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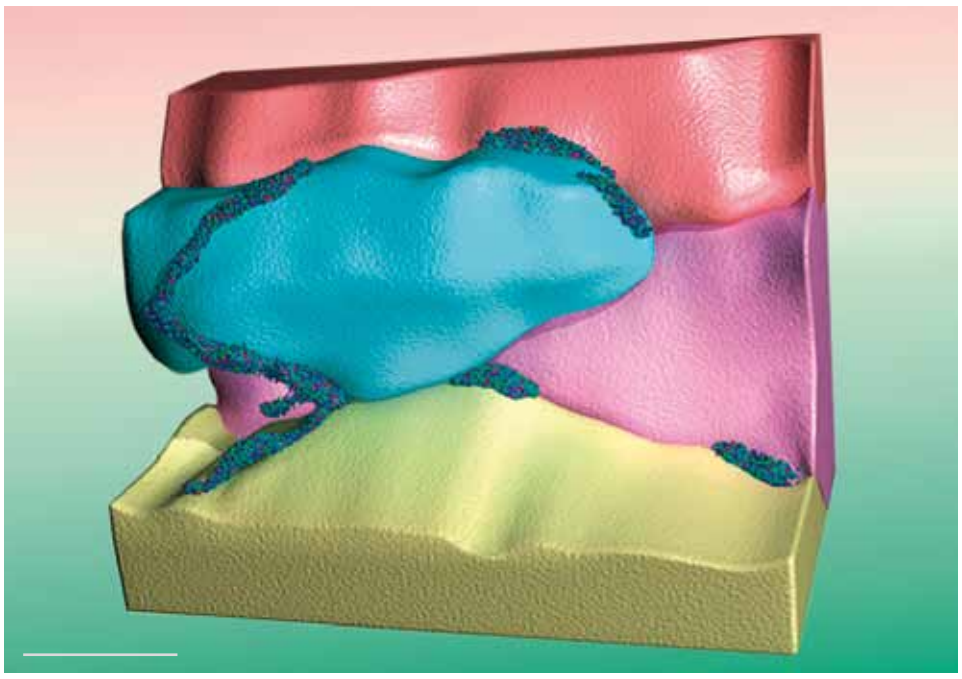
AUSTRALIAN MICROSCOPY & MICROANALYSIS RESEARCH FACILITY

RESEARCH

Nanohierarchy gives alloy mega strength



Tomographic view of solute nanostructures on grain boundaries of the 7075 alloy. Scale bar is 10 nm.

AMMRF @ USYD

Increasing the strength of metals while maintaining their formability is an interesting challenge to those developing new lightweight structures and technologies, particularly for aerospace, automotive applications and construction. There are many ways to change the mechanical properties of metallic alloys, and reducing grain size can lead to a dramatic increase in the strength. However, when the strength of an alloy is increased, there is often a loss in ductility, resulting in a brittle alloy. Dr Peter Liddicoat and Prof. Simon Ringer at the Australian Centre for Microscopy & Microanalysis (ACMM) working together with Dr Xiaozhou Liao of the School of Aerospace, Mechanical and Mechatronic Engineering at the University of Sydney have headed up an international collaboration between five research centres to work on this problem. Recently, the team have had their results accepted for publication in the prestigious journal *Nature Communications*.

Over the last twenty years, severe plastic deformation (SPD) techniques have been specifically designed to produce alloys with small and evenly sized grains. By using very high pressures, multiple gigapascals in many cases, SPD physically squeezes and mixes a solid material to generate a modified alloy. Since the application of SPD, the promise of significant property enhancement has attracted substantial interest, both for fundamental research and technological development.

Dr Liddicoat's and the team's work has produced an aluminium alloy with mechanical properties that expand the current boundaries of performance – combining new limits of strength with good ductility. The aerospace-grade 7075 alloy, exhibits a strength and uniform elongation approaching 1 GPa and 5%, respectively, and so is much stronger than previous crystalline metals. SPD typically strengthens alloys by creating small grains, high dislocation densities, and precipitate particles. The physical improvements observed, however, are significantly beyond what was predicted by standard rules relating grain size to strength. To understand this improvement, he has characterised the nanostructure of the alloy using atom probe tomography (APT) at the ACMM. Analysis revealed that the alloy comprised a solid solution, free of precipitation, featuring a high density of dislocations and many sub-nanometre intragranular atom clusters. Grains were shown to be just tens of nanometres in diameter and intergranular solute structures were observed. By using APT, the orientation of nanometre-sized crystals or 'nanotexture' was also characterised.

The unexpectedly high level of strengthening appears to be due to two factors: the high density of intragranular solute clusters that increase the dislocation storage capability of the material and the intergranular solute structures at grain boundaries that limit nanocrystal growth, strengthen interfacial cohesion, and resist embrittlement and defect generation.

Dr Liddicoat is very enthusiastic about working at the nanoscale. "Being able to really see what is happening inside our alloys at the atomic level has been a huge help in investigating their amazing properties. An exciting aspect of the study was the team's development of breakthrough new atom probe methods to measure the orientation of nanometre-sized crystals to assess 'nanotexture'." ■

INNOVATION

New Technique Finder to help researchers

Researchers now have a new tool to help them navigate their way to world-class microscopy and microanalysis capability. Developed in conjunction with Intersect Australia, the AMMRF's new Technique Finder is a web-based application that makes it easy for researchers to find the right microscopy or microanalytical technique for their specific research needs.

The Technique Finder was launched at the Australian Conference on Microscopy and Microanalysis (ACMM21) held in Brisbane in July. Its concept, development and functionality were presented in a talk at the meeting, and an announcement made to all the delegates. They also had the chance to explore the new tool at the AMMRF-sponsored internet lounge.

The Technique Finder has been designed specifically from a user's point of view, categorising the types of experiments undertaken by researchers in the biological and physical sciences and serving up the techniques available that can tackle their questions. This is a radical departure from the descriptions of instruments that, while of interest to a microscopist, were often of little help to the mainstream researcher. The tool provides information on what the techniques can achieve and where they are available throughout the AMMRF.

This deceptively simple system draws on the depth of experience and knowledge found across the AMMRF. The design of the experimental categorisation, the matching of techniques to experimental types and the content is totally dependent on this expertise.

The Technique Finder is now live on the AMMRF website. As well as providing support for researchers at all levels, it will be a valuable teaching tool for undergraduate and postgraduate courses. It will also connect into the virtual microscopy environment that is currently under development, where it can extend the scope into technique application. ■

LAB NEWS

AMMRF stars at Shanghai World Expo

AMMRF @ USYD & UQ

On 28 June, Prof. Simon Ringer (pictured), the AMMRF's Executive Director and CEO, and Dr Rongkun Zheng from the Australian Centre for Microscopy & Microanalysis at the University of Sydney, convened a one-day symposium on the emerging technology of spintronics at the Shanghai World Expo. This was done at the behest of Deputy Vice-Chancellor (International), of the University of Sydney, who invited the pair to organise the symposium as part of the University of Sydney's involvement in the Australian Pavilion at the expo.

The idea of spintronics is to use the charge and the spin of electrons (and 'holes', the positively charged counterparts of electrons in semiconductors) to process data far more efficiently than conventional microelectronics, which only exploit the electrons' charge. There are high hopes worldwide that, in the coming decades, spintronics will revolutionise modern information technologies in much the same way that microelectronics technologies have radically reshaped the globe in recent years. While the future appears bright for spintronics, there are considerable challenges, fundamental and practical, that must be met in order to convert the basic science and concepts into real devices.

The symposium attracted more than 70 professors and postgraduate students from throughout China. These hardy souls braved the enormous crowds at the expo to reach the Australian Pavilion, where they were rewarded with some amazing science. The symposium proved to be a resounding success and it allowed the AMMRF researchers to showcase their leadership in this field, and to build new links, and strengthen existing collaborations, with premier spintronics researchers in China.

Prof. Jin Zou, an Australian Future Fellow from the AMMRF at the University of Queensland, was also at the Shanghai Expo where his successful collaborations with Chinese research groups led him to receive two awards. One was for Best Practice in Collaborative Research for his work with Prof. Yuehui He at the Central South University with whom he pioneered the development of porous intermetallics and metallic nanowires. He was also highly commended for another of his collaborations, with Prof. Zuimin Jiang at Fudan University, where they investigate porous materials.

The Shanghai World Expo, which runs from May until the end of October this year, is a massive exercise in international logistics, bringing together more than 220 pavilions from nearly 180 countries. The expo's theme is 'Better City, Better Life', emphasising the desire to produce richer, more sustainable urban environments in the future. Occupying an area of over five square kilometres around the Huangpu River, the expo is already well on its way to receiving the 70 million people who are expected to visit the site. ■

Western Australian node joins National Imaging Facility

AMMRF @ UWA

In June 2010, the Centre for Microscopy, Characterisation and Analysis (CMCA) at the University of Western Australia (UWA) became the first microanalysis facility to become a node of both the AMMRF and its sister NCRIS characterisation facility, the National Imaging Facility (NIF). This new engagement highlights the synergies and continuities between imaging capabilities and makes it even easier for researchers to access the capability that they need.

The driving force for the CMCA to instigate an association with the NIF was the identification of a gap in micro-imaging facilities available to Western Australian researchers, who currently have to travel interstate for analysis.

Facilitated by the UWA Bio-imaging Initiative, a 2010 CMCA LIEF bid to establish a Western Australian Small Animal Imaging Core Facility, and an invitation to join the University of Queensland's EIF3 bid for the Centre for Advanced Imaging, led to the proposal that CMCA become the WA node of the NIF.

The success of both bids, with a combined value of $7 million, will see the development of a state-of-the-art pre-clinical imaging facility, suitable for imaging small live animals. It will be the first such pre-clinical imaging capability in Western Australia.

The suite of instruments to be acquired includes an X-ray microtomography platform, multi-spectral imaging and a micro-magnetic resonance imaging system. Acquisition should commence in late 2010. ■

COMMUNITY

Characterisation Roadshow heads South

Following the success of last year's National Characterisation Roadshow, it was agreed that the AMMRF would take part in the 2010 event. Along with representatives from the Australian Synchrotron, the National Imaging Facility and the National Deuteration Facility, Dr Miles Apperley, Dr Jenny Whiting and Uli Eichhorn headed off to Melbourne and Hobart to present the wealth of capability available through the AMMRF.

Due to the large number of research institutions in Melbourne, two events were held, the first at the University of Melbourne and the second at Monash University. Not to forget our Tasmanian colleagues, a Roadshow event was also held at the University of Tasmania. The format allowed the different capabilities to present an overview of their facilities followed by case studies to demonstrate how researchers are currently making the most of the opportunities available. There was also time allocated for consultation, where the researchers could discuss their particular research with the facility representatives. The importance of large infrastructure and collaborative facilities in supporting Australian research was highlighted by the three opening speakers. ■

EXECUTIVE DIRECTOR'S COLUMN

The AMMRF is keenly involved in major national and international conferences, whether they be focused around microscopy and microanalysis or some specialist aspect within materials science and engineering, biomedical science, plant science, archaeology or the numerous other disciplines in which our staff and user community work. Naturally, microscopy and microanalysis conferences are of particular interest because they serve as a forum for the latest methodologies, techniques and instrumentation. They present the latest research findings from the lab, demonstrate proof-of-principle of new methods, the novel use of familiar techniques or they showcase results from years of R&D in the development of new instrument platforms.

Attendees of the recent 21st Australian Conference on Microscopy and Microanalysis would have noted not only the success of the meeting – which is a credit to the University of Queensland-based organisers, the Australian Microscopy and Microanalysis Society (AMMS) and the wider scientific community – but also heard about Australian plans for hosting the International Microscopy Congress (IMC) in 2014.

The IMC is the 'Olympics' of microscopy meetings, and it is held every four years under the auspices of the International Federation of Societies for Microscopy (IFSM). 2010 is an IMC year, and in September, many of the world's microscopists will converge on Rio de Janeiro, Brazil, to attend IMC-17. This meeting is particularly significant for the Australian contingent because we are bidding for the right to host the IMC in 2014. Some months ago, the AMMS requested that my colleague Prof. Paul Munroe from the UNSW node of the AMMRF and I co-chair an Australian bid for the IMC-18, and we have grasped this major undertaking enthusiastically along with our committed bid team, a special advisory group, and with support and excellent advice from Business Events Sydney.

On 22 September, the IFSM will vote to decide which country will host IMC-18 in 2014. Representatives of around 65 microscopy societies will be casting their votes, and we expect strong competition from the other bidding cities – Prague, Istanbul and Beijing. To succeed, we – the Australian microscopy community – are required to engage in targeted lobbying for our cause, and I ask you and your teams to support the bid by promoting this Australian initiative nationally and internationally. Please spread the message far and wide, and encourage your fellow microscopists to do the same. You can be assured that the bid team will be doing our utmost to bring IMC-18 to Australia. ■

Regards,
Simon Ringer, Executive Director & CEO

COMMUNITY

ACMM21 and IFES 2010 conferences give our microscopists a chance to shine

AMMRF @ UQ & USYD

The eagerly awaited Australian Microscopy and Microanalysis Society's Australian Conference on Microscopy and Microanalysis (ACMM21) was held during July in Brisbane. Over 250 delegates enjoyed excellent science in the balmy Brisbane winter. Key AMMRF staff helped to organise the conference and made many significant contributions.

Impressive plenaries and three parallel sessions gave the delegates a stimulating diversity of research to inspire their own ideas. AMMRF staff and students made a notable impact, contributing two of the plenary lectures and over 30 talks. Prof. Simon Ringer, Executive Director and CEO of the AMMRF, and Prof. Rob Parton, Deputy Director of the University of Queensland (UQ) node, presented impressive bodies of world-class research. A great many more presentations were the result of researchers accessing AMMRF facilities around the country.

Another highlight was the plenary session where Prof. Jim Bell from Cornell University talked about his work with NASA. He is involved in the imaging systems on the Mars Rovers and he used this fascinating material to create a stunning story of exploration and imaging.

As always, the social side of the conference gave delegates a great chance to catch up with old friends and make new connections. There was also a cryo-TEM preparation workshop that featured talks and demonstrations from Rick Webb from the Centre for Microscopy and Microanalysis at UQ and Andrew Leis from the AAHL Microscopy Biosecurity Facility (ABMF).

This year four AMMRF staff and students, from the most seasoned professor to the newest PhD student, received Australian Microscopy and Microanalysis Society awards. The John Sander's Medal was presented to Prof. John Drennan for excellence in the application of electron microscopy to physical or chemical sciences and there was a Distinguished Service Award for Prof. Martin Saunders.

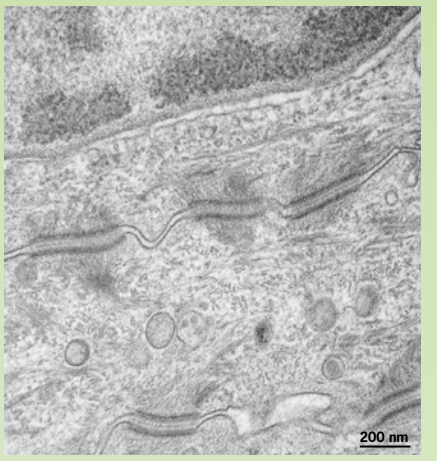
Dr Lilian Soon received the David Goodchild Award for her discovery that tumour cells appear to unravel collagen fibrils. PhD student, Rahi Varsani, from the Centre for Microscopy, Characterisation and Analysis, received the Trans-Tasman Bursary for his honours project research on 3-D EFTEM tomography on carbon nanomaterials, work that he presented at ACMM21.

As the meeting closed, outgoing AMMS president Prof. Dougall McCullough passed over the baton (quite literally) for organisation of the next ACMM meeting to Prof. Brendan Griffin from the AMMRF at the University of Western Australia. It will be combined with the Asia-Pacific Microscopy Conference and the International Conference on Nanoscience and Nanotechnology (ICONN) and will take place in Perth in 2012.

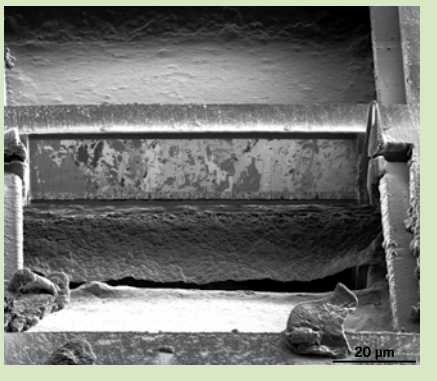
Immediately before ACMM21, the 52nd International Field Emission Symposium (IFES), was held in Sydney. The specialist symposium brought together 160 people from around the world to discuss high-field nanoscience and atom probe tomography. IFES was organised by the University of Sydney node of the AMMRF, demonstrating, along with a number of excellent presentations, the AMMRF's global leadership in this area. Prior to the symposium, the local committee organised a one-day 'Sunday School' on high-field nanoscience and atom probe tomography. It attracted 69 participants, who eagerly absorbed the latest information from international researchers. ■

And the winners are ...

The AMMRF also contributed to ACMM21 through sponsorship of the internet lounge and the best micrograph award. From all the interesting images submitted the judges decided that the best life sciences award should go to Dr Margaret Butler from the AIBN at the University of Queensland. Margaret's fine transmission electron micrograph showed a beautifully contrasted image of human skin cells, revealing particularly exquisite detail of desmosomes.



The best physical science image went to Dr Peter Hines from the Analytical Electron Microscopy Facility at the Queensland University of Technology. The copper sample was sectioned by focused ion beam (FIB) and then imaged again by ion beam. The strong channeling contrast reveals the crystalline structure. ■



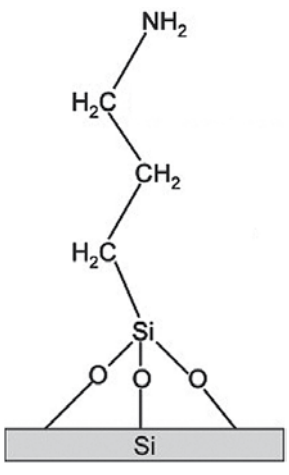
TECHNOLOGY

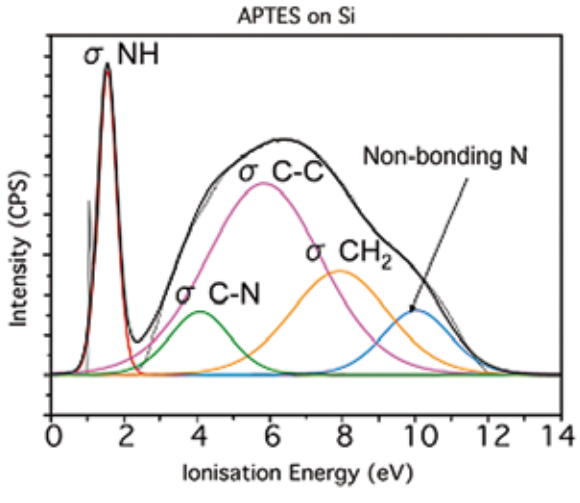
What is metastable induced electron spectroscopy (MIES)?

Metastable induced electron spectroscopy allows surface analysis with high sensitivity. It measures electron density on the very surface of the sample, thereby analysing the surface composition and electronic structure. It can be used to study solid surfaces as well as thin films of liquid. In the literature, MIES has been used to analyse catalysis, corrosion, surface coatings, surfactant solutions, self-assembled monolayers and nanoparticles.

In a MIES experiment the valence electrons – those involved in chemical bonds – are excited with metastable helium atoms and their binding energy is determined by measuring the kinetic energy of emitted electrons, similar to UV-photoelectron spectroscopy. The spectra show, however, only features that are related to those electron orbitals in the outermost layer of the sample. The same molecule placed in two different orientations on a surface will result in two readily distinguishable spectra. For instance the MIE spectrum of the surface of a silicon wafer modified with 3-aminopropyltriethoxysilane (APTES) is shown below. The spectrum shows contributions of all valence electron orbitals of the molecule. However, the orbitals forming the C–C backbone and the CH_2 groups dominate, which shows that the majority of the APTES molecules are lying flat on the surface. A surface where the APTES molecules are standing upright would predominantly show the C–N bonding and the non-bonding N orbitals. MIES averages the surface composition over an area of one to several square millimetres.

The MIES instrument at Flinders University is the only one of its kind in Australia and can be accessed by contacting Gunther Andersson (gunther.andersson@flinders.edu.au). ■





STAFF NEWS

The University of Western Australia

Sten Littman is a geochemist who has joined the University of Western Australia as the SIMS support engineer after working at the Department of Nuclear Safeguards and Security at the Institute of Transuranium Elements (ITU) in Germany. There, he managed the SIMS laboratory that analysed the isotopic composition of uranium particles in environmental swipe samples from around the world. ■

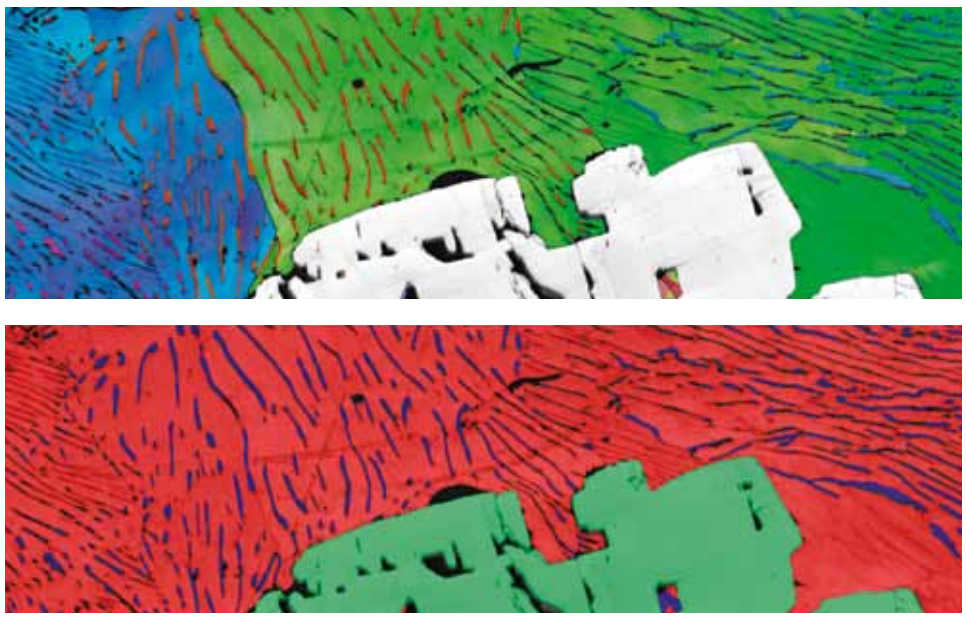
The Australian National University

Dr Andrew Christy joins the Centre for Advanced Microscopy as a support engineer in earth sciences. Andrew completed his BA and PhD at Cambridge, and after postdoctoral work moved to the Australian National University (ANU) in 1994, where he has held research fellowships, managed analytical laboratories and currently lectures in mineralogy. He is an associate editor of Mineralogical Magazine and the Central European Journal of Geosciences. ■

Dr Jennifer Wong-Leung also joins the Centre for Advanced Microscopy from the Department of Electronic Materials Engineering, at ANU. She has held an ARC postdoctoral fellowship and an ARC QEII fellowship (2002–2007). Jennifer has over 15 years of research experience and is an expert in transmission electron microscopy and electrical characterisation of wide-bandgap semiconductors, including techniques such as deep-level transient spectroscopy. ■

LAB NEWS

Cutting-edge microscopy – AMMRF staff host FIB and EBSD workshops



Orientation map (top) and phase map (bottom) of a slag sample collected with EBSD. Large TiN grains (lower part of maps) are in a matrix of ferritic iron and cementite.

This year, rather than holding a single large workshop for all staff, the AMMRF is concentrating on extending the skill base of the technical staff in order to provide the highest possible level of technical support to users. This is happening through high-level workshops in specific areas. The first two of these workshops, on focused ion beam (FIB) technology and electron backscatter diffraction (EBSD), have recently taken place.

The FIB workshop was held at the Electron Microscope Unit (EMU) at the University of New South Wales (UNSW) and was organised by Dr Charlie Kong. Numerous topics were covered, including fundamentals of FIB, high-resolution cross-sectional imaging, in-situ and ex-situ TEM specimen preparation techniques, 3-D reconstruction, micro-fabrication and micromanipulation, and making atom probe samples. Technical maintenance issues and a number of strategic matters were also covered.

The invited speaker, Dr Sergey Rubanov from Bio21, who did his PhD at UNSW, made an extremely valuable contribution, as did Dr Len Green, who showed off his elegant work on the Helios flagship instrument. The active involvement of all the other FIB masters made the event a great success.

The fleet of FIB systems in the AMMRF, along with their technical support staff, is playing a leading and increasingly important role in supporting Australia's research.

In early June, the EBSD workshop was held, hosted jointly at the UNSW and University of Sydney nodes. The workshop focused on a range of practical topics relating to the EBSD technique, including sample preparation, system set-up and approaches to processing EBSD data. Lectures were given by Dr Md Zakaria Quadir from UNSW and Dr Pat Trimby from the University of Sydney, with additional lectures from an invited speaker, Dr Mark Nave from Microanalysis Consulting Pty Ltd. Accompanying practicals and demonstrations took place on the EBSD systems at both the Australian Centre for Microscopy & Microanalysis at the University of Sydney and the EMU at UNSW. A total of eight participants from six AMMRF nodes and Linked Laboratories attended the workshop.

The participants found the advanced workshop platform to be very effective in sharing knowledge and building their networks. It also raised awareness of the capacity in other nodes, the diversity of user bases and the popular applications of these rapidly developing technologies. ■

RESEARCH

WA schoolgirl uses flow cytometry to take biotechnology prize

AMMRF @ UWA

Assist. Prof. Kathy Heel from the Centre for Microscopy and Microanalysis at the University of Western Australia has been jointly mentoring a 15-year-old high-school student, Emily Phillimore, from Shenton College in Perth, as part of the sanofi-aventis *International BioGENEius Challenge* of Western Australia, coordinated by the WA Department of Commerce.

The *BioGENEius Challenge* provides an opportunity for motivated and talented high-school students to work with a professional scientist who mentors them as they undertake research in the field of biotechnology.

Emily's project was entitled 'Fuelling our future – unlocking the potential of an ancient oil crop – *Camelina sativa*'. Under Assist. Prof. Heel's supervision, Emily determined the genome size and variability of the species by using flow cytometry, correlating the results with key biochemical, morphological and agronomic traits. She identified plants with very high levels of omega-3 fatty acid and others with profiles suited to use as a biofuel.

Assist. Prof. Kathy Heel (right) and Assist. Prof. Janine Croser (left), joint mentors of Emily Phillimore (centre).

On the basis of project reports, laboratory journals and scientific posters, the WA panel judged Emily the joint winner. She then travelled, with her parents and mentors, to the Bio2010 conference in Chicago where she competed with 13 other international finalists from Canada and the USA, presenting her work to 2000 people and manning her poster to discuss it with all comers. Although Emily didn't win the event, she was highly commended and had an inspiring trip, hanging out with the other finalists and getting to meet Bill Clinton and George W. Bush. ■

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