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AUSTRALIAN MICROSCOPY & MICROANALYSIS RESEARCH FACILITY



RESEARCH

## Ancient soils guide future sustainability

**AMMRF @ UNSW**

Soils are fundamental to ecosystems and to the productivity of the land. A particular type of soil, found and described in the Amazon Basin, is highly enriched in charcoal and is known as Terra Preta, meaning black earth. These soils are associated with human activity, the charcoal resulting from cooking fires and additional carbon and minerals coming from food waste and pottery shards. They are significantly more fertile than the surrounding soils and maintain their properties over hundreds or thousands of years, even possessing the ability to self generate once they have become established.

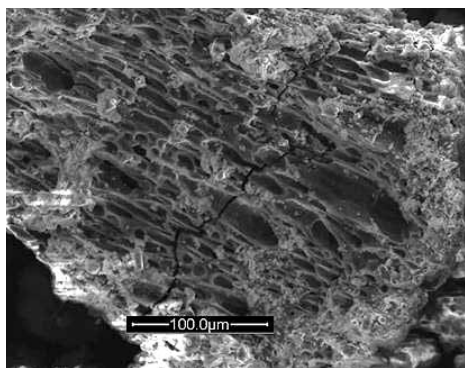
Adriana Downie, a research student from Pacific Pyrolysis is working on an Australian Research Council (ARC) Linkage Project about Terra Preta with Prof. Paul Munroe at the AMMRF at the University of New South Wales (UNSW), in collaboration with researchers from Industry and Investment NSW and the University of Adelaide. The team recently discovered that similar soils exist in Australia, and they have published their findings in the journal *Agriculture, Ecosystems and Environment*. Two Terra Preta Australis sites, as they have now been named, located along the Murray River, were dated and found to have been created 650±30 and 1609±34 years BP. This is anthropologically significant as it places the sites clearly within the period of pre-European Aboriginal habitation. Through a series of investigations including local records, site surveys and laboratory experiments the researchers confirmed the presence of all the typical features of the classical Terra Preta soils of the Amazon Basin with the exception of pottery shards. The dark colour of Terra Preta soil, in sites of Australian aboriginal oven mounds, is distinctively different from the adjacent soil as can be seen in the image shown right.

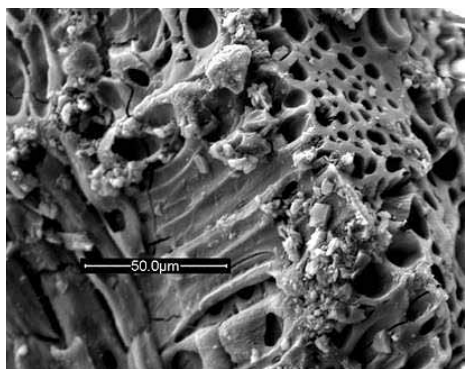
Scanning electron microscopy at the AMMRF at UNSW was used to examine the structure of carbonised particles within the soils, revealing distinctly biological structures such as those seen in the micrographs on the right. Energy dispersive spectroscopy confirmed the carbon-based composition of the particles, and, through examination of the carbon to oxygen ratios, the researchers could determine the extent of carbonisation of the original organic material that found its way into the soil.

Discovering Terra Preta soils in Australia is significant in various ways. Their existence demonstrates that Australian soils, in temperate climates, are capable of storing carbon in much higher quantities than has been previously recognised, and that this capability is founded on the unique stability and properties of charred organic matter. Furthermore, the addition of charcoal appears to have improved the physical and chemical properties, and therefore the fertility, of these soils, which were found to be richer in nutrients such as nitrogen, phosphorus, potassium and calcium. This data provides important support for the concept of soil enhancement with biochar, a manmade product resulting from the pyrolysis of many types of biomass that effectively locks away carbon, removing it from the atmosphere.

Prof. Munroe has a long-standing interest in biochar and the ARC Linkage Project has enabled him to characterise biochars generated by a variety of production methods. Analysis of the Terra Preta soils has shown that the carbonised biomass remains in the soil for many hundreds of years and maintains its carbon content over time. So, as well as sequestering significant amounts of carbon from the environment, the addition of biochars has the potential to greatly improve soil productivity and therefore improve food security for future generations. ■

*Comparison of the Terra Preta Australis soil (above left) and soil from a nearby location (above right). The location of both pits is shown in the image at the bottom of the page. SEM micrographs reveal the biological structures of the carbonised particles (right).*




GOVERNANCE

## The AMMRF on the international stage

The AMMRF has been selected to participate in the European Union–Australia Bilateral Workshop on Research Infrastructure to be held 4–5 April 2011 in Brussels. The purpose of the workshop is to promote cooperation between the European Union (EU) and Australia in research infrastructure. It will be an excellent opportunity for the AMMRF to establish or reinforce existing links with EU counterparts for the benefit of the respective research communities.

The AMMRF will convene one of three concurrent discussion sessions, focussing on cooperation in the development, management and use of research infrastructure. Of particular interest will be discussions of best practice in this sphere. The core of the AMMRF program will be sessions on health and life sciences, advanced materials and nanotechnology, and the earth and emerging energy technologies that will stimulate discussion on how microscopy and microanalysis enable research in these areas in Australia and the EU, and what joint efforts are needed for them to continue to do so into the future.

The planned objectives include an analysis of the operation of multi-user facilities, the production of a roadmap for future microscopy and microanalysis needs in Australia and the EU, and steps towards formal linkages with one or more EU facilities. Interest in the workshop has already been expressed by like-minded facilities in Europe.

"This is an outstanding opportunity for the AMMRF to showcase itself on the international stage and we are looking forward to some important outcomes," said Prof Simon Ringer, Executive Director of the AMMRF. ■

**EUROPEAN UNION–AUSTRALIA BILATERAL WORKSHOP ON RESEARCH INFRASTRUCTURE**

**MICROSCOPY & MICROANALYSIS**

RESEARCH

## Equipment grant success

New instruments will be appearing in AMMRF nodes around the country as a result of the many successful ARC LIEF awards that were announced late in 2010. The monetary value of the grants stacks up to $2.53 million and the practical value to Australian researchers will be significant.

The AMMRF at the University of Sydney will be able to acquire Gatan 3View to section and image embedded biological material directly inside a scanning electron microscope (SEM), generating fully 3-D images. Another of these systems will be acquired by the AMMRF at the University of Queensland (UQ) with funding from an internal University of Queensland grant. These will be the first systems of their kind in Australia and will be suitable for samples from plants and animals to sustainable polymers and nanocomposites to name just a few.

The AMMRF at UQ and the Linked Lab at the Queensland University of Technology will both be gaining high-end SEMs. This will allow both centres to improve their SEM capabilities, greatly extending the facilities for researchers using both campuses.

At the AMMRF at the University of Adelaide a high-performance electron microprobe analyser will be installed to support the geological sciences and the mining industry. Understanding the chemistry of materials at the micrometre scale is critical for deciphering the geological history of rocks, measuring the mobility of heavy metals in the environment and optimising the liberation of metals from ores. This new electron microprobe will provide more accurate results than was possible with previous instruments while increasing throughput.

The AMMRF at the University of Western Australia will also be acquiring a new SEM, along with a multiphoton confocal microscope to support research that requires deep-tissue imaging in the biological and nanoscience areas.

The addition of this new instrumentation will continue to strengthen capability across the AMMRF for the benefit of all our current and future users. ■

LAB NEWS

## Adelaide Microscopy – improvements for the future

**AMMRF @ SARF**

On November 26, 2010, Adelaide Microscopy at the University of Adelaide was relaunched following a major renovation and revamp. Invited guests joined the Director, John Terlet, and the rest of the staff, to hear the Deputy Vice Chancellor (Research), Prof. Mike Brooks, officially reopen the centre. Prof. Brooks outlined the centre's evolution, from its beginnings as the small Electron Optical Centre in the 1970s, through its steady development into the fully equipped facility of today.

Renovations began early last year to make way for the installation of the latest addition to the equipment profile, a FEI Quanta 450 field-emission environmental scanning electron microscope, (FE ESEM). It was purchased with funding provided by the ARC LIEF scheme and with notable support from Prof. Mark Tester of the Australian Centre for Plant Functional Genomics. Many researchers will benefit greatly from the much needed extra capacity for high-resolution scanning electron microscopy and the capability to image fully hydrated samples in their natural state using the wet SEM mode of the instrument. At the reopening event, Prof. Tester spoke about the importance of providing such state-of-the-art infrastructure to the university's researchers through facilities such as the AMMRF.

Adelaide Microscopy's refurbishment also provided an opportunity to extend the very important PC2 facility, which now houses the confocal and laser microdissection microscopes, along with the X-ray microtomography and bioluminescence instruments, to enable a wider range of experiments to be undertaken in the facility. It has already proved its worth with the confocal being used for experiments with medically important pathogenic parasites and bacteria.

With the rebuilding complete and an improved equipment profile, the staff of Adelaide Microscopy look forward to meeting the microscopy and microanalysis requirements of their University of Adelaide, SARF and AMMRF colleagues and users. ■


*Prof. Mark Tester, Director of the Australian Plant Functional Genomics Centre, speaking at the event.*

COMMUNITY

## Farewell Prof. David Cockayne

It is with great sadness that we bring you the news that Prof. David Cockayne, FRS, died on 22 December 2010. Prof. Cockayne was Director of the Electron Microscope Unit at the University of Sydney from 1974 until 1999, developing it from a small service provider to a major research facility, simultaneously establishing himself as a world-leading expert on the electron microscopy of semiconductors.

Prof. Cockayne was born in London migrating to Melbourne as a child. He read Physics at the University of Melbourne and then pursued a doctorate at Magdalen College, Oxford. In 1974 Prof. Cockayne took up the directorship of the Electron Microscope Unit at the University of Sydney and, during his time in Sydney, was instrumental in establishing the Australian Society for Electron Microscopy, becoming its first President. In 1995 he became General Secretary of the International Federation of Societies for Electron Microscopy, then in 2003, its President.

He was elected a Fellow of the Royal Society in 1999 and, although he had rejected many efforts to lure him away, a Chair in his old department, Materials Science, in Oxford was too good to refuse. He took up that position in 2000, but still came to Sydney every year. He will be sorely missed by his many friends and colleagues, and our sympathies go out to his family. ■

EXECUTIVE DIRECTOR'S COLUMN

The opportunities for the future and the successes of the past are very much in our minds at the moment. Late in 2010 the AMMRF responded to a call from DIISR for interest in hosting a session at the bilateral workshop between Australia and the European Union (EU) focussing on research infrastructure. Our proposal was accepted and we are preparing to contribute to the DIISR sponsored event in Brussels in early April. It will be an excellent opportunity for the AMMRF to reinforce existing links with EU counterparts for the benefit of the respective research communities – as well as establish new ones.

Also towards the end of 2010 DIISR announced that the Strategic Roadmap for Australian Research Infrastructure would be reviewed in 2011. Since it was developed in 2006, and subsequently reviewed in 2008, the Roadmap has helped Australia plan and prioritise investment in that research infrastructure. Its approach to investment requires collaboration in order to deliver infrastructure that supports national research priorities and is accessible to all Australian researchers.

The National Collaborative Research Infrastructure Strategy (NCRIS), through which the AMMRF is supported, has been a catalyst for the change and has been broadly supported by the research community. A strong foundation for future infrastructure programs now exists and this latest review of the Roadmap once again seeks to shape strategic investment priorities so that current facilities can be built upon and emerging new priorities can be supported. Details of the process that DIISR has devised for the roadmap are available at http://ncris.innovation.gov.au/Pages/SRARI.aspx. My perspective is clear on this important process: after several years of very hard work and great outcomes from the AMMRF team and the hardworking research communities that work with us, there is now an important opportunity to communicate our contribution and our outlook to the advancement of the Australian research agenda through the characterisation capability, of which microscopy and microanalysis is a key part.

Finally, as you will read in the adjacent article, we note the sad passing of Prof. David Cockayne. I could not end this column without extending my personal tribute to him as an esteemed colleague, friend and scientist who made such a significant contribution to microscopy in Australia and around the world. Undoubtedly, David's contributions to microscopy will continue to resonate for a long time. ■

Regards,
Simon Ringer, Executive Director & CEO

COMMUNITY


## AMMRF staff tour the USA

Here we report on the adventures of more globe-trotting staff and their microscopic tour of the USA. Prof. Paul Rigby, from the AMMRF at the University of Western Australia (UWA), was on sabbatical leave at Purdue University with Prof. Paul Robinson (a member of our ITUAG team) and Ellie Kable, Laboratory Manager from the AMMRF at the University of Sydney, was accompanying her husband during his sabbatical at the University of Wisconsin.

For a time, Ellie joined Prof. Jim Weisshaar's research group at the University of Wisconsin to catch up on high-resolution light and optical techniques. She attended several seminars and workshops including one at the University of Wisconsin in conjunction with the installation of their Titan aberration-corrected TEM. Topics on the agenda ranged from nanotubes to multiple labelling of proteins. Ellie then attended a *Frontiers of Cellular Imaging Workshop* at Marquette University with talks and hands-on practicals on fluorophore technology and live-cell imaging.

The pair visited many more labs and attended several conferences together to see how other facilities function and to learn more advanced light and optical techniques. At the Microscopy and Microanalysis meeting, they presented a poster on facility management that saw them invited to present talks on the AMMRF at the head office of Invitrogen Molecular Probes in Eugene and at Thermo Fisher in Pittsburgh, laying the foundations for greatly improved interactions with these companies in the future.

Paul's work at Purdue mainly concentrated on web-based virtual-reality tools for teaching microscopy. The university's Envision Center is an advanced virtual-reality centre and Paul was taken on a virtual tour of the only certified virtual pharmacy preparation laboratory there is. In conjunction with Prof. Robinson, he also developed a web-based Flash application to assist with basic training and assessment on a Nikon light microscope. This tool will hopefully be available for use in training sessions within UWA and, potentially, in other nodes of the AMMRF.

The opportunity to work with Prof. Simon Watkins (also a member of our ITUAG committee) in Pittsburgh was a highlight as Paul and Ellie honed their skills on multi-colour TIRF and more live-cell microscopy while seeing how Prof. Watkins runs his very successful Center for Biologic Imaging.

Now both back in their respective nodes, they are keen to share their newfound knowledge and experience with users. ■

## AMAS Symposium a success in Canberra

**AMMRF @ ANU**

The Australian Microbeam Analysis Society's Eleventh Biennial Symposium (AMAS XI) ran between 6–11 February this year at the Australian National University (ANU), continuing the tradition of these meetings by combining practice-based instructional workshops with a symposium in which sessions were anchored by review lectures delivered by prominent microscopists and analysts.

Convened by Prof. Tim White and Dr Frank Brink through the newly refurbished Centre for Advanced Microscopy at ANU, the meeting was a great success. Over 100 delegates participated in ten workshops covering topics in scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray tomography, while the symposium sessions attracted more than 60 people. All who attended appreciated the dedication of the workshop organisers and their colleagues who generously gave of their time.

The technique workshops brought together experts from around the world to share their extensive knowledge and expertise, accumulated over many decades. These were a particular success with even the most experienced delegates impressed with what they learned.

Seven invited speakers led topical sessions at the symposium; Prof. Val Randle from Swansea University, Dr Ed Vicenzi from the Smithsonian Institute, A/Prof. Jo Etheridge from Monash University, Dr David Steele from JK Tech, Dr David Paterson from the Australian Synchrotron, Dr Heiner Jaksch from Carl Zeiss, and Dr Shane Kennedy from ANSTO. This mix of speakers allowed wide coverage of topics in SEM, synchrotron and neutron methods, atom probe tomography, and TEM. In addition, 29 contributed oral papers were presented to the specialist symposium.

The AMMRF provided significant support to the meeting, bringing out Prof. David Joy (one of the AMMRF's International Technical and User Advisory Group) from the USA to convene the SEM workshop and by sponsoring the electron-probe microanalysis masterclass and the visit of Prof. Val Randle. ■

TECHNOLOGY

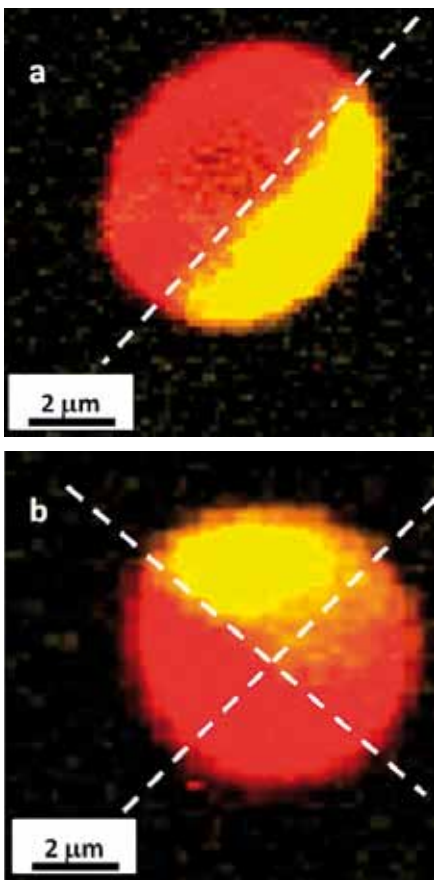
## What is confocal Raman spectroscopy?

Confocal Raman spectroscopy combines a highly efficient Raman spectrometer with a high-resolution confocal optical microscope. The Raman spectrometer can identify different types of molecules from their distinct vibrational spectra. The confocal Raman uses this spectral information to generate an image from the Raman signals as it scans across the sample at the sub-micrometre lateral resolution of the confocal microscope. This combined instrument can identify polarisable organic and inorganic molecules, and, by assigning different colours to different types of bonds, generate an image showing their positions. A typical scan is collected over a period of around 45 minutes.

The AMMRF at Flinders Microscopy (of the South Australian Regional Facility) has the latest generation Witec aplha300 confocal Raman instrument, the first institution in Australia to have this capability. Excitation wavelengths of 785 nm and 532 nm are available, making it possible to achieve a spatial resolution of 350 nm.

This versatile technique has been used at Flinders Microscopy to analyse a range of samples, including ophthalmic lenses, living cells, carbon nanotubes, porous silicon and gold thin-films and to monitor the photo-polymerisation of diacetylene gels. Dr. Christopher Gibson manages the system and, along with Prof. Nico Voelcker, has used confocal Raman spectroscopy to investigate the internal chemical functionality of polymer microparticles. The particles had been fabricated by Prof. Joerg Lahann's group, in the Department of Chemical Engineering at the University of Michigan, to generate either two or four precisely controlled structural compartments in which 50% or 25% of the internal structure, respectively, was functionalised with acetylene groups. The confocal Raman technique was used to determine the spatial distribution of functional groups inside the particles and the results can be seen in the images on the right. ■

*More information: Dr Christopher Gibson, ph. 08 8201 7978 or christopher.gibson@flinders.edu.au*




ACCESS

## Successful end to the TAP scheme

The highly successful Travel and Access Program (TAP) for short-duration secondments to core nodes and Linked Labs within the AMMRF has been a victim of its own success. This popular program, which facilitated access to AMMRF instrumentation around the country, is no longer available. It supported 142 projects and had great outputs, although now, the funding has all been allocated and no further applications can be considered.

The TAP helped to provide access to state-of-the-art instrumentation and expertise for the research community, enabling hundreds of novel projects to get off the ground. The emphasis was on assisting early career researchers explore new projects and provide seed funds for exploratory work. Projects undertaken addressed questions in nanotechnology, food science, drug development, environmental science, biomaterials, light alloys and earth sciences. ■

## STAFF NEWS

**The Australian National University**

**Animesh Basak** has joined the Centre for Advanced Microscopy as a support engineer, a joint position between the AMMRF and the ACT node of the Australian National Fabrication Facility. He has a BSc in metallurgical engineering from Bangladesh University of Engineering and Technology and received his master's and PhD degrees from Kathilieke Universeteit Leuven, Belgium. Then followed a couple of years at the Mechanical and Manufacturing Engineering Department at the University of New South Wales before taking up this current role. He has expertise in high-resolution microscopy and probe analysis, novel FIB-SEM techniques, TEM sample preparation methods and nanoscale fabrication of materials. ■

**Queensland University of Technology**

**Dr Deb Stenzel** has worked at the Analytical Electron Microscopy Facility (AEMF) for many years, most recently as its co-director. Although she has now moved on, she will continue her involvement with the facility through her teaching and research activities within the Cell and Molecular Biosciences Discipline in the Faculty of Science and Technology. Dr Loc Duong has also recently left the AEMF. Bill Kwiecien has joined AEMF team as acting laboratory manager, bringing with him experience of a broad range of microscopy and analytical techniques. ■

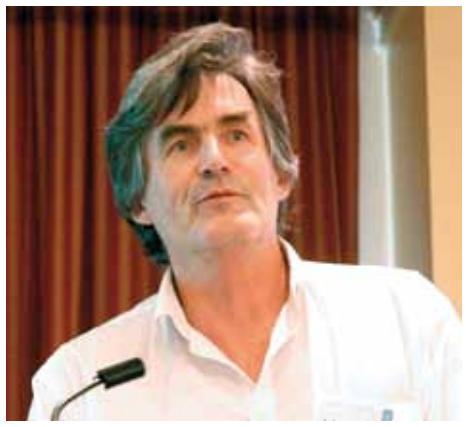
## FROM THE NODES

# Brisbane stories – survival and progression


**AMMRF @ UQ & QUT**

The AMMRF node at the University of Queensland (UQ) and the Linked Lab at Queensland University of Technology (QUT) have both come through the recent floods unscathed and with just centimetres to spare. There were some very anxious moments as the waters rose, especially with the QUT labs being in the basement and so close to the river. Their shared experience extends beyond flood survival into the joint revitalisation of their infrastructure. They successfully obtained Australian Research Council funding to improve their scanning electron microscope infrastructure. The combined package will include a high-resolution and an analytical instrument and will greatly increase the capabilities for providing high-quality data to researchers across both campuses. This collaborative effort is a good example of the close links between the Queensland laboratories, links that have been facilitated, in part, by the AMMRF through its Linked Lab scheme.

International links are also being forged through a UQ Trans Pacific Fellowship that has been awarded to Prof. John Drennan, Director of the AMMRF at UQ, to develop novel materials architectures for protecting surfaces of high-speed aircraft. The fellowship is designed to develop collaborative links with the University of Washington in Seattle and Prof. Drennan will join the materials laboratory of Prof. Raj Bordia for three months in 2011. Prof. Bordia is well known for developing unique ceramic microstructures, and Prof. Drennan will attempt to use Prof. Bordia's pioneering techniques to manufacture ceramic structures that will withstand extreme environments. ■



*Prof. John Drennan, Director of the AMMRF node at the Univerity of Queensland.*

# Alumina, microscopy and seagrass

**AMMRF @ UWA**

Two important meetings have recently been held at the AMMRF at the University of Western Australia (UWA). Australia is the largest supplier of bauxite worldwide and the Alumina Technical Panel (ATP), comprising R&D Managers of the alumina producers with technical capabilities in Australia, held their most recent meeting at the Centre for Microscopy, Characterisation & Analysis (CMCA) at the UWA. They were very impressed by the capabilities and how they can contribute to alumina-based R&D projects.

The other notable meeting was a symposium marking the retirement of Prof. John Kuo after 35 years as a researcher at UWA, most of it within the CMCA. Speakers included John's PhD advisor, former and current colleagues, former students and his daughter Ivana (now a post-doctoral microscopist at Yale). The talks highlighted John's contribution, through microscopy, to botanical research, including his seminal contribution to the study of seagrasses. Although John has officially retired he remains as active as ever within the CMCA. ■

The AMMRF is funded by

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National Collaborative Research Infrastructure Strategy

NSW Industry & Investment

Queensland Government

Government of South Australia

## TEACHING

# Teaching timetable for 2011 now online

This year, as there is so much news and so many courses, we have decided to present the course timetable online only.

Postgraduate education and training in all aspects of microscopy is on offer in 2011 at all the nodes of the AMMRF and many of the Linked Labs. Courses range from one-day refreshers in specific techniques to masters degrees in microscopy and microanalysis. This year is the first time that an entirely online masters course in microscopy is available through the Centre for Advanced Microscopy at the Australian National University. Aimed at professional microscopists seeking to upgrade their skills, this course utilises both virtual microscopy platforms and tele-microscopy, where remote operators can drive microscopes within the AMMRF node. They can then practice reproducing the results on their own instruments. Such innovative courses break new ground in 21st century education.

The full timetable is available online at ammrf.org.au/teaching.php. ■

# Development of online training tools


For those of you who have been following the development of the online training tools, you will be pleased to hear that the new area of the website is now online and hosting the first completed module, that on scanning electron microscopy. Teams of experts around the AMMRF have been extremely busy developing the content of six modules that will be worked up and rolled out during 2011.

These virtual microscopy tools will be an extremely valuable addition to our training repertoire so please have a look and promote them to your students and new users. They can be found at ammrf.org.au/characterisation.

Questions and feedback should be directed to Dr Bronwen Cribb at b.cribb@uq.edu.au. ■

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