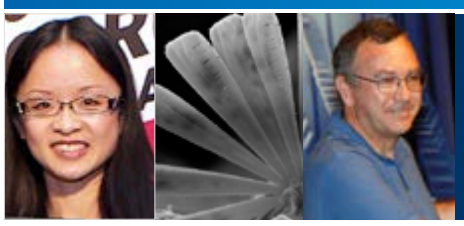
ammrf NEWS

Volume 25
March 2014

AUSTRALIAN MICROSCOPY & MICROANALYSIS RESEARCH FACILITY

Online at
ammrf.org.au



RESEARCH

Supercapacitors to fuel the future

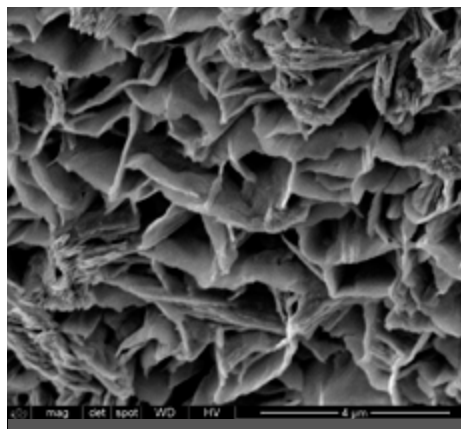
Electric vehicles and portable electronic devices are increasingly in demand due to the heightened awareness of climate change and the need to find alternatives to fossil fuels. Electrochemical energy storage devices are the key components of these new technologies. Currently, the most promising rechargeable electrochemical energy storage systems are lithium-based batteries. However, they are not very applicable for the large, multi-cell modules required, due to their limited cycle life and problematic safety features.

Supercapacitors are an emerging technology that can store far more energy than traditional capacitors yet release it quickly. They can repeat this many times without loss of storage capacity. One disadvantage of state-of-the-art supercapacitors is their relatively high fabrication cost compared with lithium-ion batteries. Researchers at the University of New South Wales (UNSW) are investigating a new material for superconductors: exceptionally thin sheets of cobalt oxide (Co_3O_4) .

It is known that only the surface-most atoms of active electrode materials play a key role in the supercapcitor function, and that the electrochemical activities of electrodes are closely related to their microstructures. Therefore manipulating those microstructures enables the design of better materials specifically for energy conversion and storage. A range of different Co_3O_4 morphologies, including nano-spheres, nano-needle and nano-sheets, have been successfully fabricated and reported so far. However, among such morphologies, it is the porous Co_3O_4 nano-sheets, attached to their supporting material by their edges, which show the greatest capacitive behavior.

The high fabrication cost of current super-capacitors is due primarily to their graphene support. Although carbon is cheap and available, it is demanding and costly to make it into graphene, a single-atom layer form of carbon. Porous carbon foam, with the same excellent electric properties as other carbon-based materials, could therefore be an ideal replacement. Owing to its network of tiny holes all through the structure, similar to a sponge, porous carbon foam provides a large surface area on which the supercapacitive material can be deposited.

Electrochemical deposition of metal hydroxides has been the usual way of making supercapacitors. This is suitable for large-scale industry, since it is simple and convenient, but is not stable in the long term. Also the chemistry of the process does not lend itself to effective deposition of cobalt oxide. To enable the safe and efficient deposition of Co_3O_4, postgraduate student Zhemi Xu, under the guidance of Prof. Sean Li and Dr. Dewei Chu at the UNSW used ultraviolet (UV) irradiation at room temperature to bring about the necessary chemical reactions. UV treatment gives an easy and effective solution. The method leads to a network of cobalt oxide nano-sheets attached to the carbon foam along their edges. The researchers used both transmission and scanning electron microscopy in the AMMRF at UNSW, to confirm aspects of the nanocrystalline structure of the Co_3O_4 nano-sheets and their compositional homogeneity. The new technique with its simple synthetic procedures and reaction conditions is suitable for industrial-scale production of Co_3O_4 nano-sheets on carbon foam bringing the promise of more commercially viable supercapacitors. ■



Scanning electron micrograph of Co_3O_4 nano-sheets on a carbon foam base.

Tell us your story!

Your work could be featured here – tell us about your AMMRF-enabled research. Contact jenny.whiting@ammrf.org.au

INTERNATIONAL

European collaborations renewed

On 25 November 2013 in Heidelberg, Germany, the AMMRF and Euro-BioImaging (EBI) renewed their formal Collaboration Framework. EBI is a research infrastructure project on the European Strategy Forum on Research Infrastructures Roadmap. EBI will offer a range of imaging technologies to life scientists in Europe and beyond (www.eurobioimaging.eu). It aims to be a distributed research infrastructure largely modelling itself on the successful way that the AMMRF provides open access to users.

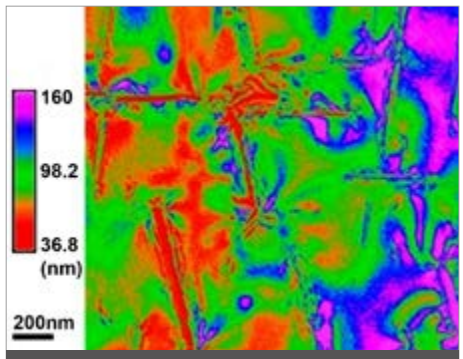
Under the Framework, the AMMRF and EBI cooperate in the establishment and operation of world-class collaborative research infrastructure in the area of microscopy and imaging for biological and medical sciences. Practical outcomes of the cooperation to date include the sharing of information about best practice in facility operation, training, outreach and management and support for the highly rewarding specialist master class in correlative light and electron microscopy held in Sydney last June. ■

RESEARCH

Innovative microscopy – award-winning research

USYD

The conference paper, *The Role of Precipitates Upon the Electrochemical Stability of Aluminium* received the Marshall Fordham Research Paper Award at the annual conference of Australasian Corrosion Association (ACA) in November last year. The award is given annually to the best research paper either published in *Corrosion & Materials* or in the annual *ACA Conference Proceedings*. The award-winning paper describes the work of PhD student Xian Zhou and her supervisor, A/Prof. Nick Birbilis from Monash University who, along with co-authors Prof. Simon Ringer and colleagues at the University of Sydney (UoS), are part of the ARC Centre of Excellence for Design in Light Metals. They used innovative transmission electron microscopy techniques in the AMMRF at UoS to show that for a compositionally identical alloy, the size, volume, and number of precipitate particles has a significant influence on the corrosion of the alloy. The detailed microscopy for this project needed careful measurement of sample thickness in-situ by using plasmon loss, and quantification of the alloy microstructure. Coupling state-of-the-art electrochemical analysis and microscopy in this way had not previously been reported and its success in identifying the causes of corrosion was recognised in this award. ■



In-situ thickness measurement of an alloy sample.

MEET THE RESEARCHERS

From macro to micro scale: plastic pollution

UWA

Julia Reisser is a PhD student from the University of Western Australia's (UWA) Oceans Institute and is using the AMMRF at UWA to study a relatively recent type of marine contamination: plastic pollution. Julia is passionate about protecting our oceans and their marine life. She has been out on eight trips collecting samples from the seas around Australia using a specially designed net to catch floating plastics, which she then examines in the AMMRF at UWA.

"I am really enjoying my PhD experience at UWA. I get to be out on boats and then analyse the data using global ocean current models and microscopes. It gives me the opportunity to study my research topic, plastic pollution, from the big picture to the microscopic scale".

In her first PhD publication, Julia and her collaborators concluded that each square kilometre of Australian sea surface water is contaminated by around 4,000 tiny pieces of plastic. There were higher plastic concentrations close to major Australian cities (Sydney, Brisbane) and industrial centres (Karratha) and where ocean currents converge (such as south-west Tasmania).

The plastic fragments, commonly called microplastics when smaller than five millimetres, make up the vast majority of human-made debris present at beaches, on the seafloor, and in the water column. Throughout their marine journey, plastics break down into increasingly smaller pieces, mostly due to the effect of sunlight and heat. The effects of plastics on food webs and ecosystems have become a focus of concern over the last decade. It is now known that over half of our plastic objects contain at least one ingredient classified as hazardous.

Scanning electron micrograph of a *Licmophora* alga growing on a piece of microplastic. Each arm is 35 micrometres long.

To make matters worse, plastics that enter the oceans become increasingly toxic by adsorbing oily pollutants onto their surface. When plastic is ingested, these concentrated toxins can be delivered to animals and transferred up the food chains, affecting the health of entire food webs, which include humans. This biomagnification of toxins is more likely to occur when plastics are small enough to be ingested by small fish and zooplankton. This, in turn, is more likely to happen when they are covered with microorganisms.

Julia is now back in the lab investigating the microscopic inhabitants of these millimeter-sized marine plastics. "This SEM study is essential to improving our knowledge of plastic pollution hazards to marine environments. By knowing what kind of creatures attach to these tiny floating plastics we will be able to better understand marine plastic pollution fate and impacts." ■

EXECUTIVE
DIRECTOR'S COLUMN

Recent leadership by Australians in microscopy & microanalysis conferences indicates a strong, diverse and relevant scientific research community. The joint meeting between the Australian Society for Microscopy & Microanalysis (AMMS) and the International Conference on Nanoscience & Nanotechnology (ICONN 2014) in Adelaide provided a world-class program and a tradeshow premiering new technologies to the influential Australian community. Last September, the international meeting Frontiers of Electron Microscopy in Materials Science was held in Victoria and again featured some of the leading electron microscopists in the world. Very soon, Focus On Microscopy, an international light microscopy conference will take place in Sydney. The Australian organisers of these meetings have done a fantastic job and have served their community in a very important way.

Naturally, these meetings are very significant to the AMMRF. Many of the speakers are from our 3,000-strong user base, reporting their findings. Our facility staff present new technique developments and themselves learn new techniques.

Therefore, we are very exited to be working with AMMS in championing a bid for the 2018 International Microscopy Congress (IMC). This meeting, the 'Olympics' of world microscopy conferences, always has a remarkable scientific program coupled with an enormous corporate exhibition. Prof. Paul Munroe and myself have accepted the challenge set to us by AMMS and are now earnestly working to promote the Australian bid. A brand new, amazing convention centre will be available for the meeting in Sydney.

It is our international colleagues on the International Federation of Societies for Microscopy (IFSM) council that we must convince to bring IMC2018 to Sydney. A vote from the council at the IMC2014 in Prague will determine whether or not Australia gets to host the meeting for the first time since the early 1970s. I urge you all to get behind the Aussie bid with your advocacy. Please tell your international colleagues about the fine track record we have in this country for running superb scientific conferences, particularly in microscopy and microanalysis! There will be booths to promote the Aussie bid at the forthcoming M&M conference of the Microscopy Society of America, and at the Prague IMC2014 meeting, so if you are there please do drop in and show your support.

Simon Ringer Executive Director & CEO

CONFERENCE

Microscopy and nanoscience conference in Adelaide

The ICONN2014/ACMM23 conference held in Adelaide in February was a wonderful joint meeting for over 900 microscopists and nanoscientists. Many of our staff and researchers took advantage of this conference to get together and catch up on the latest technical and research developments in their areas.

We also sponsored Prof. Wolfgang Baumeister's attendance at the meeting. A world leader and visionary in the area of electron cryo-tomography and member of our International Technical & User Advisory Group, Prof. Baumeister kicked off the meeting by presenting the David Cockayne memorial plenary lecture. It was a very impressive talk on the wide range of applications of electron cryo-tomography in structural biology.

A visit by Dr Ed Vincenzi from the Smithsonian Institution was also supported by the AMMRF. As well as attending the conference, Dr Vincenzi visited the AMMRF at the University of Sydney to discuss new applications of atom probe tomography with a view to future collaborations.

Prof. Martin Saunders, president of the The Australian Micrsocopy & Microanalysis Society (AMMS) presented a number of awards for excellence in microscopy. In recognition of his leadership and outstanding contribution to microscopy, the Director of the AMMRF at the University of Adelaide, John Terlet was awarded life membership of AMMS. A major user of the AMMRF at the University of Sydney, Prof. Xiaozhou Liao, was awarded the John Sanders Medal for excellence in developing or applying electron microscope techniques to problems of practical importance in the physical and chemical sciences. Dr Jamie Richies from the AMMRF Linked Lab at the Queensland University of Technology won the David Goodchild Award for excellence in biological microscopy. At the beginning of the career spectrum, PhD student and AMMRF user, Jeffrey Henriquez, won an AMMS poster prize. ■

Our sponsorship role enabled us to reach a large community of researchers in nanoscience and all areas of microscopy. We sponsored the conference Technology Hub right in the centre of the exhibition space, highlighting our online tools and providing a central networking area for delegates.

Adelaide Workshops

Associated with ICONN2014/ACMM 23 were eighteen microscopy-related workshops held before and after the conference.

Many of these were organised and run by AMMRF staff in conjunction with invited guest presenters and supplier demonstrations. They covered a wide range of topics from Beginner's Image Analysis to advanced techniques, including Microstructural Analysis using EBSD and In-vivo Bioluminescence & Fluorescence Imaging.

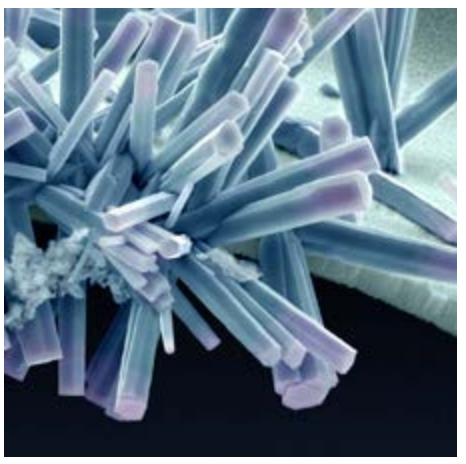
Over 250 delegates attended the workshops, which took place in AMMRF labs around Adelaide.

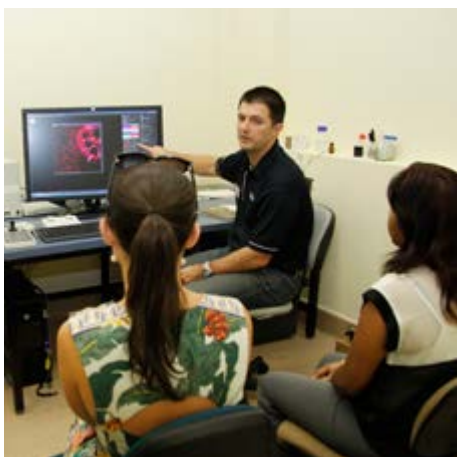
They provided intensive learning opportunities for microscopists and researchers to pick up the latest developments from experts in their fields. ■

Micrograph Awards 2014 & *Life in the micro cosmos*

The AMMRF sponsored the micrograph competition to encourage excellence in microscopy. Our node directors on the judging panel had a hard job choosing three winners. CSIRO's Mark Talbot won First Prize for his image (below) that niftily combines a 10kV and a 30kV backscatter electron image through the green and red channels to highlight both cell walls and nuclei within the reproductive apex of a wheat plant. Second Prize – Sue Lindsay, Australian Museum: for an SEM of cottonwood pollen. Third Prize – Linnea Rundgren, RMIT University: for her SEM of zinc oxide crystals (right).

To coincide with the conference, the AMMRF at the University of Adelaide had teamed up with Linnea to present a joint exhibition: *Life in the micro cosmos*, at RiAus. Linnea (pictured above) explores the natural world through art and science in a range of media. The exhibition images were taken on a variety of microscopes in the AMMRF Linked Lab at RMIT University. For more information on Linnea's work visit linearphotography.com ■





COMMUNITY

Celebrating 50 years of microscopy excellence

The AMMRF node at the University of Western Australia, is the Centre for Microscopy, Characterisation & Analysis (CMCA). They celebrated CMCA's fiftieth birthday on 6 December 2013. Back to 1963 the University decided to purchase a high-resolution transmission electron microscope. Although it was housed in the Physics Department, the intention from the outset was that it be the nucleus for a central facility available to the whole university.

As part of the festivities, CMCA hosted a group of students from Duncraig Primary School for a treasure hunt. The students brought items to examine using the optical, electron and X-ray microscopes at the Centre. Dr Simon Carroll from Scitech kindly awarded prizes to the students. The event concluded with the cutting of a stunningly realistic TEM cake!

In the evening a dinner was held. Bernie Hobbs, ABC Science Broadcaster, was the MC for the evening introducing speakers with some highly entertaining reflections. Over fifty guests including current and past staff members enjoyed the evening, celebrating past achievements and current excellence. ■

In 1967 a second electron microscope was commissioned. During the ensuing years the Centre's state-of-the-art facilities and staff have played a prominent role in the provision of the nation's microscopy infrastructure.

FLAGSHIP

New skills from Harvard

Prof. Matt Kilburn, the NanoSIMS Flagship Engineer in the AMMRF at the University of Western Australia recently returned from a six-month sabbatical with Prof. Claude Lechene at Harvard Medical School. This lab has been key in developing techniques for applying NanoSIMS to biomedical research, primarily in the use of stable isotope labelling to identify new cell growth. Prof. Kilburn was involved in projects to identify new cell generation in the brain, the intestines and in human fat cells. He said, "Working in another lab in another country is an enlightening experience on many levels. Not only does it give one the opportunity to learn something new and interact with different people, but it also provides insights into how other organisations conduct research and how research is funded, and for me has reaffirmed the relative stability we still enjoy here in Australia."

With his new knowledge and improved toolkit in biological NanoSIMS, Prof. Kilburn will be in a strong position to support users from the biomedical sciences in their experiments. ■

ANNOUNCEMENTS

Prof. Kendall lecture

The AMMRF is sponsoring a talk by Prof. Mark Kendall on Tuesday 1 April 2014 at the Australian Academy of Science in Canberra. Prof. Kendall's team makes extensive use of the AMMRF facilities at the University of Queensland in the development of the vaccine Nanopatch™. The talk is part of the Science Stars of Tomorrow speaker series (science.org.au/events/speakerseries/rs).

New course list

now online: ammrf.org.au

FOM 2014 in April

Focus on Microscopy takes place April 13–16 at the Seymour Centre, Sydney focusonmicroscopy.org

STAFF NEWS

Dr Pamela Young is the new Light & Optical Microscopist in the AMMRF at the University of Sydney. She received her PhD in Medical Biophysics & Biomolecular Imaging from Indiana University and went on to do postdoctoral research at the University of Wisconsin in the Laboratory for Optical and Computational Instrumentation where she developed new techniques for breast cancer imaging. Dr Young is interested in advanced fluorescence techniques such as FLIM, FRAP and FRET.

A whole raft of new staff have joined the AMMRF at the University of Western Australia and Sean Webb, Centre Manager for the Centre for Microscopy, Characterisation & Analysis (CMCA), is now full time.

Dr Aaron Dodd has joined as a Senior Research Officer in electron microscopy.

A materials engineer, with a BSc and PhD from the University of Western Australia, he has worked with Antaria Ltd, UWA and at the AMMRF at UNSW before returning to WA for his current role.

Diana Engineer completed her MSc in Medical Biotechnology in 2012 at the University of Technology, Sydney. She has joined CMCA as a Graduate Research Assistant, working in bio-Imaging and flow cytometry. She is also the technical point of contact for micro-CT for bio-imaging and is looking forward to broadening her skills to include high-resolution X-ray microscopy, multi-spectral and live-animal imaging and upskilling in informatics, visualisation and data management.

Dr Malcolm Roberts is Senior Research Officer in electron beam microanalysis. During his PhD at the University of Manchester, UK, he specialised in the petrogenesis of granitoid magmas. Following a post-doc in Austria and a stint at Rhodes University, South Africa, he joined the South African Geological Survey. From 2007, Malcolm was principal geologist for a Perth-based exploration company operating in the PNG highlands. His research revolves around the petrogenesis of high-grade metamorphic rocks and he will be a useful interface between the research and the commercial sectors.

Also joining the CMCA team are **Alysia Buckley**, Graduate Research Assistant, **Irma Larma** Senior Research Officer (FLOW) and **Paul Gualiardo** Senior Research Officer (SIMS).

The AMMRF is funded by

An Australian Government Initiative
National Collaborative Research Infrastructure Strategy

NSW GOVERNMENT

Queensland Government

Government of South Australia

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

Editorial enquiries:

Prof. Simon P. Ringer
Executive Director & CEO
Ph: 02 9351 2351
Email: simon.ringer@ammrf.org.au

Dr Jenny Whiting
Marketing & Business Development Manager
Ph: 02 9114 0566
Email: jenny.whiting@ammrf.org.au

ammrf.org.au