ammrf NEWS

Volume 03
September 2008

ammrf.org.au

AUSTRALIAN MICROSCOPY & MICROANALYSIS RESEARCH FACILITY

RESEARCH

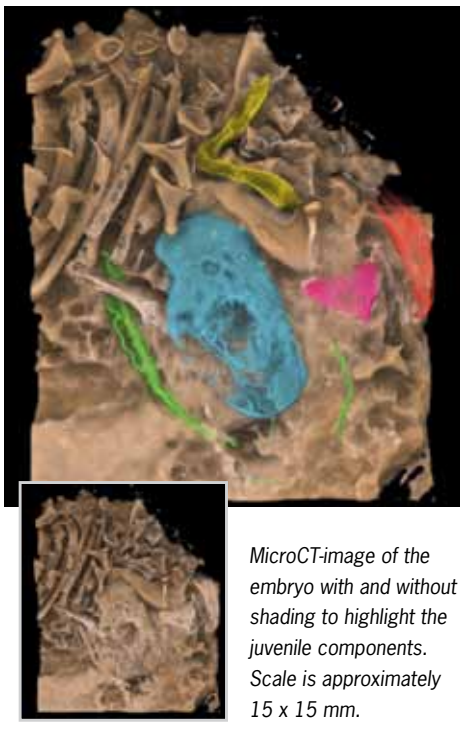
Sir David Attenborough honoured by fishy find

AMMRF @ ANU

A well preserved embryo has been discovered inside a fossilised fish some 380-million-years old from Gogo, in the Kimberley district of Western Australia. This is the oldest example of live birth known amongst the vertebrates.

Researchers from Museum Victoria, the University of Western Australia (UWA) and the Australian National University (ANU) have collaborated in documenting this remarkable fossil – a new genus and species named *Materpiscis attenboroughi*, after Sir David Attenborough – in *Nature* (453, 650-653, 2008).

The *Materpiscis* fossil was collected during a research trip to Western Australia in 2005 under an Australian Research Council (ARC) Discovery Project based at ANU. Dr John Long, Head of Science at Museum Victoria, extracted the specimen from a limestone nodule by using acetic acid, and discovered a partly developed small skeleton inside the body cavity. The fossil has revealed details of the umbilical cord and recrystallised yolk sac, soft-tissue structures very rarely preserved as fossils. Fragments of the preserved umbilical cord were studied by Dr Kate Trinajstic (School of Earth and Geographical Sciences, UWA) thanks to the microscopy facilities of the AMMRF's Centre for Microscopy, Characterisation and Analysis, UWA, and the assistance of technical staff Steve Parry and John Murphy. Further juvenile bones were observed by X-ray microCT (XCT) at ANU by the AMMRF's A/Prof. Tim Senden. The 3-D visualisation of the XCT data was aided by Dr Ajay Limaye, ANU Vizlab, and his reconstruction software Drishti.



MicroCT-image of the embryo with and without shading to highlight the juvenile components. Scale is approximately 15 x 15 mm.

Materpiscis belongs to the extinct armoured fish group called the *Placodermi*. These are common fossils at Gogo, the world's best-preserved site of Devonian fossilised fish. Dr Trinajstic re-examined some key specimens in the museum collection in Perth and found an additional three small embryos inside an adult female of a closely related form, Austroptyctodus. Previous descriptions of male *Austroptyctodus* by Dr Gavin Young (Research School of Earth Sciences, ANU) had already indicated an advanced reproductive biology, involving copulation and internal fertilisation, as in modern sharks. The preserved embryos now demonstrate that these placoderms did not lay eggs, but produced live young, a remarkably advanced reproductive strategy for its time.

"The Gogo material produces perfect skeletons of ancient skulls and braincases, and recent research has revealed the oldest preserved vertebrate muscle tissue and nerve fibres," said Dr Young. "We hold a very significant Gogo fossil collection at the ANU, the result of many years research – it even includes the specimen used by David Attenborough when he visited Gogo for the 1979 TV series *Life on Earth*." A/Prof. Senden added, "We never know, even in well-studied specimens, what additional information may be revealed by new techniques like XCT scanning."

At the press release of the *Nature* letter, Sir David Attenborough said, "I am very, very flattered, and I am very undeserving. This fish was discovered in a marvellous place, in Gogo, Western Australia – I was very lucky to go there back in the 70s to see this site, where these extraordinary fossils are produced and are preserved in such a wonderful state that you can now look at the details of its anatomy including this fish which actually has a baby in the uterus. It is the first and earliest known vertebrate to have internal fertilisation and to rear its young with a placenta and with an umbilical cord. Now what I've done to deserve that, I really can't imagine." ■

During a press conference in Adleaide, and via satellite link to the Royal Institute in London, Dr Susannah Eliott, CEO of the Australian Science Media Centre, presents the authors of the Nature *letter to Her Majesty the Queen, Baroness Susan Greenfield and the Honourable Mike Rann: (left to right) Drs John Long, Kate Trinajstic and A/Prof. Tim Senden. (Photo: Sarah Long).*

LAB NEWS

AMMRF welcomes additional Linked Laboratories

The AMMRF's rollout of linked laboratories continues with the recent announcements of new partnerships with the CSIRO's Australian Animal Health Laboratory (AAHL) and Macquarie University. The Linked Laboratory partnership with the CSIRO will assist in the establishment of the Australian Biosecurity Microscopy Centre (ABMC), a facility that will strengthen Australia's ability to respond to the threats posed by animal disease emergencies. The new centre, which will be constructed within the purpose-built facilities of AAHL in Geelong, Victoria, will include live-cell imaging and a transmission electron microscope – all in a microbiologically secure environment. The ABMC is being made possible by the AMMRF Linked Laboratory partnership and co-investment from the CSIRO and a second NCRIS capability, *Networked Biosecurity Framework*.

According to Prof. Helen Garnett, Chair of the Australian Biosecurity Intelligence Network, the establishment of the ABMC and the linkage with the AMMRF is likely to result in a substantial enhancement of national disease diagnostic capability and a strengthened national biosecurity framework. "By upgrading our laboratory infrastructure and bringing a range of disciplines together we are developing a better connected biosecurity system for Australia," she said.

An agreement has also been finalised with Macquarie University, linking the AMMRF with the optical micro-characterisation facility. The instruments at Macquarie will add to the AMMRF's capability in the areas of fluorescence excitation, lifetime spectroscopy and Raman spectroscopy, techniques that find applications in chemistry, biology, biochemistry, physiology and materials science.

"Forming linked laboratories is an important strategy of the AMMRF to develop our 'hub and spoke' model, so forming a distributed national capability grid," said Prof. Simon Ringer, Executive Director and CEO of the AMMRF. "It helps Australian researchers access a variety of specialised laboratories, thereby enabling world-class research outcomes." ■

CSIRO

MACQUARIE UNIVERSITY ~ SYDNEY

LAB NEWS

The speakers of the Small Matters opening event (from left): Dr Michael Spence, Vice Chancellor & Principal of the University of Sydney; Prof. Simon Ringer, AMMRF Executive Director & CEO; David Ellis, Director of the University Museums; and Dr Paul Willis (ABC Catalyst); at the Macleay Museum.

Small Matters – Exploring the World of Microscopy

AMMRF @ USYD

More than 100 guests packed the University of Sydney's Macleay Museum on the evening of 6 August 2008 for the much anticipated launch of *Small Matters – Exploring the World of Microscopy*, the Macleay's latest exhibition. The official proceedings treated the attendees to an entertaining presentation by Dr Paul Willis, from ABC's *Catalyst* program, on the scientific revolution driven by microscopy, as well as his personal experiences with microscopy. Dr Michael Spence, the University of Sydney's new Vice Chancellor, then proceeded to open the exhibition after reflecting on the way that advanced instrumentation like modern microscopes naturally facilitate interdisciplinary interaction and collaboration. *Small Matters – Exploring the World of Microscopy* is a unique display that takes the world of modern microscopy to the general public. With eye-catching micrographs and easily understood explanations, the exhibition covers six techniques: atom probe tomography, light and laser microscopy, scanning electron microscopy, scanning probe microscopy, transmission electron microscopy and X-ray microtomography. Rounded out with a display of specimen preparation equipment for each technique, some historical microscopes, and modern art work created with microscopes, the exhibition has something for everyone. There is even a hands-on section for the kids, where they can use light microscopes to examine a variety of everyday objects, though this is proving even more popular with the adults. The success of *Small Matters* is evident in the strong interest shown by the media, which has included an article in the *Sydney Morning Herald*, and forthcoming pieces in popular science magazine *Cosmos* and Channel Ten's children's show *Totally Wild*.

The *Small Matters* exhibition is part of the celebrations for this year's golden jubilee of the Electron Microscope Unit (EMU) at the University of Sydney. Established in 1958 as the first centralised electron microscopy facility in Australia, the unit has grown to incorporate the Australian Key Centre for Microscopy and Microanalysis, now headquarters of the AMMRF.

The exhibition, which runs until 1 February 2009, was created through a partnership between the EMU and the Macleay Museum. A series of public lectures about microscopy will be held in conjunction with *Small Matters* – see www.emu.usyd.edu.au for more information. ■

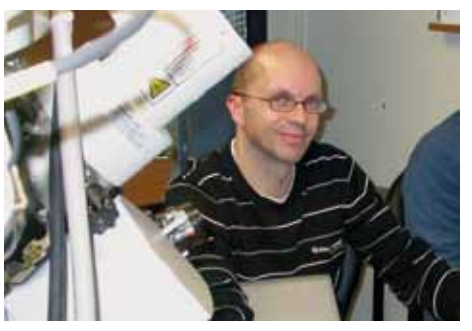
COMMUNITY

Cutting-edge microscope begins cutting sections

AMMRF @ SARF

Recently, potential users of the Adelaide Microscopy's flagship, the FEI Helios NanoLab DualBeam, were invited to an introductory lecture by Dr Oliver Wilhelmi (pictured) from FEI Company, Netherlands. Oliver's enthusiasm and knowledge impressed attendees to the point that subsequent practical sessions on the instrument were over-subscribed.

The DualBeam combines a high-resolution electron microscope with a focussed ion beam (FIB), making it a flexible nanofabrication tool. So, the sessions covered the preparation of cross-sections through the surface of polymer membranes, preparation of TEM lamella from inclusions in mineral samples, and maximum-resolution milling of electronic structures. Quality cross-sections were made of a conventionally prepared biological sample of liver, rather than by the traditional method of microtomy. Three-dimensional reconstructions on the nanometre scale are now possible, and a project is underway to map the positions of cilia on mouse nasal septum as part of the research into cystic fibrosis. ■



'Brain drain' continues from University of Queensland

AMMRF @ UQ

Key members of the AMMRF technical staff at the Centre for Microscopy and Microanalysis, the AMMRF's node at the University of Queensland, are being targeted once again by overseas laboratories. As sinister as this might sound, however, it's not really bad news, because these international stints are short-term visits to allow the technical staff to learn new skills and techniques.

Mr Graeme Auchterlonie, a research officer in the centre, has just returned from the University of Lille in Northern France where he spent several weeks in the laboratory of Prof. Jean-Paul Morniroli, world-respected expert in the electron microscopy technique of Large Angle Convergent Beam Electron Diffraction (LACBED). While in Lille, Graeme performed LACBED experiments on advanced ceramics at variable temperatures. The LACBED technique, largely pioneered by Prof. Morniroli, is proving very useful in determining unambiguously the space group of crystalline phases that are otherwise difficult to pin down. Graeme has brought this technique back to Queensland, and the node is looking forward to installing the necessary software and hardware on instrumentation soon.

Rick Webb, pushing back the frontiers in San Francisco.

Laboratory Manager Mr Rick Webb, whose expertise in biological sample preparation is taking on legendary status, was enticed to Lawrence Berkeley National Laboratory, California, for a six month stay. He will pass on his expertise while in the USA and, at the same time, gain valuable experience in cryo-electron microscopy techniques from some of the pioneers in the field.

Although the absence of these staff from the centre produces some scheduling headaches, it is completely worthwhile if their international experiences can improve the facility's support for researchers and introduce new techniques to the laboratory. More broadly, it is also pleasing to note that the AMMRF is rapidly developing an international reputation and that technical staff from across the nodes are finding opportunities for funded training overseas. ■

Australasian flow cytometrists meet

AMMRF @ UWA

The Australasian Flow Cytometry Group (AFCG) held its 31st Annual Scientific Meeting in Fremantle, Western Australia, on 13-15 August. The highly successful meeting was organised and hosted by a committee led by UWA-node staff Dr Kathy Heel (President) and Ms Tracey Lee-Pullen (Secretary).

The meeting covered a range of research and clinical presentations related to the flow cytometry application in studying and managing infections and immunological disorders. Presenters included Dr Matthew Helbert, Prof. David Price, Dr Fiona Wood and Dr Erika O'Donnell. A full-day techniques workshop on 12 August focussed on technical aspects of flow cytometry, such as fluorochrome choice, experimental controls and multicolour flow.

The AMMRF was well represented at the meeting with two of the three student prizes awarded to postgraduate students for work done using the flow cytometry facility at the UWA node. ■

EXECUTIVE DIRECTOR'S COLUMN

The Commonwealth recently released the 2008 Strategic Roadmap for Australian Research Infrastructure, under its National Collaborative Research Infrastructure Strategy (NCRIS). Six months in the making, the review updates the previous 2006 roadmap and, with reference to high-level microscopy and microanalysis, states: "Demand for existing techniques is high and is expected to increase as exploration of nano and microscale phenomena by researchers from an increasing range of backgrounds and disciplines increases, in part due to the investment from the initial NCRIS funding as well as new, exciting techniques that will become available. Delivery through a shared facility with ready access for all researchers is preferred, building on the AMMRF service model that provides a range of techniques, expertise and geographical coverage. Future investments should be guided by strategic planning based on user-demand and usage."

My colleague AMMRF Node Directors and I spend a lot of time involved with 'new user meetings', seeking to understand researchers' scientific efforts so that we can direct the power of our facility's people and instruments to address their questions. Right now, our General Manager, Dr Miles Apperley, is feverishly working with the nodes to collate user-demand and usage data for current NCRIS reporting requirements. Whilst groaning noises are muttered (albeit barely audibly) among the team as we pull together this sizeable task, the data itself is fascinating because it reveals exactly who is using the AMMRF and what they are doing.

Although there are many highlights, here I want to emphasise our successful engagement with various state and Commonwealth research centres. For example, a glance through the annual research reports of many of the ARC's Centres of Excellence reveals important images and spectral data in photovoltaics, quantum computing, optical rectification devices, light alloys and functional nanomaterials. The same is true for the collaborations at the Ian Wark Research Institute in SA, the John de Laeter Centre of Mass Spectrometry in WA, and the Australian Institute for Bioengineering and Nanotechnology (AIBN) and the Institute for Molecular Bioscience (IMB) in Queensland, to name just a few. The synergy between peak Australian research facilities like the AMMRF, with our specialist research capability, and peak national research centres, which are pursuing particular research questions, is clearly alive and well and, according to the new strategic roadmap, will continue to be important in the context of possible 'future investments'. ■

Regards,
Simon Ringer, Executive Director & CEO

RESEARCH

Probing the way to lighter materials

AMMRF @ USYD

Recent research in the ARC Centre of Excellence for Design in Light Metals has used atom probe tomography to reveal the unique nanoscale microstructure, or 'nanostructure', of an aluminium-based alloy containing trace additions of tin.

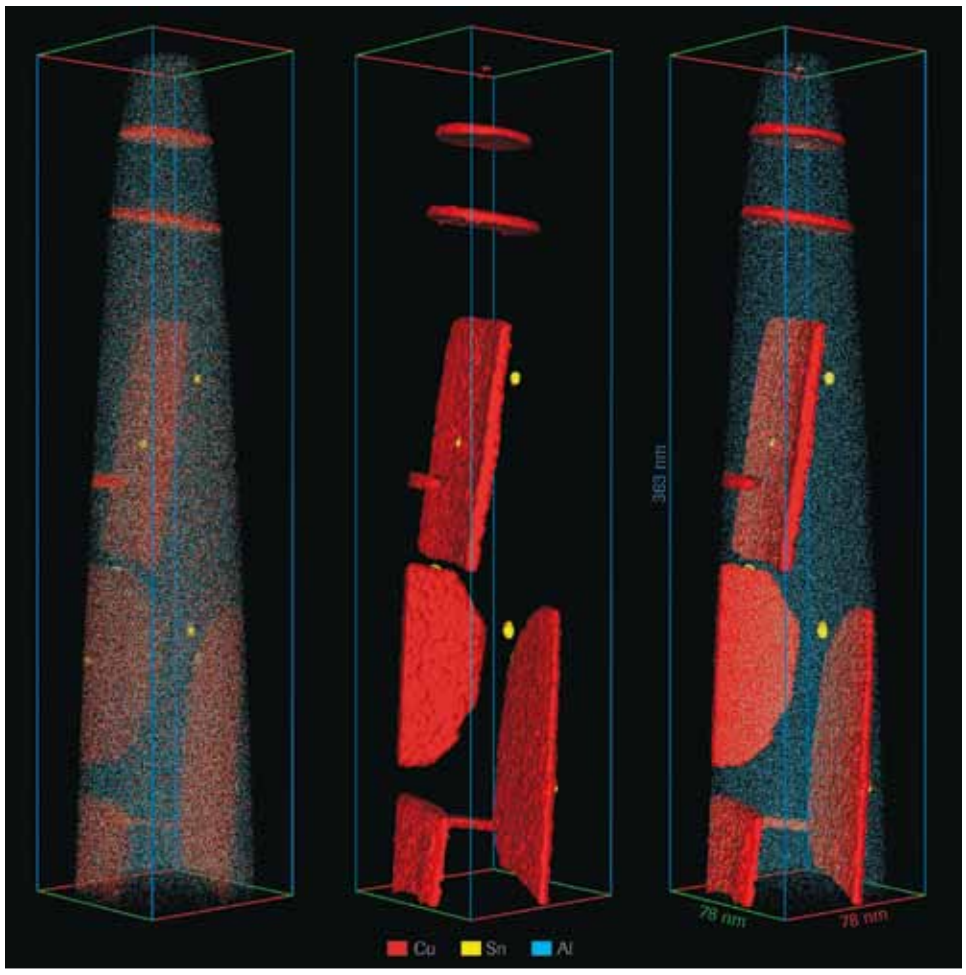
Such aluminium alloys, along with those based on the other 'light' metals magnesium and titanium, are increasingly used as engineering materials in aircraft and other forms of transport because of their high strength-to-weight ratios. This enables construction of lighter vehicles with improved performance and significantly reduced fuel consumption. Seeking more sustainable transport options for society, materials engineers want to design alloys with new combinations of properties. Microalloying elements like tin alter the microstructures and properties of the alloys. These alloying additions are combined with novel heat treatments to control the development of nanostructure.

As shown in the image, the nanostructure in this scientific alloy comprises copper-rich, plate-shaped precipitate particles together with small precipitate particles of tin. The tin particles 'seed' or nucleate the platelets, which strengthen the alloy by impeding deformation. Researchers are using this model system to learn how to apply these design principles to develop new engineering alloys with tailored properties.

This stunning experimental image was recorded with a Local Electrode Atom Probe (LEAP), a microscopy technique that provides 3-D imaging of the atoms in a small volume (100 x 100 x 500 nm^3). Atoms are successively removed from the surface of a needle-shaped specimen under the effect of an intense electric field and then reconstructed digitally to give a 3-D image of the sample. These specimens were prepared for tomography by electrochemical polishing.

Two LEAPs are flagship instruments at the Australian Key Centre for Microscopy and Microanalysis, the AMMRF's node at the University of Sydney. The Key Centre also leads the university's node of the Centre of Excellence for Design in Light Metals, a collaboration among Monash University, Deakin University, the University of New South Wales, the University of Melbourne, the University of Queensland and the University of Sydney. ■

One of the AMMRF's flagship instruments: the Imago wide-field-of-view laser atom probe (LEAP3000) is unique in the Southern hemisphere.



Each blue dot represents a single aluminium (Al) atom, the red dots represent copper (Cu) and the yellow dots represent tin (Sn). The left image is an atom map where less than 1% of the atoms are displayed, for clarity. The middle and right hand images reveal isoconcentration surfaces that highlight the Cu-rich plates and the Sn precipitates.

LAB NEWS

Establishing best practice – the AMMRF staff exchange program

A program of AMMRF staff exchange and secondment is set to build best practice in facility operation. The concept of moving technical staff around the nodes of the facility was identified at the AMMRF Strategic Planning Workshop in May 2008 as an important way to build community and core capability. This concept has now been developed by the Laboratory Managers Committee for implementation.

The purpose of staff exchange and secondment is twofold. Firstly, it will give staff the opportunity to experience the culture of another node as it deals with the "user experience" and other daily operational matters. This experience will strengthen "community" of the AMMRF as elements of best practice, in such diverse areas as OHS and user training, are transferred more easily across nodes and become pervasive throughout the AMMRF.

Secondly, the secondments will provide opportunities to cluster people with similar technical capability together in a 'mini workshop' or 'master class', thereby raising the level of competency in that specialisation across all nodes. Examples of techniques that could be clustered include microwave fixation, wavelength-dispersive X-ray microanalysis, cryo-TEM, EBSD and FIB, although there are many others that can be considered.

This is an exciting initiative and is a direct outcome from the last AMMRF Workshop. The plan of exchange or secondment will be managed by the Laboratory Managers Committee, which can provide more information on request. ■

COMMUNITY

New AMMRF Marketing & Business Development Manager

Dr Jenny Whiting, the AMMRF's new Marketing & Business Development Manager.

Dr Jenny Whiting has recently taken up the position of Marketing & Business Development Manager within the AMMRF. She joins us from the Wellcome Trust in London where she was responsible for building their collection of microscopic and medical images and making it available to academic and commercial users.

Her new role is to promote the capabilities of the AMMRF to the Australian research community, identifying new user groups and encouraging a wide range of new collaborations. Along with Dr Miles Apperley and Uli Eichhorn, Jenny will be working closely with the nodes and Linked Laboratories, to make the most of the wide range of expertise that exists across the Facility.

After completing her BSc and PhD at the University of Adelaide's Biochemistry Department, Jenny spent nine years undertaking basic research in molecular and developmental biology at several institutions in London before she left the lab to join the Wellcome Trust. She will be based at the headquarters of the AMMRF at the University of Sydney. ■

IN BRIEF

The AMMRF node at the **University of New South Wales** recently installed a second flagship instrument, the JEOL 7001F SEM. This field-emission SEM is designed for high-resolution imaging and for advanced analysis with its wide range of detectors: a secondary electron detector for topographic studies, a back-scattered electron detector for compositional contrast, an electron backscattered diffraction (EBSD) detector for crystallographic studies, a silicon-drift detector for chemical analysis, and a cathodoluminescence (CL) detector for analysing defect structures in device materials. This spectacular combination of detectors allows scientists and engineers to push research boundaries in the fields of physics, chemistry, materials science and nanotechnology. ■

July 2010 will see the the University of Sydney's **Australian Key Centre for Microscopy and Microanalysis** hosting the 52nd International Field Emission Symposium (IFES) in Sydney. This biennial symposium will gather together scientists from diverse areas such as field emission, nanoscience, atom probe and laser-matter interactions. This will be the first time in the symposium's history that it has been hosted by an Australian university. The decision – which was announced at the 51st IFES in Rouen, France – is testament to the Key Centre's international recognition for its research in atom probe tomography. ■

Two new world-class Zeiss microscopes now online

The AMMRF's nodes at the University of Sydney and the Australian National University each recently had a Zeiss UltraPlus scanning electron microscope installed thanks to infrastructure (LIEF) funding from the Australian Research Council. These field-emission microscopes will provide users with the tools needed to image and analyse materials down to the nanometre scale.

The Ultra Plus microscope exploits Zeiss's Gemini electron optics to bring researchers the ultimate in flexibility for SEM imaging, with nanometre resolution at voltages from 30 kV down to 0.1 kV. This impressive performance comes from patented lens assemblies and an electrostatic 'beam booster', which minimises aberrations even at low voltages. With four distinct types of electron detectors on board and a cavernous chamber, there is an abundance of structural and chemical information available and plenty room for large samples. Both systems are equipped with detectors for rapid energy-dispersive X-ray spectroscopy and electron backscattered diffraction (EBSD).

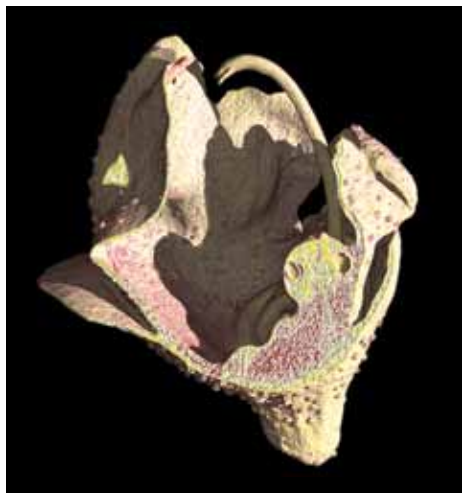
Zeiss application specialist Heiner Jaksch will be in Sydney the first week of October to help users get the most out of this powerful system. ■

STAFF NEWS

Congratulations to AMMRF team members

Edd Stockdale, PhD student at the UWA node, has been awarded the prestigious Daniel Jouvance Scientific Award for 2008. Each year, the Daniel Jouvance Society presents this award to one young researcher worldwide for doing outstanding work in marine biology, oceanography or biotechnology. Edd's research focuses on the unique biomineralisation system of chitons, a marine mollusc that biomineralise iron to form magnetite (iron oxide) teeth. These hard teeth allow chitons to feed by scraping nutrients off rocks. Edd received the prize for his original and creative application of microscopy techniques to study chitons. ■

Dr Allan S. Jones from the USYD node was invited guest speaker at the 2008 SkyScan User Meeting in Antwerp, Belgium, from 15-17 June. With more than 70 participants, the meeting was one of the largest gatherings of users of X-ray microtomography technology to date. Besides contributing to an excellent series of scientific presentations – which covered fields as diverse as food technology, bone modelling, kidney stones and mechanical testing – Allan won a contest held at the meeting for the best X-ray microtomography image.



The winning image is of a small native flower (about 10 mm in diameter), which highlights the fact that X-ray imaging can be successfully applied to non-rigid, low-density samples. The pistil, anthers and petals of a *Prostanthera sieberi* are evident in Allan's winning micrograph (above), along with the X-ray dense outline of the ovary (yellow) at the flower base. ■

AMMRF at ICEM 2008

With an acronym to rival the longest of those used in microscopy and microanalysis, the IUMRS-ICEM 2008 was in Sydney from 28 July to 1 August. This international conference, otherwise known as the International Union of Materials Research Societies' International Conference for Electronic Materials 2008, had a diverse program of interdisciplinary materials topics with a particular focus on electronic, optical, energy and environmental technologies.

The AMMRF was an active participant in ICEM 2008, with researchers from several AMMRF nodes presenting their research. Once again, the AMMRF teamed up with the Australian National Fabrication Facility to jointly exhibit the complementary capabilities in characterisation and fabrication. A steady stream of researchers from Australian and overseas visited the exhibition booth, which promoted the AMMRF's capabilities to a wide audience, and many of the international visitors praised Australia's initiative in having truly national research facilities that are accessible to all researchers. ■

The AMMRF is funded by

An Australian Government Initiative
National Collaborative Research Infrastructure Strategy

First for Business
Department of State and Regional Development

Queensland Government

Government of Western Australia

Government of South Australia

The AMMRF *News* is published four times a year.

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