded smoother films (see Figure 3). The application of bias appears to impact upon the size of depositing clusters as well as their structure.

During deposition with -50 V applied bias, the surface morphology appeared to resemble craters and ridges on the scale of 50-400 nm, with a base structure consisting of 20-30 nm clusters (see Figure 4). During deposition under this bias, and the shortest substrate-to-target distance (38 mm), the ridges began to display signs of erosion and appeared highly textured (see Figure 5). At this close proximity to the target, deposition is taking place at the greatest deviation from the confocal position leading to a highly angular deposition. This is supported by the observation of poor thickness uniformity for this film. It is also possible that resputtering is occurring. For this particular sputtering system, it will be important to orient substrates more closely to the axis of deposition when operating at short substrate-to-target distances to ensure good film uniformity and control of surface roughness.

This investigation has successfully demonstrated that control over the crystallinity and structure of TiO_2 based films is possible with room temperature reactive magnetron sputtering. This control has been obtained most effectively through manipulation of applied substrate bias, while changes to the substrate-to-target distance were ineffectual. Moving forward, the investigation will explore deposition under a finer range of applied bias voltage in order to investigate greater control over the preferred orientation of TiO_2 films. As potential photo-electrode materials for photo-electrochemical water splitting, crystalline thin films of TiO_2 are promising, and by avoiding heat treatment form the basis for a range of novel solar materials.

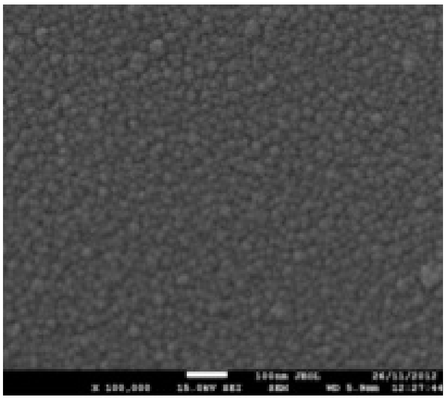


Figure 2. SEM image of film deposited at a substrate-to-target distance of 60 mm and 0V applied RF bias.

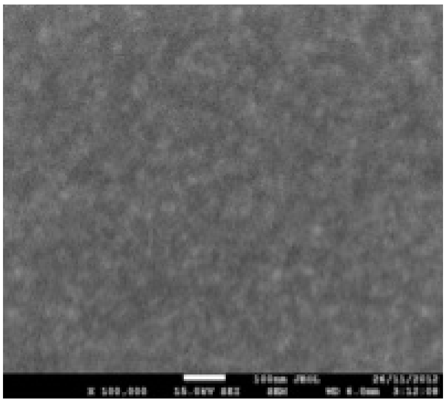


Figure 3. SEM image of film deposited at a substrate-to-target distance of 60 mm and 150V applied RF bias.

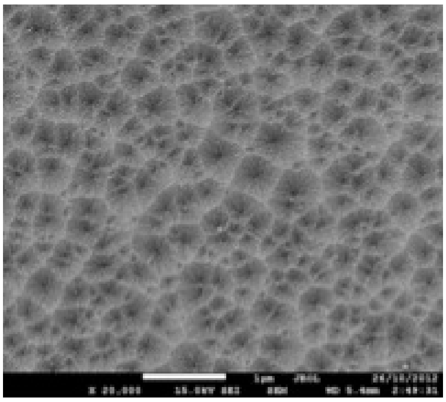


Figure 4. SEM image of film deposited at a substrate-to-target distance of 73 mm and 50V applied RF bias.

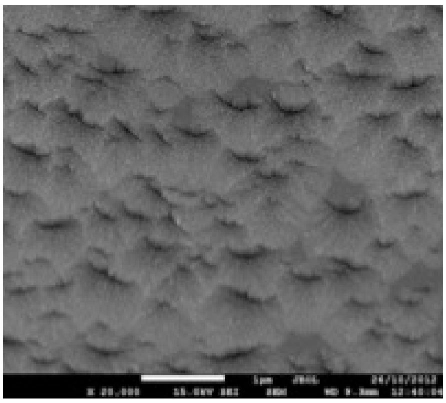


Figure 5. SEM image of film deposited at a substrate-to-target distance of 38 mm and 50V applied RF bias.

LIST OF TABLES

Table 1.
Summary of applied deposition variables

Deposition Parameter	Value
Working pressure	0.2 Pa
Base pressure	<5 x 10-5 Pa
Power	200 W DC
Argon : Oxygen ratio	10 : 2.4
Target	Titanium
Deposition temperature	298 K
Substrate rotation	20 rpm
Substrate-to-target distances	
15 mm high pillar	73 mm
30 mm high pillar	60 mm
44 mm high pillar	47 mm
60 mm high pillar	38 mm

ACKNOWLEDGEMENTS

This work was kindly supported by the Australian Research Council (DP0987084). Access to the UWS Advanced Materials Characterisation Facility was also kindly supported by the UWS Office of the Pro-Vice Chancellor (Research).

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SOURCE

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Shining a Light on Welding: From Blacksmithing to Laser Beams

Author: Sally Wood

Technology used in welding has advanced at rapid pace, particularly since the 1950s. The industry has augmented, from blacksmithing and arc welding, to laser beams and friction stir welding. Modern welding techniques can join miniscule pieces of metal, and make joins and welds with more depth and accuracy than ever before. As technological advancements continue, so will the quality and efficiency of the welding industry as a whole.

The welding industry can trace its origins to ancient times. Archetypal examples of welding date back more than 2,000 years, to the Bronze Age; small circular gold boxes were crafted by pressure welding joins. In the Iron Age, Egyptians and other civilisations around the Mediterranean learned how to weld iron materials. During the Middle Ages, the blacksmith was an essential member of the community, producing a range of iron products, welded together by hammering.

It was not until the 19th century that modern welding techniques were invented.

In 1800, Sir Humphry Davy discovered that, by using a battery, an arc between two carbon electrodes could be created. Then, in 1836, Edmund Davy discovered acetylene.

On the back of these two discoveries, Auguste De Meritens used the heat from an arc to join lead plates in 1881. His pupil, Nikolai N. Benardos secured the British welding patent in 1885, and the American welding patent in 1887. These patents, for an electrode holder, marked the birth of carbon arc welding.

In 1900, the coated metal electrode was invented. This electrode had a thin coating of clay or lime, which generated a much more even, balanced arc. At the same time, resistance welding (including spot, seam, projection and flash butt welding) were introduced. Gas welding was also perfected following the invention of the blowtorch in 1887.

With the outbreak of World War I, the demand for armament production increased exponentially, boosting the importance of the welding industry. Welding companies (as well as companies manufacturing welding equipment and electrodes) sprang up across America and Europe to meet the ever-increasing armament requirements.

In 1920, P. O. Nobel invented automatic welding. This welding process used bare electrode wire (on direct current) in conjunction with arc voltage to regulate feed rate. Automatic welding was used mainly in the automobile industry, for patching motor shafts and crane wheels, and manufacturing axle housings.

Throughout the 1920s, various types of welding electrodes were developed, and welding standards were introduced that mandated the use of high-quality weld metal. These developments meant that by 1930, covered electrodes were commonplace.

The 1930s saw the development of stud welding at the New York Navy Yard, used to attach wood decking to metal surfaces. Submerged arc welding was also developed at a pipe mill in Pennsylvania to make longitudinal seams in pipe. Submerged arc welding is still one of the most productive welding processes.

Gas Tungsten Arc Welding (GTAW), ideal for welding magnesium, stainless steel and aluminium, gained monomentum in the 1940s. Perfected, patented and christened Heliarc® welding in 1941, GTAW remains one of the most important welding processes.

The 1950s saw the debut of countless welding techniques, and a real renaissance of the welding industry. Many of the technologies and processes invented in this decade are still used today.

In 1953, CO_2 welding (which uses consumable electrodes within an atmosphere of CO_2 gas) increased in popularity. Using this welding technique, equipment manufactured for inert gas metal arc welding could be used for more economical welding purposes. CO_2 welding rapidly matured into short-circuit arc welding, (dubbed Micro-wire®), short-arc, and dip transfer welding. These welding variations enabled welding on thin materials from any position and promptly became the most ubiquitous gas metal arc welding technique.

Soon after the evolution of CO_2 welding, the Dualshield® variation was developed. This welding variation was dependent upon a special inside-out tubular electrode wire that contained fluxing agents on the inside. In 1959, this product was taken

a step further, when Innershield® came onto the market. An inside-out electrode that required no external gas shielding, Innershield® was favoured for non-critical welding.

Plasma arc welding was invented in 1957. With its high temperature, plasma arc welding is often used for metal spraying and cutting. Electron beam welding, which relies upon a focused beam of electrons within a vacuum chamber, was developed in 1957. The concentrated heat source in electron beam welding made deep, narrow welding possible. The automotive and aircraft industries are still major users of electron beam welding. Electroslag welding, critical for joining thicker materials, was inaugurated in 1958 by the Russian Federation.

With the invention of the laser beam in 1960, laser beam welding quickly gained momentum. Originally developed by the Bell Telephone Laboratories for communication purposes. Because of its huge energy concentration (within a very small space), laser beam welding is particularly useful for high-speed automatic applications. Today, there are two main types of laser beam welders: solid-state lasers and gas lasers. Solid-state lasers operate using synthetic ruby and chromium, yttrium aluminium garnet or neodymium in glass. Gas lasers use helium, carbon dioxide, or nitrogen.

Electromagnetic pulse welding also became popular around 1967. This welding process uses magnetic forces to drive, and join, material together. A cold weld process, it can be used on conductive metals comprised of either similar or dissimilar material. This particular welding technique is environmentally sound. It generates no sparks, radiation, smoke or gas; emissions are negligible.

One of the most recent advances in the welding industry was the invention of friction stir welding in 1991 by Wayne Thomas at The Welding Institute. This type of welding was specifically developed to maintain the atomic integrity of thick metal as much as possible. The atomic integrity is maintained by heating the metal as little as possible. Instead, friction welding using the friction created by a spinning rod to soften to metal plates along a seam. The plates are then squeezed together, fusing the plates through dynamic recrystallization. Apple regularly uses friction welding, to join the aluminium components of the iMac desktop computer.

Hull Steel Toughness Testing for Australian Naval Vessels

Source: Structural Materials and Fabrication - Maritime Division - Defence Science and Technology Organisation

Figure 1. Australia's HMAS WALLER.

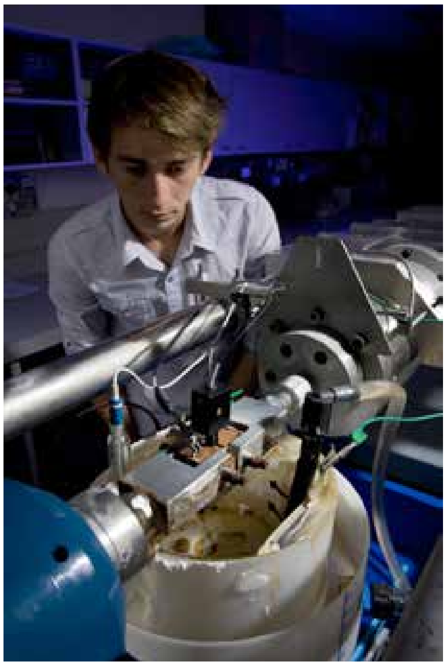


Figure 2. Rising displacement test for determining susceptibility of high strength steels and welds to stress corrosion cracking.

The Defence Procurement Review (2003) tasked the Defence Science and Technology Organisation (DSTO) with providing independent advice to Government on technical feasibility, maturity and overall technical risk for all Defence acquisition decisions. As a part of this process, DSTO scientists assess the suitability of steels and welds to be used in Australian Naval vessels.

Hull steel properties are of critical importance for submarines since they operate in such an unforgiving environment (figure 1). Consequently, submarine steel is subjected to a comprehensive testing program covering all aspects of the steel suitability – from simple mechanical tests (such as tensile and charpy impact tests) to more specialised testing including weldability, fatigue, magnetisation, Baushinger effect, susceptibility to stress corrosion cracking (figure 2), corrosion fatigue and various forms of corrosion.

One of the most important properties of hull steel is the fracture toughness – particularly the dynamic fracture toughness under high strain rate conditions such as those that might occur as a result of an explosive loading event. The toughness of steels for Australian submarines is determined using a tiered approach which begins with charpy impact and dynamic tear tests and ultimately finishes with the United States Navy Explosion Tests. This tiered approach ensures that the steel does not progress to the expensive and logistically difficult explosion tests without first passing the less expensive screening tests.

The general setup of the Explosion Tests is shown in figure 3. A 760 x 760 x 50mm steel test plate is cooled to approximately -30 ºC in a bath of ethanol and dry ice. After the plate has 'soaked' at that this temperature for 2 hours it is removed and is quickly placed on the steel annulus shown in the inset of figure 3. Depending on the yield strength of the steel being tested, either 12 or 15kg of high explosive is positioned above the plate, on a cardboard spacer. When the plate warms to -18 ºC the charge is detonated (figure 4) and the explosion forces the plate into the annulus. There are two types of Explosion Tests – the Crack Starter Test and the Explosion Bulge Test. The Crack Starter Test determines the ability of the steel to arrest a crack under explosive loading conditions, whilst the Explosion Bulge Test is a measure of the low temperature ductility of the steel at the high strain rates of the test.

The Crack Starter Test plate has two notched brittle weld beads placed at the centre of the plate on the side facing away from the charge. These weld beads crack during the first blast event thus initiating a crack in the

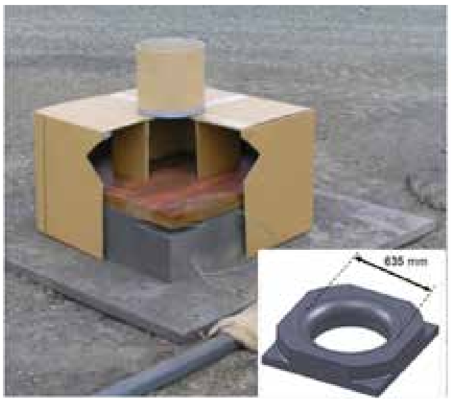


Figure 3. Explosion test setup with a cutaway to reveal the internal arrangement. Note the steel plate setting on the annulus (detail inset) and the cylindrical explosive charge sitting on the cardboard spacer.

parent plate. The plate is once again cooled, placed on the annulus and then hit with another blast event. The steel is examined after each blast and is considered to pass the test if there are no through thickness cracks, no cracks extending out to the annulus and no portions of the steel which have been ejected from the plate.

If the steel passes the Crack Starter Test then it progresses to the Explosion Bulge Test. Explosion Bulge Test plates do not have crack starter weld beads but rather are subjected to multiple blasts until they reach at least 14% thinning (for a 690MPa steel). Additional to this thinning requirement, the plate must also pass the same pass criteria as the Crack Starter Tests – namely no through thickness cracks, no cracks extending to the annulus, and no material ejected from the plate.

Whilst these test requirements might appear onerous, they provide maximum assurance that hull steel for Australian submarines is up to the job of providing adequate protection for our submarines and, more importantly, for our submariners.

Low temperature toughness is also important for surface ships such as Australia's new Air Warfare Destroyers (AWD) (figure 5). This is due to the extreme low temperatures that the ship could experience in its area of operation in the Southern Ocean. It was suggested that DH36 would have adequate low temperature toughness. Consequently, DSTO in collaboration with the AWD Alliance undertook a program of charpy and Explosive Loading testing to determine if the ductile to brittle transition temperature of the proposed steel was below the temperature expected in the AWD's areas of operation in the Southern Ocean. The explosive loading tests for this program were similar to the Crack Starter tests but with significant differences:

1. the plate thickness was only 8mm owing to the thinner hull steel used in surface ships
2. tests were conducted at a range of temperatures from 22°C to -37°C
3. after each test the fracture surfaces were examined to determine the percentage fibrosity (figure 6).

These tests verified that the proposed steel would not undergo brittle fracture at the temperatures expected in the areas of operation of the AWD and moreover that the cold weather capability of the AWD would satisfy the requirements of the Royal Australian Navy.

Figure 4. Blast resulting from explosion test.

Figure 5. The Hobart Class Air Warfare Destroyer.

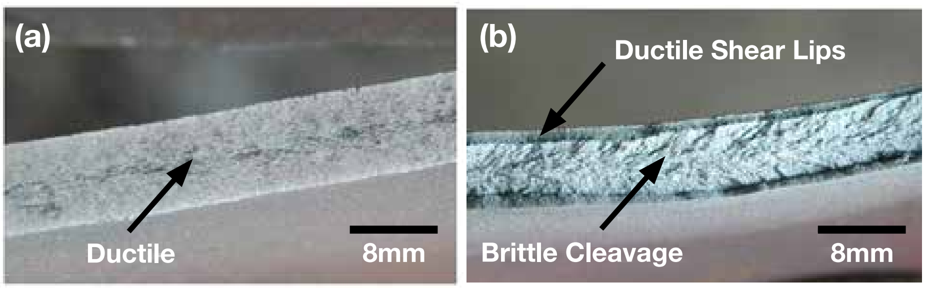


Figure 6. Typical fracture surface appearance for a predominantly (a) ductile and (b) brittle fracture in explosively loaded test plates.

Manufacturing Closures Spark Welding Industry Changes

Author: Sally Wood

The Australian welding industry is teetering on the brink of massive change. The current demand for metal fabricators and welders far out-strips supply, with local construction giants regularly employing highly skilled migrants to fill vacant roles.

All this could change by 2017. The closure of automotive manufacturing and engineering design centres across Australia will see some 2,000 highly skilled welding professionals made redundant within the next three years. Rather than flooding domestic industries, Australian welders seem to be looking overseas for their next post. Unless government and industry bodies step in now, this trend could see the permanent loss of skills and knowledge, impacting heavily on national development.

According to the Australian Workforce Development Agency, there were 86,400 people employed as metal fabricators, pressure welders and welders in 2013. This is equivalent to just 0.77% of Australia's entire working population. Of these 86,400 people, only 0.8% was female.

In terms of historical employment growth within the sector, there has been a 12.3% increase in the number of people employed as metal fabricators and welders over the past five years. This growth is expected to continue at a rate of 7.2% over the next five years.

When compared to Australia's overarching workplace demographic, metal fabrication and welding is a relatively young occupation. Just 32.9% of the workforce is aged over 45 years (compared to 39.9% for the Australian workforce as whole). Labour turnover rates are also relatively low, at just 9.7% (compared to 13.1% for the Australian workforce as a whole).

Given the historical and projected growth for the welding industry, and short-term shortage of home-grown skilled welding professionals, the Australian Government recently mandated that welders are eligible under Australia's 457 visa skilled migrations program. This migration program was introduced to ensure that the shortage of qualified welding operators and engineers does not threaten other Australian manufacturing industries. In 2103, 12.8% of all metal fabricators, pressure welders and welders working in Australia were non-Australian citizens.

There are growing concerns about this local short-term labour shortage across the welding industry. As recently as April 2014, American construction contractor Bechtel announced that they were increasing the number of 457 skilled migrant visa workers required for their $70 billion Curtis Island Liquefied Natural Gas project in Queensland.

Bechtel's general manager in Gladstone, Kevin Berg, confirmed that up to 50 specialist welders and pipefitters were hired from overseas on 457 visas, with a further 30 surface tension welders still needed. Bechtel confirmed that the last 30 welders are expected to be a mix of migrant workers from the UK and Ireland, with some local employees.

While the closure of automotive manufacturing and engineering design centres across Australia had been expected to inject some much need labour into the welding industry, it now seems that this will not eventuate.

The Society of Automotive Engineers – Australasia (SAE-A) estimates that more than 2,000 professional Australian engineers, technicians and welders will be made redundant by 2017. Many of these professional engineers, who hold qualifications that are internationally recognised, are now looking overseas for their next post. In the United States alone, there is high demand, with the SAE-A estimating that there are more than 7,000 current vacancies for automotive engineers. Significant skills shortages also exist in Europe and Asia for automotive engineers.

In America, shortages of skilled welding professionals are already impacting manufacturing. The US Department of Labour's Occupational Outlook Handbook surmised that job prospects for welders are excellent, with employment rates expected to increase by up to 20% from 2012. Project labour shortages with the US welding industry are expected to reach 200,000, as baby boomers retire.

In southern America's Gulf Coast (which includes Alabama, Florida, Louisiana, Mississippi and Texas), the demand for welders is so high that more than 265,800 workers will be required by 2016. Much of this demand can be attributed to the boom in oil and gas production. Louisiana alone will need at least 86,300 workers, with the biggest shortages in the welding, fabricating and pipe fitting occupations. Construction companies across the United States are looking to sweeten the deal for welders, offering higher salaries, higher contributions to superannuation funds, and payment of university debts.

The SAE-A has noted a sharp increase in the number of overseas companies advertising in Australia seeking automotive engineers for international postings. A number of foreign companies currently have talent scouts either in, or heading to Australia, interviewing Australian engineers for overseas jobs. Whilst historical data shows that many engineers eventually return to Australia, a large percentage do not, resulting in a permanent loss of skill and knowledge, detrimental to national development.

To avert this permanent skill loss, the SAE-A is working to support welding industry workers that are made redundant over the next few years and has requested funding from Minister Hodgett (the Victorian Minister for Manufacturing) for an employment transition program. The program will support the transition of professional engineers and technicians made redundant due to the shutdown of manufacturing into other industries within Australia.

University of Sydney Designing Safer Steel Structures

Author: Sally Wood

University of Sydney civil engineering researchers are developing a design process that makes steel structures safer, more reliable, less expensive and gives Australian businesses a competitive edge.

Structural reliability expert Dr Hao Zhang says the team will complete a four-year analysis of the steel structures used in the Australian construction industry.

"In the project we shifted the focus of design from the individual components and its connection strengths to the overall structural behaviour and strength of the entire system," says Dr Zhang, Senior Lecturer in the School of Civil Engineering and co-investigator on the project.

"The component-based design approach can overestimate the load carrying capacity of structural systems, causing unsafe designs.

"The core of this project has been a rigorous statistical assessment of the system strength which considers structural redundancy, consequences of failure and statistical variations in loading and variables affecting the frame strength."

The advanced structural analysis process developed by the University's team that combines examination, evaluation and capacity checking into a single step has highlighted failure modes within the system currently used.

"The one-step process provides the opportunity to consider the consequences of failure during the design phase of the process. This is vital when designing any building including magnificent structures such as Beijing's Bird Nest or National Grand Theatre, or the Water Cube whose engineering team included Australian experts," says Dr Zhang who worked as a structural engineer for the Atlanta based company Uzun & Case prior to joining the university.

Professor Kim Rasmussen, head of the School of Civil Engineering, emphasises the importance of changing the model of steel structural design.

"What is important is the strength and weight of materials used to design reliable steel frames," says Professor Rasmussen.

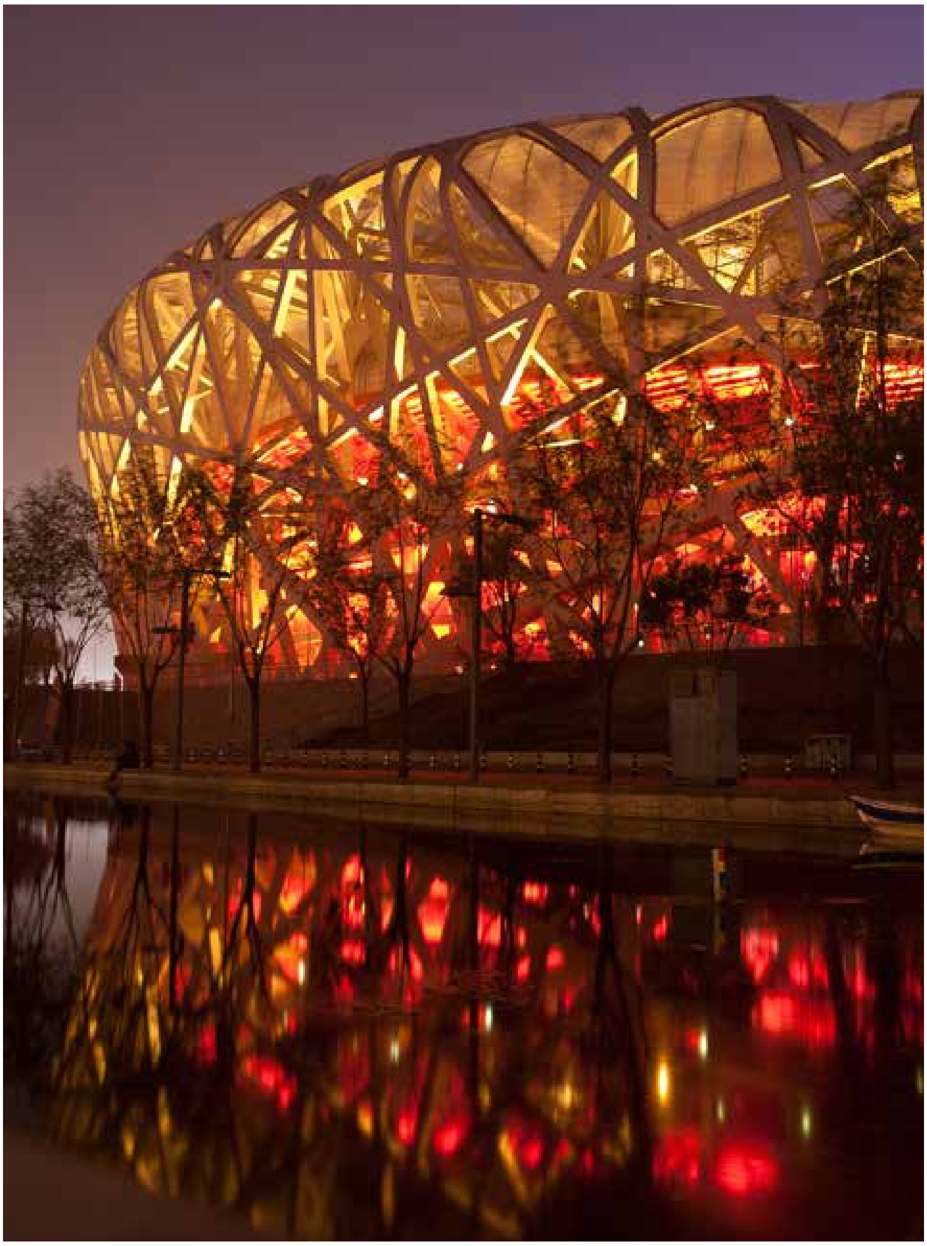


Photo: ZHang Hao

The one-step process will improve the design of structures such as Beijing's Bird Nest Stadium.

"However, the veracity of the structural components and the parts that connect them as a whole are the hidden key."

He suggests the researchers' one-step process will give Australian businesses the competitive edge on the international market.

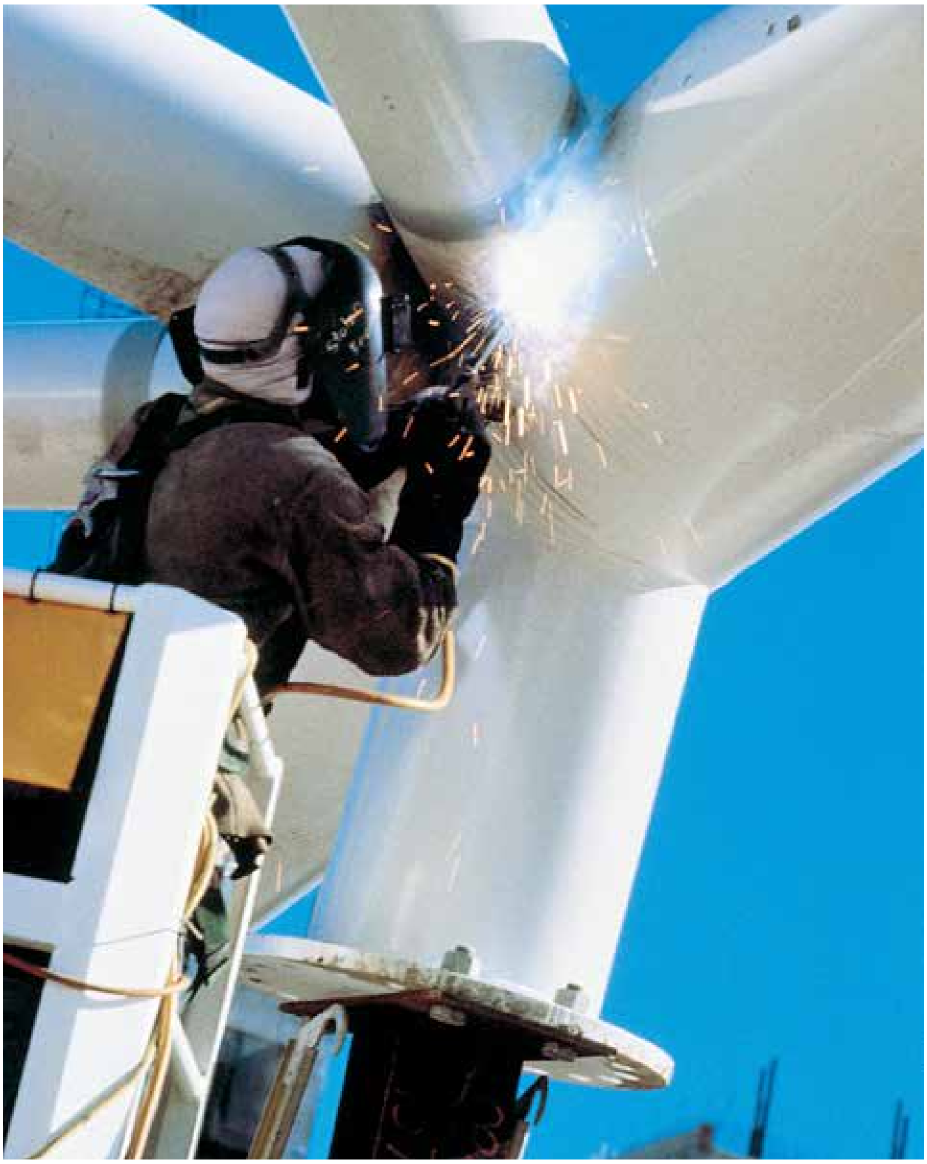
"The outcomes of this project will help Australian structural design firms and engineers to be at the forefront of design methodology. It also can assist Australian companies competing in South East Asia, Middle East and European markets.

"We envisage that over time our one-step methodology will be adopted throughout the world," predicts Professor Rasmussen.

A team at University of Sydney including Professor Kim Rasmussen, Dr Hao Zhang and five PhD students conducted the research. Leading international researcher Professor Bruce Ellingwood from the Georgia Institute of Technology, in Atlanta, USA, also collaborated on the project.

Welding the Future of Australia

Source: Anne Rorke, Welding Technology Institute of Australia



Welding at the Sydney Olympic site (photo courtesy Lincoln Electric).

Welding has a long history in Australia and has played a central role in the growth of our nation, as an enabling technology for nearly every industry sector; mining, oil and gas, power generation, pressure equipment, defence, pipelines, manufacturing, and infrastructure including ports, roads, rail, bridges and construction to name a few. Welding technology is essential to the development of our natural resources, the conquering of our distances, and the achievement of the quality of life we have grown to expect.

Outstanding iconic projects, such as the Snowy Mountains Hydro-Electric Scheme and the construction of the Sydney Olympic facilities, depended on welding technology, delivered by skilled individuals and capable companies, to see them come to fruition. Current day ventures - from the development of North West Shelf oil and gas reserves, exploitation of coal seam gas and its processing on Curtis Island, and the Air Warfare Destroyer and Joint Strike Fighter projects - to the microjoining of medical devices - demand a similar level of expertise and innovation in welding and joining technologies.

Welding technologies continue to develop, and recent advancements include friction stir welding, laser welding, keyhole-TIG and the use of robotics in welding and cutting - even virtual welding simulators for the training of welders.

In recognition of the 25th anniversary of the Welding Technology Institute of Australia (WTIA), established in 1989 through the amalgamation of the Australian Welding Institute (AWI) established 1929, and the Australian Welding Research Association (AWRA) established 1964, this article reviews some of the highlights of the development of welding in Australia and takes a look towards the future.

Roots in History

Gas welding and cutting processes reached Australia in the early 1900s, with the first demonstration of oxy-acetylene welding and cutting given to the Victorian Institute of Engineers in 1909. Some believe that electric arc welding was already being trialled in Australia as early as 1889 and though this cannot be proven, it should not be discounted, since it would not have been the first time - or the last - that new technology had been taken up in Australia so soon after it had been invented.

Welding for the iconic Snowy Mountains Hydro-Electric Scheme.

By 1923 the world's largest completely welded structure was a 2.75 million cubic feet gas-holder - built right here in Australia. The structure involved more than 5,000 steel plates and 15 miles of welded seams. The confidence shown in welding the gas-holder and the successful outcome was the catalyst for the growing use of welding in critical structures from that point on.

The world's second longest welded steel bridge was built in Australia across the Snowy River at Mackillop's Crossing in the early 1930s. Although the first bridge was destroyed by an unprecedented flood, examination of the wreckage showed that the welded joints 'had resisted forces which twisted and bent the adjacent steel sections as if they had been so much brown paper' – delivering another vote of confidence for the process of welding.

The tradition of 'firsts' lives on today, with structures such as the North Rankin A Platform, the world's largest production platform for natural gas constructed in the 1980s and located off the WA coast. At 214 metres tall it was above the height of the Sydney Harbour Bridge and equivalent to a 50-storey office building, and required 50,000 tonnes of welded steel in its construction. Although the facilities were not available to build the platform in Australia, a significant amount of module work, the construction of onshore and wharf facilities and the laying of underwater natural gas pipeline was successfully completed by local companies utilising welding technologies.

Soon however, platforms such as North Rankin will be dwarfed by a Floating Liquefied Natural Gas (FLNG) plant being built for Shell, to develop its Prelude and Concerto gas fields 475 km north-northeast of Broome WA. Once complete the facility, which will load chilled compressed LNG directly into ocean-going LNG carriers, will have decks measuring 488 by 74 metres, the length of more than four soccer fields. Fully ballasted it will weigh roughly six times as much as the largest aircraft carrier. Some 260,000 tonnes of that weight will consist of steel – around five times more than was used to build the Sydney Harbour Bridge. Again, though Australia does not have the heavy engineering facilities needed for the construction of the floating plant, billions of dollars will be spent in Australia on capital and operating expenditure, with the main onshore facility for spare parts and equipment currently under construction in Darwin. Another significant benefit will be in employment and the training of personnel for the operation and maintenance of the facility.

Robotic welding (photo courtesy Lincoln Electric).

The availability of well qualified and certified personnel for the management and coordination of welding operations is, in fact, critical to a company's ability to produce quality welded product in a timely manner, and its productivity and competitiveness in global markets.

Training, Qualification and Certification

As early as the 1920s, as the industry was being established, welding institutes were taking shape in Australia and putting in place the foundations for the qualification and certification of people ranging from welders to welding supervisors for pressure equipment, welding supervisors for structural steel and welding inspectors.

The Victorian Institute of Welding Engineers, which was established in 1925, introduced certificates of welding competency issued to welders who passed an Institute examination. It changed its name in 1929 to become the first AWI and in 1930 a NSW division of the Institute was formed. The division conducted its first examination for welders in 1935 and there were 16 successful candidates.

Generations of personnel have built their careers in the welding industry on the acquisition of qualifications through AWI, and later WTIA when it took over this role after the amalgamation in 1989. Equally, industry over the years has relied on the Institutes' high integrity to ensure the capabilities of staff critical to company competitiveness.

As the Australian Member Society of the 56-member country International Institute of Welding (IIW), the WTIA has been instrumental in the benchmarking of this country's personnel and companies to international standards.

The IIW qualification programme was introduced by WTIA to Australia in 2000, and dovetailed with the existing Australian qualification system. Through its representation of Australia at IIW, the Institute has ensured that local personnel qualifications, recognised as being amongst the best in the world, are linked with the harmonised global programme.

A wide range of IIW qualifications are now available in Australia: International Welding Engineer (IWE), Technologist (IWT), Specialist (IWS) – all eligible to be nominated as their company's Responsible Welding Coordinator – Practitioner (IWP), Inspector (IWI) at three levels, and International Welded Structures Designer (IWSD) at three levels; in addition to local qualifications.

WTIA has also successfully introduced systems of on-going certification of qualified welding and inspection personnel. Certification provides written assurance that an individual is competent to carry out a specified class of work. This gives both the individual and the industry in which they work the confidence to know that the person can carry out their work professionally, in line with current regulations, standards and requirements.

IIW Welding Coordination Personnel are called up by AS/NZS ISO 3834:2008 *Quality*

CRC-WS sponsored research and demonstration of the welding of X80 thin-walled pipe.

requirements for fusion welding of metallic materials and ISO 14731:2006 *Welding coordination – Tasks and responsibilities* as well as many international and Australian standards, and are a cornerstone of world-class welding quality management.

As the IIW Authorised National Body for Company Certification (ANBCC) in Australia, WTIA assesses companies to the IIW Manufacturers Certification Scheme According to ISO 3834 (IIW MCS ISO 3834) and assists them and their Responsible Welding Coordinators to implement the principles of AS/NZS ISO 3834 for improved welding management, productivity and competitiveness.

In support of industry and the introduction of the IIW qualification scheme, WTIA launched the OzWeld School of Welding Technology (SWT) in 2008. The school, an IIW Approved Training Body, offers a range of courses leading to IIW qualifications and WTIA certification as well as training relevant to local industry needs. In 2013 there were 780 student attendances at training modules delivered Australia-wide by the SWT expert lecturers.

Technology Transfer and R&D

Innovation and improved productivity in industry is dependent upon access to leading edge technologies, as well as the availability of 'technology receptors' - well qualified, skilled and competent personnel within a company who can implement such innovation. Such technologies may be sourced at a company level through research and development, through government organisations, or through collaboration which is often government funded and coordinated through industry associations.

Until the AWRA was established in 1964, research into welding was not attempted on a nationally organised basis. Government instrumentalities, such as the Snowy Mountains Authority and CSIRO, and companies such as BHP and CIG, had welding research programs, but industry generally did not have coordinated research facilities.

A meeting of leaders of the Australian engineering industry agreed that there was a need to develop research facilities in Australia to meet Australia's own particular needs. This was partially in response to the 1962 failure of the King Street Bridge, on a cold day in Melbourne, due to brittle fracture of welds on low-alloy steel, which highlighted the lack of high level expertise available for local projects.

The objective of AWRA was to become a local authority on welding and to assist in the development of industry by undertaking and promoting research and development in the welding and allied fields. The association was granted a Federal Government subsidy to augment members' fees for the allocation of specific research projects to the universities and other bodies.

Technical Panels, modelled on and linked to IIW Commissions, were established utilising experts who volunteered their time and produced excellent tools for Australian industry, such as the Technical Note series of publications. Technical Panels and the Technical Note publications continue to support industry today through the WTIA.

In 1991, the Federal Government introduced its new research funding policy via the Cooperative Research Centres (CRCs) and in 1992 the CRC for Materials Welding and Joining (CRC-MWJ) was established. WTIA became a Core Partner along with the CSIRO, ANSTO, BHP Steel, and the Universities of Wollongong and Adelaide. A series of research projects were established and contributed significantly to the technological development of industries utilising welding. For example, pipeline welding research through the CRC during the period 1996 to 2000 reportedly saved the pipeline construction industry over $100 million.

In 1998, a new grant proposal for $12.0 million was successfully made to Federal Government to continue the good work with a new CRC for Welded Structures (CRC-WS) with a total of 15 Core Partners including WTIA with responsibility for technology transfer to industry.

WTIA Developing a National Welding Capability

Launched in 1998 with industry and Federal, State and Territory Government support, the OzWeld Technology Support Centres (TSC) Network enabled WTIA to create an outstanding cooperative network between centres of technical excellence in industry, research, government and education, sister organisations and individuals, both locally and overseas, to diffuse technology into industry. The project included the employment of expert WTIA Technology Managers around the country and further administrative staff, to support technology diffusion and qualification and certification initiatives for the benefit of Australian industry.

The subsequent SMART TechNet Project saw the establishment of a group of WTIA 'Save Money And Re-engineer with Technology' SMART Industry Groups for the power generation, petrochemical, defence and pipelines sectors, identifying common challenges and sourcing potential solutions through the TSC Network. This innovative concept was expanded in 2003 with additional SMART Groups for alumina processing, inspection and testing and later microjoining, and a range of Industry Sectoral Projects, again with industry and government support. Later, as part of the WTIA National Diffusion Networks Project, further SMART Industry Groups for the rail, road transport, water, pressure equipment, building and construction, mining and defence shipbuilding sectors were established, and most of these SMART Groups continue to be active today.

With the demise of the CRC-WS in 2006, WTIA again took up the lead role in coordinating, facilitating and conducting research.

Between 2007 and 2011, with the support of the Australian Government Industry Cooperative Innovation Program (ICIP), WTIA led two industry consortia with SMART Industry Group members. The 17 member-company consortium 'Optimum welded plant in the heavy engineering and infrastructure industry' addressed strategic needs of the power generation, defence shipbuilding and alumina processing industry sectors while a further five member-company consortium undertook projects to 'Design, maintain and repair critical road and rail bridges'. A total of 16 research, development and technology diffusion projects were undertaken, and the outputs have generated excellent returns for the consortium members, the industry sectors and companies servicing them, and the community, particularly in terms of improved public safety. Consortium members estimated there could be savings of $890 million over 20 years through implementation of the project outputs.

The industry support infrastructure established through all these now-completed projects remains an integral part of the WTIA's portfolio and initiatives such as the OzWeld TSC Network, SMART Industry Groups, research and development, and education, training, qualification and certification initiatives remain viable and active today.

The Way Forward for Australia

Globalisation may present Australian industry with many challenges - but it provides even more opportunities. International cooperation enhances this country's ability to capitalise on these opportunities.

Welding was one of the first engineering disciplines to form an international body, with the formation of the IIW in 1948, and this tradition of collaboration and sharing continues today. Through WTIA's membership of the IIW, Australia both contributes to the global body of knowledge in welding and benefits from advances made around the world.

The WTIA's OzWeld TSC Network is an excellent example. The network currently links Australian industry to the resources of over sixty leading edge organisations in the field, and over thirty of these are overseas, enabling access to a wide range of world-class technologies and knowledge which cannot be sourced locally. Additionally, the concept of the network has been shared, by the WTIA through the IIW, with countries around the world. A very successful network in SE Europe, for example, has been developed with Australian support and is contributing positively to industry development and quality of life in the region.

Additionally an IIW White Paper, facilitated by WTIA and developed by over 70 world experts including representatives from Australia, is enabling countries around the world, particularly emerging economies, for example India, to learn from others in order to build up their own national welding capabilities and resources, and to improve welding management and public safety for their people.

WTIA's role in these projects has enhanced Australia's credibility and recognition as a proactive and mature member of the international welding community.

Back home in Australia, the WTIA's own Australian National Welding Capability Project promotes a holistic national approach to offset the decline of, and meet the challenges faced by, Australia's manufacturing and fabricating industries today.

By utilising the 'build blocks' established through the previous networking projects, enlisting the support of governments, industry and the community, and optimising access to technology and knowledge from the international community through IIW, WTIA believes the Australian National Welding Capability Project can secure a sustainable national capability in welding-related activities to meet the current and future needs and requirements of Australian industry, Government and the community.

Perpetuating the aspirations of those original pioneers of welding there will be new generations; the future leaders of industry to guide Australia through the challenges and opportunities of the coming decades with the certitude, inventiveness, persistence and perseverance of their forbearers.

For further information on the activities of the WTIA contact the national office on Tel: +61 2 8748 0100, email info@wtia.com.au or visit www.wtia.com.au

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Improving Sydney's Major Traffic Arterials

Source: Chess Engineering

Part of the 110 km Sydney Orbital Network, the 6 km Eastern Distributor motorway links Sydney's central business district with the airport. With approximately 2.5 km of tunnels, the centrepiece of the Eastern Distributor is a 1.7 km tunnel, running between Woolloomooloo and Surry Hills.

Airport Motorway Limited (the operator of the Eastern Distributor) recently completed works on the tolling infrastructure at the William Street exit and at Woolloomooloo, and replaced the existing Traffic Control Management System (TCMS). Airport Motorway Limited contracted Kapsch TrafficCom, an international provider of multi-lane free-flow tolling solutions, for these works.

As part of the TCMS replacement, Kapsch TrafficCom awarded Chess Engineering (an Australian-owned design, fabrication and manufacturing firm) the contract for the supply, manufacture and installation of a single-span overhead gantry, designed to house tolling collection points.

With a particularly tight project timeframe, Chess Engineering delineated clear priorities from the outset. "We were awarded the tender in November 2013. The first gantry section had to be installed on the 2nd of March, and the second and third gantry sections installed on the 30th of March 2014. This timeframe had to take into account the Christmas and New Year holiday period, specified road closures, and exacting manufacturing and installation requirements," said Elham Haddo, Project Manager at Chess Engineering.

Given these strict scheduling requirements, the fabrication and welding process was tightly planned to ensure that Chess Engineering's experienced welders, boilermakers and certified site personnel were available at critical times.

The nature of the project presented a number of fabrication challenges. Due to its expansive 37 m length, the gantry had to be fabricated in three separate sections: the 11 m long eastern welded frame; the 11 m long western welded frame; and the 15 m long central frame. All structural steel components were fabricated in accordance with AS 1554.1 and AS 4100.

The protracted span of the gantry mandated construction with a camber of 40 mm. To compensate for the natural sagging of the girder at the final installation due to its weight and the gravity, the welded frame was pre cambered 40 mm, as per the design requirements. Chess Engineering used specialised fabrication techniques to achieve this camber, including assembling the three sections of the girder in a cambered orientation.

Given its length, galvanising the gantry was not an option. The largest galvanising bath available was 13.8m L x 2.0m W x 2.2m D. This simply wasn't large enough to fit the girder sections; therefore painting was the only option. The paint requirement was to have a 20-year warranty, which required a third party inspector to inspect each stage of the blasting and painting.

The fabrication phase had to ensure that the three different gantry sections joined smoothly at assembly; the 37 m long gantry was assembled at the workshop and then transported to the site for installation as a single piece. As such, trial assembly of all gantry components was undertaken, both before and after welding, to ensure that all connecting plates aligned. Chess Engineering also used templates to guarantee that all columns fitted snugly to the girder. The template that was used for

the base plates was then used on-site, for all the footings.

The welding process was embedded with strict two-layer quality controls: rigorous inspections both before and after welding. Prior to the commencement of welding on butt weld joints, all butt weld preparations were inspected by one of Chess Engineering's approved verifiers. In addition, welding did not commence until all of Chess Engineer's weld procedures were reviewed and approved by Kapsch TrafficCom.

Once approved, Chess Engineering used MIG (metal inert gas) welding, the welding process in which an electric arc forms between a consumable wire electrode and the workpiece metal, heating the metal and causing it to melt and join. A backing bar was used for welding the right-hand side of the gantry to the base plates. All welding was carried out in accordance with the provisions of AS/NZS 1554.1.

Once completed, all welds were subject to the second layer of Chess Engineering's strict quality control procedure. A 100% visual inspection was conducted on all welds throughout the structure. A 100% ultrasonic test was then performed on all butt welds. Finally, a 10% magnetic particle inspection was completed on all fillet welds.

"There was no margin for error. A major focus during the fabrication and welding phases was on precision. Chess Engineering's machining and fitting team prepared all components exactly as required to ensure that the installation was seamlessly smooth," said Haddo.

The project required use of a range of steel plates and sections, including hot-rolled steel plates (AS 3678 Grade 350), hot-rolled steel sections (AS 3679.1) and pre-galvanized sheets (DX51D+Z275 MA-C). Stainless steel was also used extensively, conforming to the requirements of Grade 316 in accordance with AS 1449. The stainless steel plate for bridge bearings was manufactured with a Brinell hardness of not less than 125.

Welding consumables had to be compatible with the parent metal, classified and identified in accordance with the provisions of AS 1553, AS 1554.1, AS 1858, AS 2203 and/or AS 2717.1. Standard bolts, nuts and washers (that complied with AS 1110, AS 1111, AS 1112 and AS 1237) and high strength bolts, nuts and washers (that complied with AS 1252 were used on the project). All bolts, nuts and washers were hot-dipped galvanised, in accordance with the requirements of AS 1214. Chess Engineering submitted material certificates for all material used to construct the gantry, as well as for the fasteners.

The on-site project team faced a number of challenges. The two gantry installation sites were extremely demanding, with high frequency road traffic. As such, the gantry installations had to be completed outside standard working hours to minimise disruption to traffic flow. Safety was also of paramount importance, with mandatory certification of site personnel for working at heights.

"What was most pleasing, and a testament to the way the Chess Engineering team works together, and manufactures to such a high standard, was the seamless, efficient installation of the main girder. The whole installation process took no longer than 20 minutes. The plates and bolt holes, and cladding aligned perfectly, ensuring that the installation could be completed well inside the required timeframe," said Haddo.

Combined with the existing Plant Control and Monitoring Systems (PCMS), the newly installed TCMS now forms a complete Operations Management and Control System (OMCS). The OMCS enables efficient management of growing traffic demands on the Eastern Distributor, facilitates operations from a single interface, and enables more effective monitoring of traffic conditions and management of traffic incidents.

According to Airport Motorway Limited Chairman, Andrew Head, the removal of the old tolling infrastructure will provide a safer environment for both motorists and maintenance staff on the Eastern Distributor. With the gantry spanning across the north and south bound lanes, there is no maintenance requirement for technicians to be on the road.

"The next stage in construction is to remove the decommissioned tolling booths to improve the overall look and efficiency of the motorway and allow the permanent realignment of traffic lanes, which we expect to take place in the second half of the year," said Mr Head.

The OMCS integrates the existing plant management control system and various traffic management subsystems (including tunnel ventilation, motorist emergency telephone, traffic flow and the motorway network communication system). Devices such as lane use and dynamic message signs, CCTV, a traffic control room video wall and other roadside devices have also been integrated into the system.

MATERIALS
A U S T R A L I A

Materials Australia Magazine's 2014 Features List and Deadlines

Materials Australia has planned the following features for 2014, designed to highlight different disciplines and sectors of the Materials Community.

Our aim is to publish a relevant, interesting and current magazine for those involved in all aspects of Materials. These features attract attention from the right audience and if your business is active in one of these areas, then you will want to be involved.

We offer your company the opportunity to promote your business directly to decision makers in the Materials Community.

Materials Australia also encourages members to contribute to our magazine and we will consider all editorial contributions.

September 2014

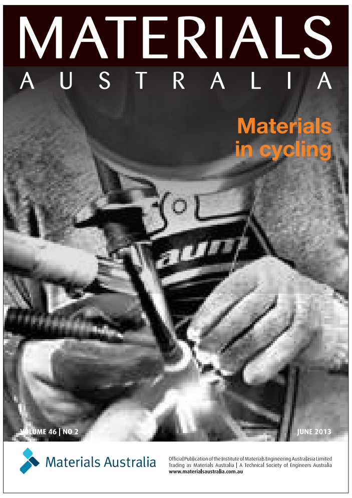
Focus on Education and Training. Targeting: universities, high school students and vocational training.

Content Deadline: Friday 29th August
Advertising Deadline: Friday 5th September

December 2014

Power Generation. Materials for Energy: Solar, Wind & Wave Energy.

Content Deadline: Friday 21st November
Advertising Deadline: Friday 28th November



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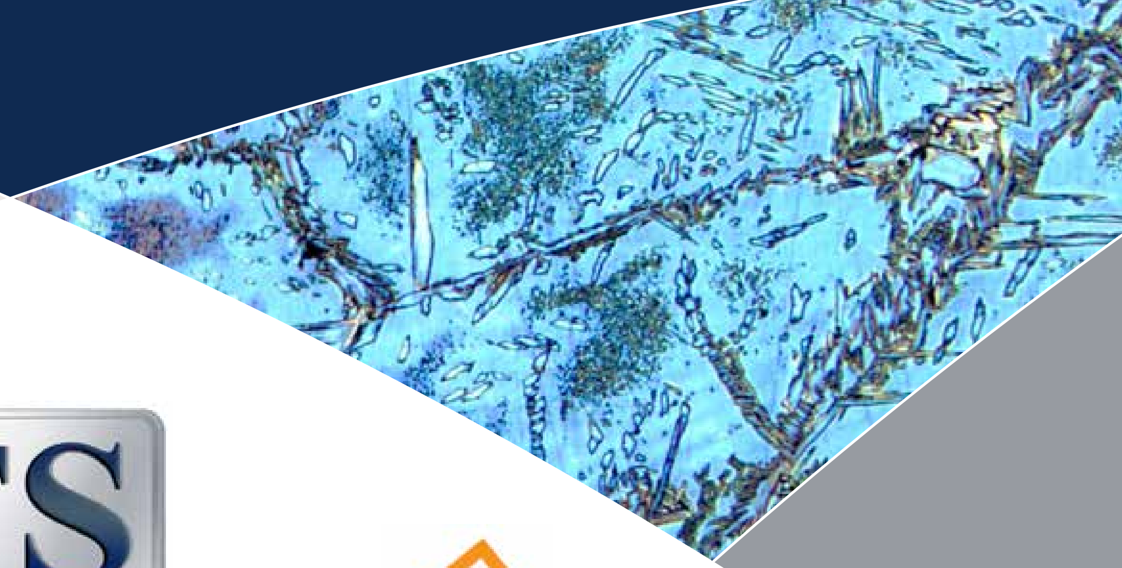
Materials Australia

Official Publication of the Institute of Materials Engineering Australasia Limited
Trading as Materials Australia | A Technical Society of Engineers Australia
www.materialsaustralia.com.au



MTS
Metallurgical Testing Services

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Hi Rod,
I have attached some graphics for possible inclusion. I would like to view the proof that you put together before making a decision.

NOTES:
In view of the focus of the June edition, the message I want in the add is that:

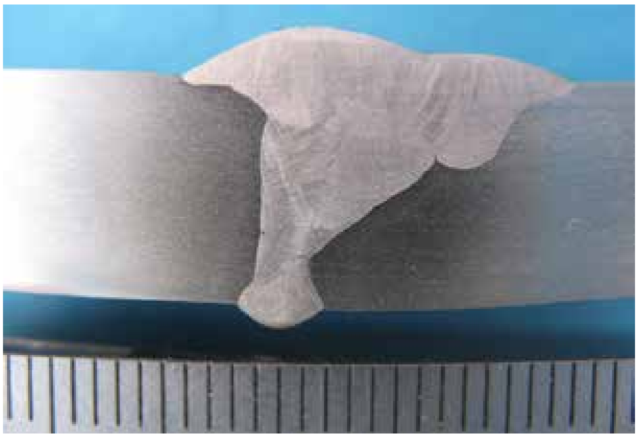
- We are NATA accredited.
- Our expertise in welded joints is outstanding. We have specialist knowledge in the testing of complex welded joints for corrosive and high stress chemical processing and subsea environments.
- We have a highly skilled team.
- We can prepare specimens more precisely than anybody else.
- Our excellent equipment and methods give us the edge in turnaround times.

We also are highly experienced in:

- Rail welded joints – Flash butt and Aluminothermic.
- Fasteners (bolts, nuts, screws) testing.
- We specialised in a wide range of metals and metal products testing.

Enquiries contacts are myself and John Carroll as per website info.

Regards,
Colin M. Lorrimar
Managing Director



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