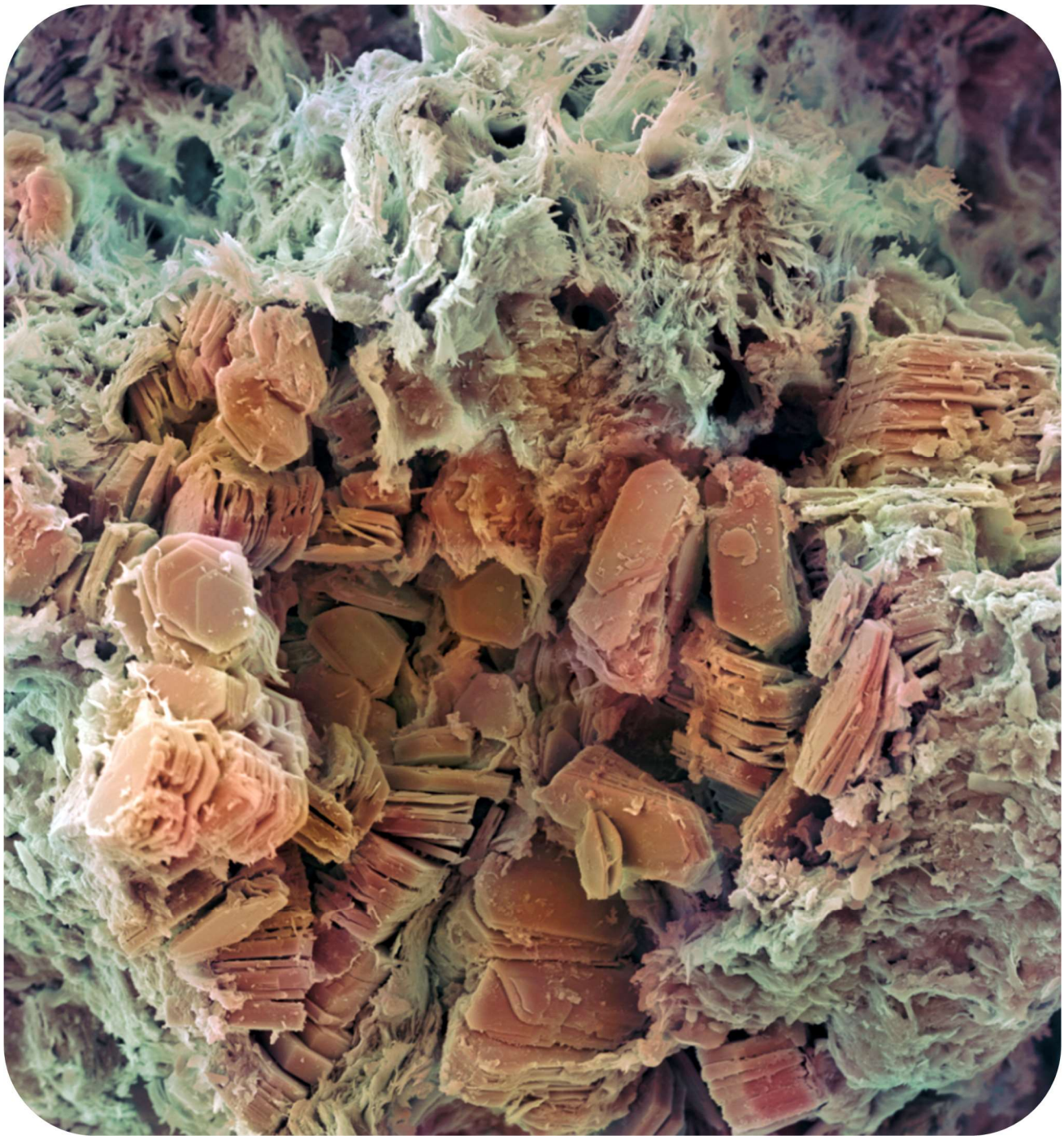
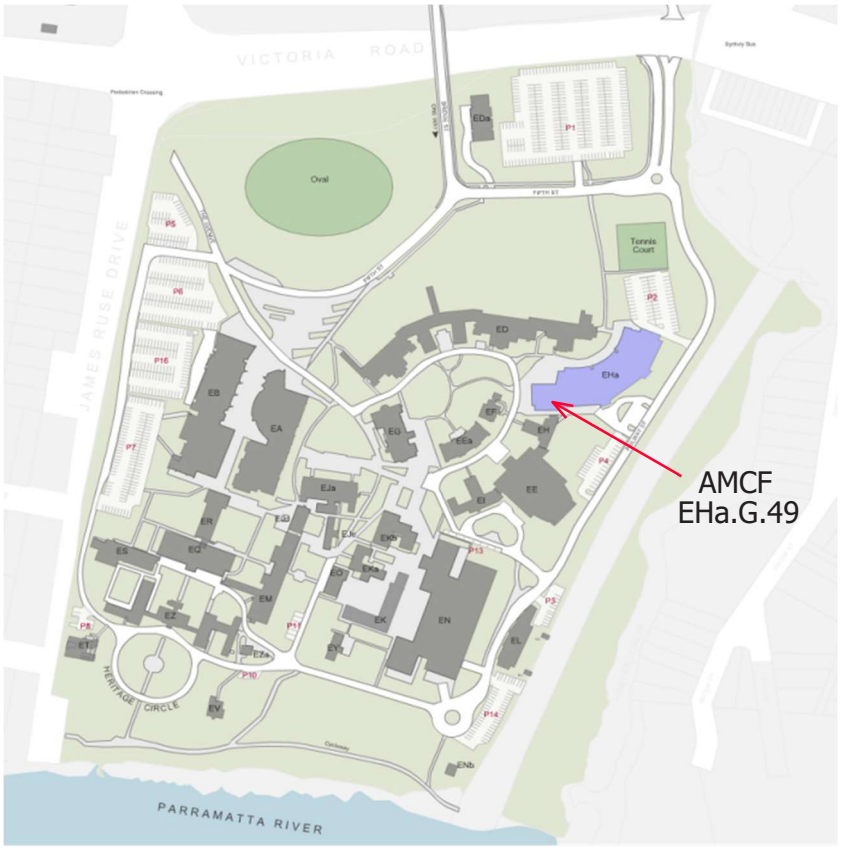
WESTERN SYDNEY
UNIVERSITY



AMCF

Advanced Materials Characterisation Facility

Newsletter: December 2023



Address
Western Sydney University,
Advanced Materials Characterisation Facility (AMCF),
Parramatta South Campus, Building EHa G.49,
Victoria Road, Rydalmere NSW 2116

Front Cover Image:
A pseudo-coloured backscattered electron micrograph of different clay particles taken by Dr. Daniel Fanna on a Hitachi FlexSEM scanning electron microscope.

Back Cover Image:
A pseudo-coloured focus stacked optical microscope image of crystals taken by Hyun Min.

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12th Edition Newsletter, December 2023
Editors: Daniel Fanna, Laurel George and Richard Wuhrer

The AMCF is a part of:
Research Infrastructure Research Services
Office of the Deputy Vice-Chancellor (Research, Enterprise and International)

FROM THE FACILITY RESEARCH MANAGER

What a blur! What a year! We reflect on so many things happening in the last year, now we are now only a couple of weeks from Christmas and New Year celebrations.

The AMCF initially attracted researchers and academics to utilise the AMCF instrumentation. Over the last 6 months we have seen a rapid increase in the number of HDR's requiring access and training. This is great to see. The facility already has several dozen bookings for January 2024, and we are now booking out many dates in February.

As you read through the newsletter, you will see why the year has passed so quickly. The many users operating a variety of instrumentation; the number of courses, workshops and masterclasses offered during the year; the presence of international visitors and tour groups; the instrument upgrades; and new software upgrades have kept staff and instrumentation fully engaged. Currently, a Single Crystal X-Ray Diffractometer (SCXRD) is being installed and we are soon to take delivery of a new Micro-CT.

Indeed, the AMCF in conjunction with Bruker have recently finished a 1-day workshop on XRD processing software called "EVA". The EVA software has many functionalities allowing for Phase ID, semi-quantitative analysis, peak fitting, crystallite size analysis and more. This has proven to be very popular with users/clients and AMCF staff have been kept busy training new AMCF users on XRD quantification.

The New Year will be busy as we plan to run various introductory workshops on our instruments. The first course/workshop is set for February 2024. Further information will be sent out in the New Year.

As always, we are happy to show anyone our facility. Please do not hesitate to contact us for a walk through our labs.

The AMCF will be closed for the Christmas to New Year period from Friday 16th of December (12pm) until Tuesday 2nd of January 2023. No usage of instrumentation and/or bookings will be possible due to the closure. Instruments will either be shut down or placed in standby mode during this period. All instruments should be up and running again by Wednesday 3rd of January 2024 with first bookings allowed from 4th of January 2024.

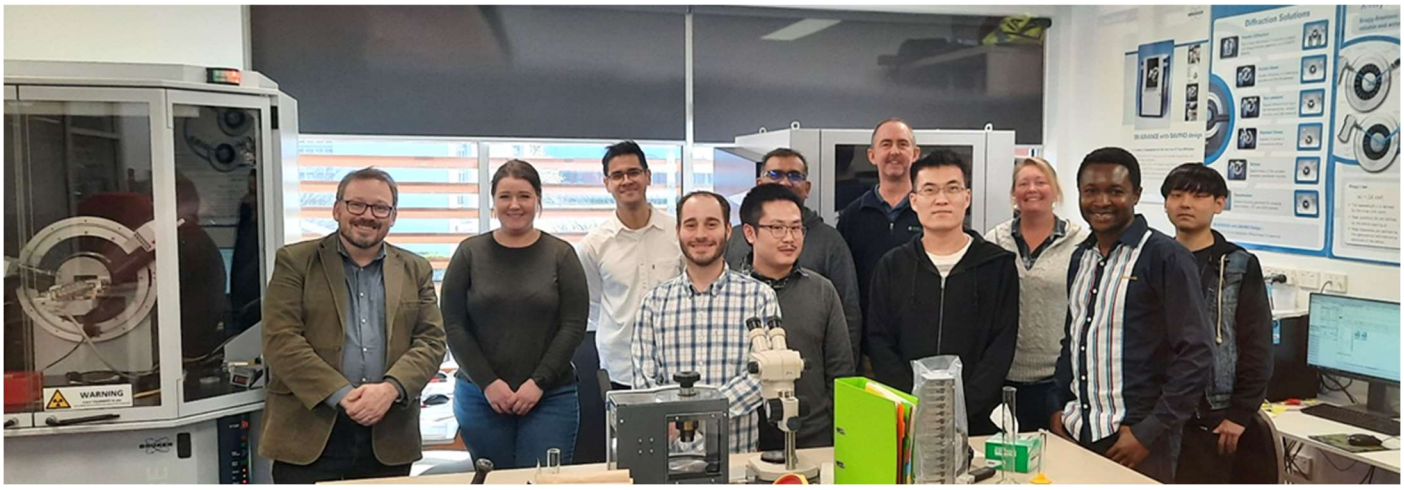
On a final note, I would like to wish everyone a Merry Christmas and Happy New Year. I look forward to seeing everyone in the New Year.

Dr. Richard Wuhrer
Facility Research Manager
December 2023

RECENT ACTIVITIES

Bruker EVA workshop

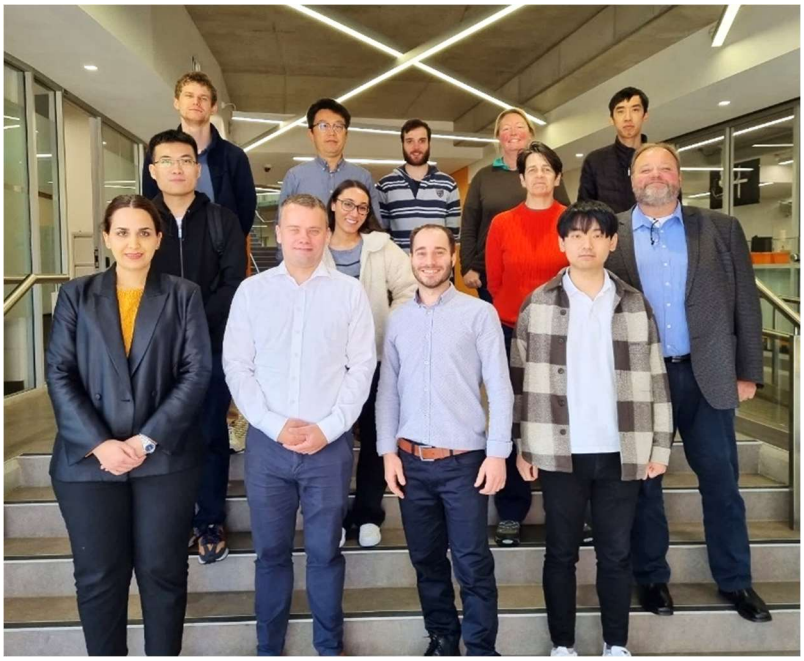
In August we were fortunate to host a 1-day workshop with Bruker on XRD processing software EVA. This was run by Dr. Manoel Manuputty from Bruker AXS. The workshop was a great success and guided beginner and intermediate level users through various functionalities and analyses in EVA, including phase ID, database & chemical filters, semi-quantitative analysis, peak fitting tool, crystallite size analysis, degree of crystallinity analysis and more. This is the second Bruker XRD software workshop we have hosted, and like the TOPAS workshop before it, attendees were given fantastic hands-on training and the opportunity to ask questions and have the local expert solve analysis problems. A special thanks is extended to the team at Bruker AXS (who include Neil Hughes and Dr. Manoel Manuputty), and AMCF Scientist, Dr. Daniel Fanna, for making this event possible.



EVA workshop attendees touring the AMCF and checking out or Bruker D8 XRDs post workshop.

Anton Paar powder XRD and SAXS seminar

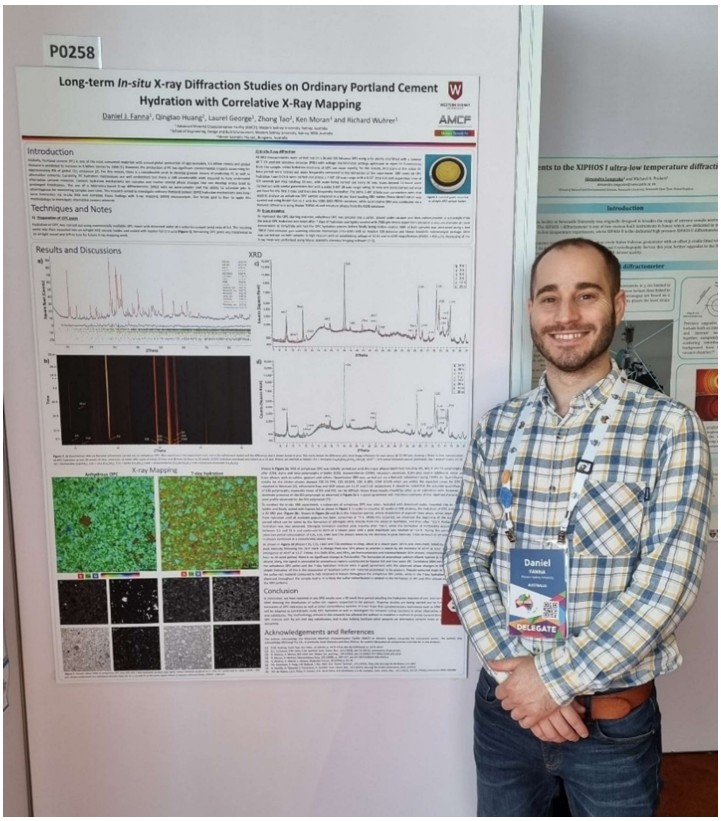
Also in August, we welcomed Dr. Andrew Jones from Anton Paar Austria and Dr. Shamim Shahrokhi from Anton Paar Australia & New Zealand to our lab to present a seminar on powder XRD and Small Angle X-ray Scattering (SAXS). Their talks introduced attendees to the latest advances in XRD, SAXS and non-ambient XRD, in which Anton Paar are one of the global leaders. Further insight to tips, tricks and common challenges users might encounter during XRD (especially with non-ambient measurements), were discussed. The event was fantastic and provided a great opportunity for our local attendees to have questions and challenges answered by the experts on non-ambient XRD. We thank the teams at Anton Paar for making this possible.



Anton Paar experts front left Dr. Shamim Shahrokhi and Dr. Andrew Jones to the right with seminar attendees.

Daniel Fanna at 26th IUCr and AXAA events

The 26th International Union of Crystallography (IUCr) was hosted in Melbourne in August. This marked 75 years of IUCr and the second time the conference has been hosted in Australia. AMCF scientist, Dr. Daniel Fanna attended to present some of the work he has been developing on "Long-term In-situ X-ray Diffraction Studies on Ordinary Portland Cement Hydration with Correlative X-Ray Mapping". In his study, Dr. Fanna has been using in-situ XRD to observe the changes in crystalline phases that occur in cement hydration. The conference was an excellent opportunity to showcase some great work being done in the AMCF. Dr. Fanna was also able to capture insight to other great projects employing X-ray scattering techniques, and the latest characterisation technology developments. The location and timing of the conference presented a great opportunity for Daniel to attend a co-organised International Centre for Diffraction Data (ICDD) and Australian X-ray Analytical Association event that included an ICDD workshop on their database, and was followed by a fantastic AXAA event showcasing interesting projects.



Dr. Daniel Fanna at the 26th IUCr congress presenting work on in-situ XRD analysis of cement hydration.

Upcoming X-ray instruments

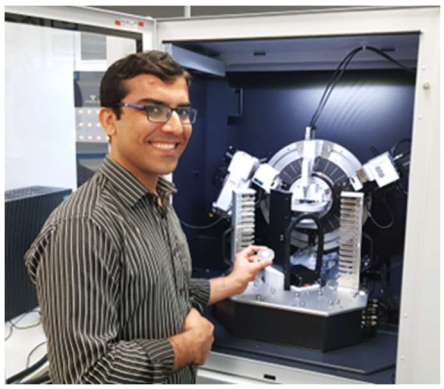
The AMCF has been preparing plans to make 2024 a stellar year for X-ray based techniques. We are excited to report that we have an Oxford Gemini Single Crystal X-ray Diffractometer (SC-XRD) and two new Bruker Skyscan X-ray Micro Computer Tomography systems (MicroCT). These will be available to AMCF users in 2024. Check out the Instrument News section for further details.

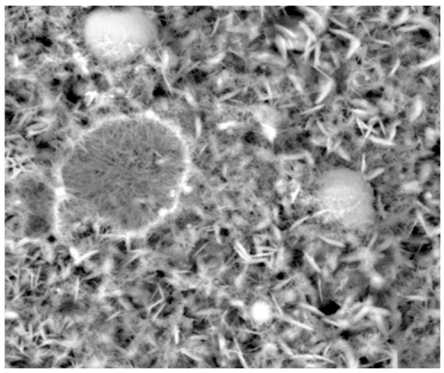
Left: Oxford Gemini SC-XRD being commissioned in AMCF. Top Right: Bruker Skyscan 1272 MicroCT and bottom right: Bruker Skyscan 1273 MicroCT.

RESEARCHERS AT THE AMCF

Farhan Ahmad

School of Engineering, Design and Built Environment





RESEARCH

Engineering PhD student Farhan Ahmad is interested in green and sustainable cementitious composites. Farhan has been working on an ARC funded Discovery Project evaluating the performance of fibre-reinforced Magnesium Oxychloride Cement (MOC) based composites.

IMPACT

MOC is a green, carbon-neutral cement that has the potential to replace Ordinary Portland Cement (OPC). Currently, the OPC industry contributes 5-10% of the world's greenhouse gas emissions, adversely affecting the environment. New types of cements such as MOC, which has reduced CO_2 emissions compared to OPC, need to be established as they are energy efficient and eco-friendly.

SUPERVISORS

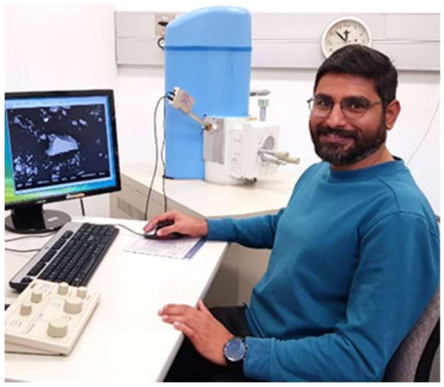
Prof. Sarah Zhang, Prof. Chunhui Yang, Prof. Zhong Tao, Dr. Sanket Rawat, Prof. Lihai Zhang (External)

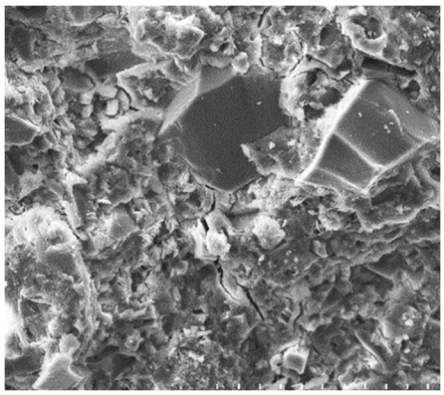
INSTRUMENTS

Farhan has been using the AMCF's:
SEM/EDS: for imaging and elemental analysis.
XRD: to find different crystalline phases present in samples.

Tariq Aziz

School of Engineering, Design and Built Environment





RESEARCH

Tariq Aziz is about to complete his Ph.D. in Civil Engineering. His research focuses on the development of an innovative concrete that incorporates waste glass. He is exploring ways to make concrete more sustainable and environmentally friendly through the use of recycled glass in its composition.

IMPACT

This research aims to benefit both the construction industry and the environment. By integrating waste glass into concrete, this approach not only addresses the issue of glass waste but also contributes to lowering carbon emissions associated with cement manufacturing. Construction projects using this novel concrete would be more eco-friendly, and the reduction in waste and emissions could contribute to a healthier, more sustainable world for future generations.

SUPERVISORS

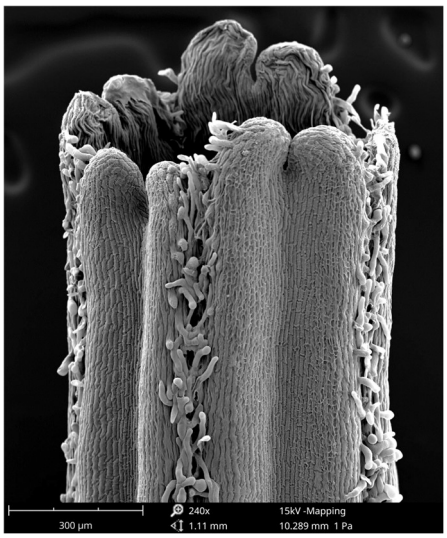
Prof. Zhong Tao and Dr. Utsab Katwal

INSTRUMENTS

Tariq has been using the AMCF's:
SEM/EDS: for sample imaging and elemental analysis.
XRD: to find different crystalline phases present in samples.

Happy

Hawkesbury Institute for the Environment (HIE)



RESEARCH

Happy is a PhD student whose research focuses on developing a novel non-contact sonication technology for enhancing tomato floral pollination. As the primary pollinator of tomatoes, the European bumble bee, is not found in Australia. Tomato growers need to employ labour-intensive mechanical pollination methods using electric wands and trellis tapping.

The new non-contact frequency-dependent sonic vibration technology Happy is working on can disrupt the pollen within the flower's anther, enabling efficient release of pollen.

IMPACT

This new technology can help to automate tomato floral self-pollination, reducing costs, and enhancing fruit quality. By examining the floral structures of different tomato varieties, we can begin to understand why some varieties are easier to induce self-pollination than others. Findings may also pave the way to new ideas to engineer self-pollinating tomato varieties that no longer require any mechanical stimulation.

SUPERVISORS

Dr. Chris Cazzonelli and Dr. Rob Sharwood.

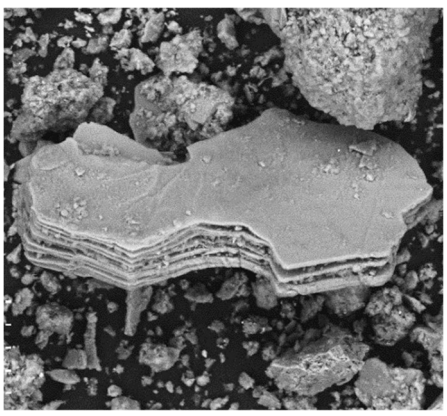
INSTRUMENTS

Happy is using the AMCF's:

Phenom SEM: to image trichome structures joining the floral anther cone (image left), and ***micro-CT:*** to study reproductive gamete proximity from different tomato varieties that are easy or hard to pollinate by mechanical stimulations.

Hadeel Alzghool

School of Engineering, Design and Built Environment



RESEARCH

Engineering PhD student Hadeel Alzghool is working on a project to stabilise the highly expansive Bringelly shale and its residuals. These are found in soils in the Sydney area. The expansive nature of these soils results in undesirable swelling, shrinkage and loss of structural integrity, therefore affecting the stability of foundations, pavements, and tunnelling. Hadeel plans to treat these soils using alkali activation of the aluminosilicates in clay minerals. She will then investigate the effect these treatments have had on the soil's microstructure, including its morphology, phases present and binding gels.

IMPACT

Soils containing Bringelly shale and its residuals are problematic for major construction of infrastructure projects in Sydney. Hadeel's approach aims to optimise performance of the soils by ensuring stability in swell potential, while also creating a treatments that have a minimal carbon footprint and are cost-effective.

SUPERVISORS

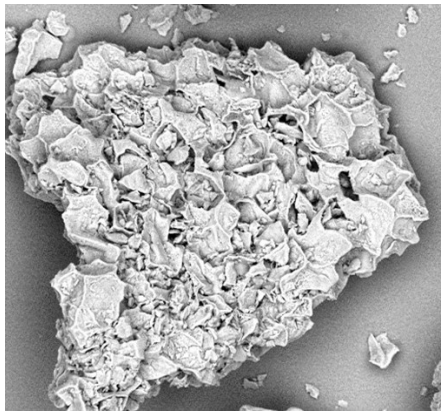
Dr. Pan Hu, Prof. Chin Leo, Prof. Samanthika Liyanapathirana and A/Prof. Qinghua Zeng.

INSTRUMENTS

Hadeel has been using the AMCF's **XRD:** to identify chemical phases present, and **SEM/EDS:** for identification of elements present and imaging of structures.

Namita Bhattarai

School of Science (Food Science)



RESEARCH

Namita is completing a Masters research project with the School of Science. Her research focus is on the analysis of spent coffee grounds from different countries of origin. In particular, she is looking at differences in their physical characteristics and porosity.

IMPACT

Spent coffee ground waste usually ends up as landfill. Its anaerobic decomposition then contributes to the emission of CO_2 and other greenhouse gases. By characterising and understanding differences between spent grinds from different origins, Namita hopes to help find what aspects of this waste material could be of value to other industries, reducing environmental waste in the process.

SUPERVISORS

Dr. Sunil Panchal.

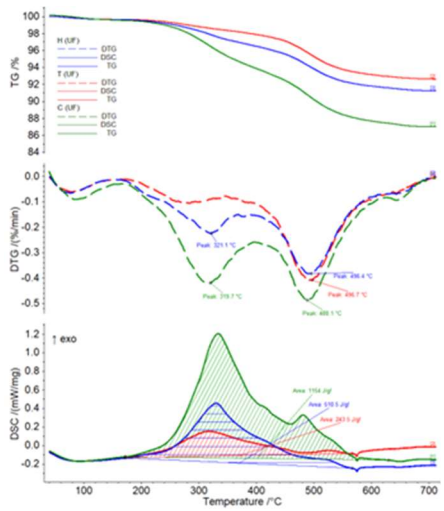
INSTRUMENTS

Namita has been using the AMCF's:

SEM/EDS: for sample imaging and comparison of grinds.
TGA/DSC: To observe differences in thermal events such as mass loss percentage at different temperatures.
ASAP2020: To find the surface area and pore size of grinds.

Dr. Alireza Aghajani Shahrivar

School of Engineering, Design and Built Environment



RESEARCH

After completing his PhD at WSU, Alireza has taken up the position of Project Officer with the NSW Circular Challenge program. This collaborative initiative involves two prominent industries: Global Renewables Ltd and Austral Brickworks Co. Alireza aims to enhance the value of Alternate Raw Materials (ARM), which consists primarily of organic composts and is derived from food waste. Alireza aims to incorporate ARM as one of the ingredients in brick production.

IMPACT

By substituting virgin and natural clay materials with ARM during the manufacture of bricks, Alireza is helping to create a circular economy. The heat released by the ARM organic material when it combusts during brick firing, has the potential to replace some of the natural gas needed by the furnace.

RESEARCH TEAM

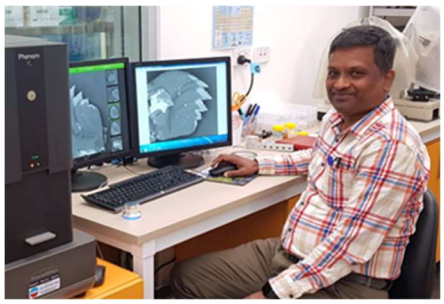
Alireza is working with Dr. Dharma Hagare's team which also includes Prof. Bijan Samali, Prof. Zhong Tao, A/Prof. Maria Varua, and PhD student Mr Bnjo Akinyemi. The team also includes researchers from Macquarie University and industry partners.

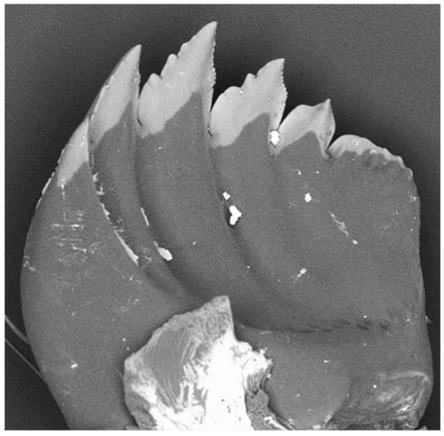
INSTRUMENTS

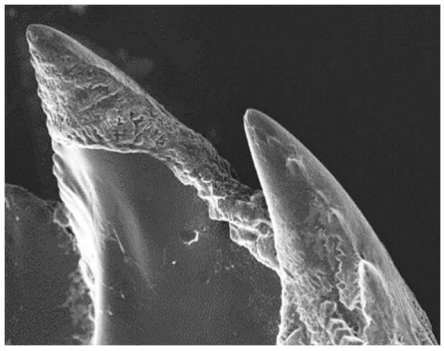
Alireza has been using the AMCF's:
XRD: to identify crystalline phases present in the raw and finished products.
SEM/EDS: for imaging and elemental analysis.
TGA/DSC: to analyse the thermal characteristics of the materials.

Dr. Sakthivel Ramesh Babu

Hawkesbury Institute for the Environment (HIE)







RESEARCH

Dr. Sakthivel Ramesh Babu, Associate Professor (Entomology), is a visiting fellow with the HIE Silicon Research Group. Ramesh's research project focuses on the application of potassium silicate on maize plants, and aims to find the effect silicon and mechanical control has on the new invasive pest, fall armyworm (*Spodoptera frugiperda*). To do this he released larvae onto maize plants and followed larval growth over 7 days of infestation. Plants were then harvested and analysed for silica and phenolics content under different treatments. The effect silicon had on the mandibles of the insects were also studied.

IMPACT

The new invasive pest, fall armyworm (FAW) Spodoptera frugiperda is polyphagous and causes significant losses to the maize crop. As this is a new invasive pest, the study of the interaction between silicon and new pest paves the way for the management of this pest. The research aims to identify the effect of silicon on the biology of the insect pest and also on the secondary metabolites of the plants.

RESEARCH GROUP

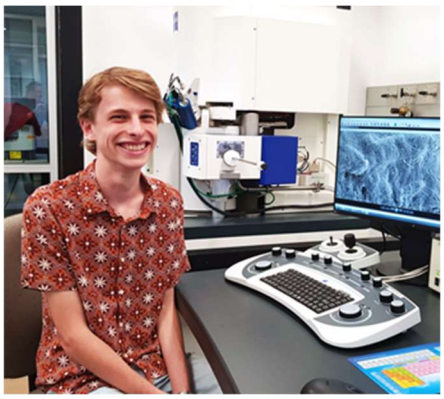
The HIE Silicon Research group is headed up by Professor Scott Johnson. Ramesh's work is supported by the Indian Council of Agricultural Research (ICAR) National Agricultural Higher Education Project (NAHEP).

INSTRUMENTS

Ramesh has been using the AMCF's:
Phenom SEM: to image the mandibles of these chewing insects.
Critical Point Drier: For sample preparation.

Rowan Heggen

School of Science



RESEARCH

Rowan has been undertaking an undergraduate research project for his Bachelor of Advanced Science on how microbes impact the decomposition of bones. His work aims to identify trends in bacterial community composition, bone chemistry, and bone structure over time. If microbe-affected characteristics of the bone surface follow predictable trends, new models could be developed to link these features to time since death.

IMPACT

In forensic investigations, the time since death is invaluable for determining who was found, how they died, and who may be culpable. Estimations for skeletonised remains, however, are often very imprecise. More tests are needed to supplement current methods employed.

SUPERVISORS

Dr. Hayley Green and Dr. Oliver Morton

INSTRUMENTS

Rowan has been using the AMCF's ***SEM*** to characterise and track changes in the microstructure and biofilms of ageing bones and ***EDS*** to determine whether chemical changes in hydroxyapatite are measurable over short timescales.

RESEARCHER FOCUS

Scott Johnson

BACKGROUND

Scott Johnson is an Professor at the Hawkesbury Institute for the Environment (HIE). As an ecologist, he is working to improve plant resilience to biotic (e.g. pest attack) and abiotic stress (e.g. drought) using more sustainable agricultural approaches. He completed an Australian Research Council (ARC) Future Fellowship in March 2023 which, together with a concurrent ARC Discovery Project, established the potential mechanisms by which silicon accumulation in plant tissues improves resistance to insect pests and drought tolerance. He currently leads a research group exploring the functional role of silicon accumulation in several important crops for alleviating diverse stresses, ranging from salinity stress to heat waves.

RESEARCH

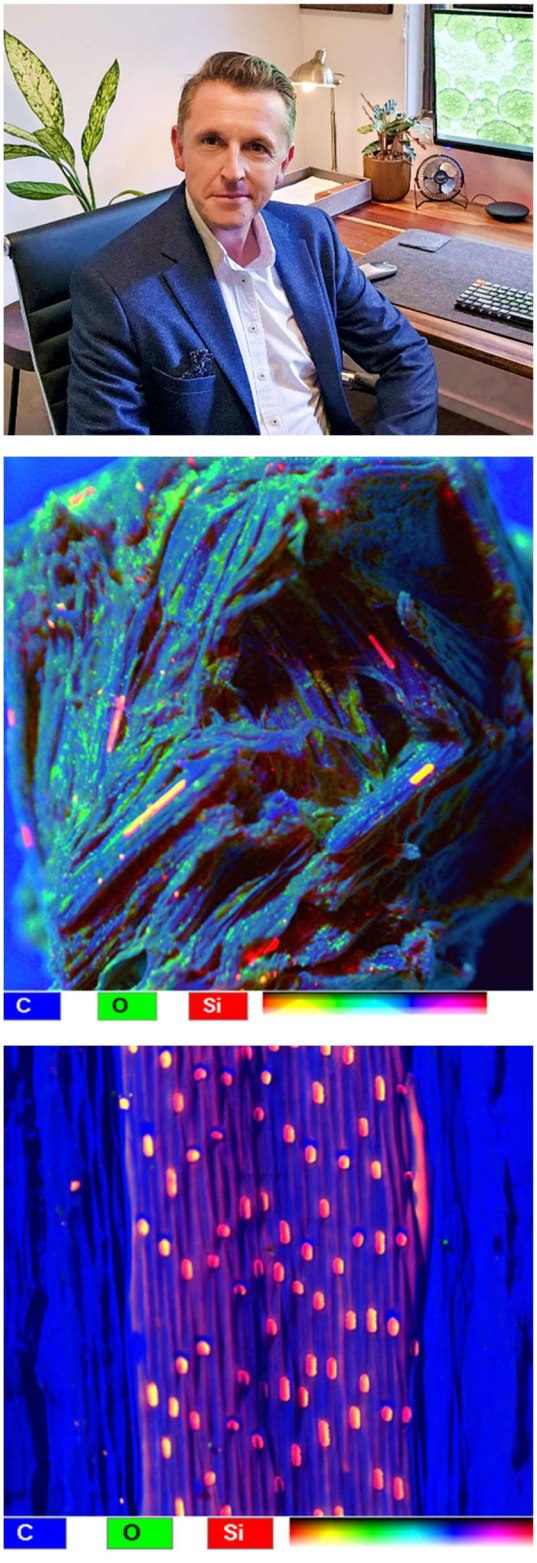
Scott's current research aims to translate fundamental knowledge gained from the ARC Fellowship and Discovery projects into key environmental and economic benefits for Australian agriculture. This will be principally achieved via an ARC Linkage grant awarded to Scott and colleagues in 2023, running between 2024-2028. The project will determine the extent to which silicon intervention strategies in wheat can alleviate the impacts of drought and improve resistance to pests and disease. Scott's team will work with AMCF staff to pinpoint silicon deposition at the cellular level to provide the mechanistic basis for how silicon accumulation improves water use efficiency and regulates defences against pests and diseases. The route to translation involves a diverse group of partner organisations, including broadacre farmers from across Australia, to develop effective management strategies involving silicon fertilisation.

IMPACT

Wheat is Australia's foremost exportable crop, contributing 6–11% of global production that collectively provides 4.5 billion people with 20% of calories and protein. Global production of wheat is in long term decline due to the impacts of climate change while demand is expected to increase by 26% by mid-century. Australia has the potential to help sustain global supply through innovative approaches to reducing costs and increasing yields. Australian production is particularly vulnerable to water scarcity, however, with yield losses of 50% or more being common in drought years. This research will provide the evidence base for how silicon uptake by the roots, and deposition in the shoots, operates when plants experience water stress and pest attack and how we can use this for more sustainable farming practices.

INSTRUMENTS USED AT THE AMCF

Scott's team has been using the AMCF'S ***Scanning Electron Microscopy (SEM)*** to image silicon deposition in cells of many plant species, in organs such as leaves and the root nodules of legumes, but also in the organs of insect herbivores. They also use the Moran Scientific ***Energy Dispersive Spectroscopy (EDS)*** and ***X-Ray Mapping (XRM)*** system to pinpoint and map elements, particularly silicon structures found in their samples.



Professor Scott Johnson *(top)*, and pseudo- coloured elemental X-ray maps of frass pellets from the cotton bollworm *(middle)* and the leaf surface of a tall fescue plant *(bottom)*. These maps highlight the elemental abundance of Si (red), O (green) and C (blue). Yellow regions indicate presence of both Si and O, typical of silica (SiO_2) deposition in leaf surface.

INSTRUMENT NEWS

Moving forward with X-ray capabilities – Crystallography

We are excited to announce that we have acquired an Oxford Gemini Single Crystal X-ray Diffractometer from the University of Queensland (UQ) and a second instrument from Queensland University of Technology (QUT) as parts to support the main instrument. At the time of writing this newsletter, it is undergoing installation and recommissioning in the AMCF. Single Crystal X-ray diffraction (SC-XRD) is a non-destructive analytical technique crucial to chemistry, materials science, and biological fields to determine the atomic and molecular structure of crystalline materials. This technique is especially useful for identifying the crystal structure of new materials.

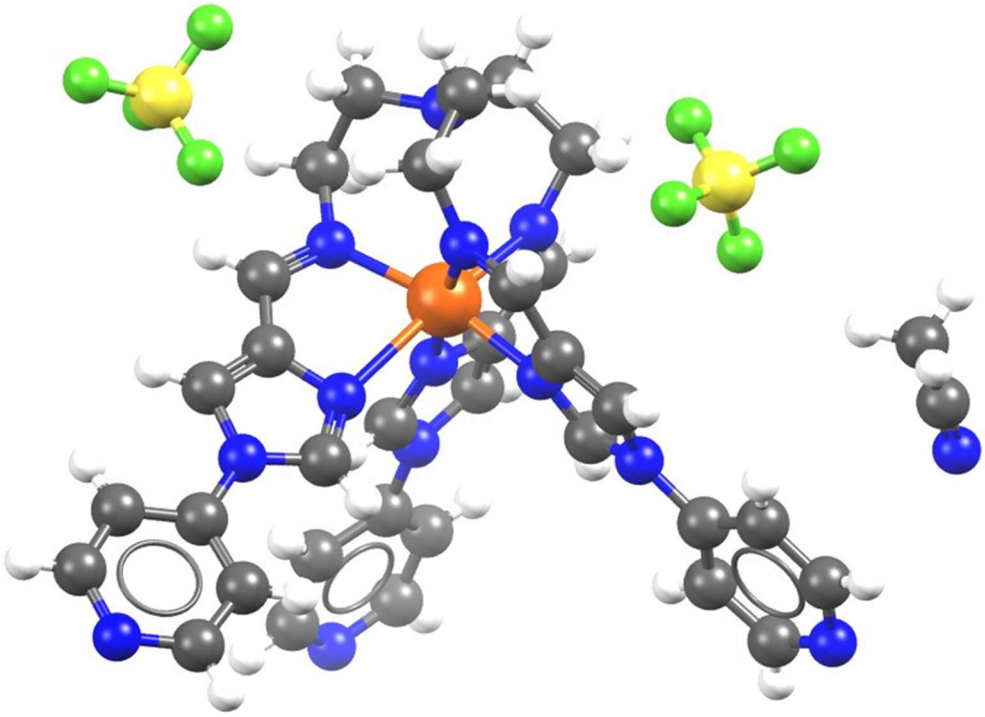
Some key Features of the Oxford Gemini SC-XRD include:

- Dual X-ray Source: The Oxford Gemini SC-XRD is equipped with both copper and molybdenum X-ray tubes, providing researchers with the flexibility to choose the optimal wavelength for their experiments.
- Updated Eos S2 CCD Detector: The instrument comes with an updated CCD detector, enhancing data collection capabilities.
- Oxford 800 cryostream: Precise temperature control from 80 to 400 Kelvin, ensuring accurate and controlled conditions for experiments and protection for sensitive samples.

In addition to single crystal samples, this instrument setup can be used for some powder X-ray diffraction (XRD) applications, especially for non-ambient measurements. This versatility makes it a valuable asset for a wide range of research projects, expanding the possibilities at AMCF and complementing our existing XRDs.

We are eagerly anticipating the valuable insights and data this instrument will generate, and we cannot wait to see the results of its application. Contact the AMCF team if you are interested in learning more about the Oxford Gemini SC-XRD or simply want updates on availability. We aim to make the instrument accessible to user bookings from early 2024.

The Gemini SC-XRD in the AMCF. Left: Mid installation in the AMCF with a very happy Daniel and Lee cheering that the seriously heavy goniometer is back on the instrument. Right: The Gemini setup almost at completion.



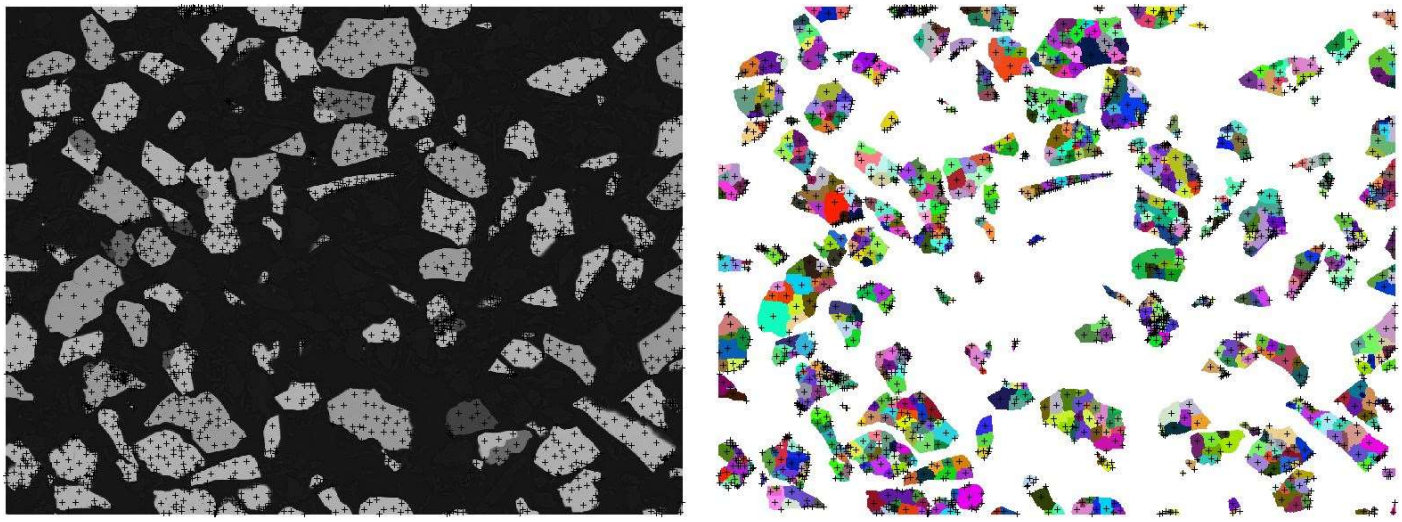
Crystal structure of an iron metallo-supramolecular complex.

During commissioning, AMCF user Hyun Min had the opportunity to run the first crystal structure to be collected on our Gemini SC-XRD. The figure shown here is Hyun's iron metallo-supramolecular complex which is one of many compounds he has synthesised during his MRes project. Hyun's crystal structure is shown in a ball-and-stick style where atoms are indicated by carbon as grey, nitrogen as blue, iron as orange, boron as yellow, fluorine as green and calculated hydrogens as white. The crystal structure was collected at room temperature using a Mo source.

AMICS and GSR software installed on Hitachi FlexSEM

Over the last couple of months, we have been working with NewSpec to install advanced software upgrades on the Bruker microanalysis side of our benchtop Hitachi FlexSEM 1000II. These upgrades include the Advanced Mineral Identification and Characterisation System (AMICS) developed by Bruker, and automated Gun Shot Residue (GSR) analysis developed by Ken Mason at Ardennes Analytique kft.

AMICS software allows users to automate microanalysis of larger sample regions, identify and quantify mineral phases present in the sample. This software has already proved its versatility in earth and materials science and in industries such as mining. GSR software on the other hand, is of great interest in forensics, as it can be setup to automatically scan a sample and identify the presence of GSR particles. A special thanks is extended to Dr. Tim Murphy and Graeme Jones from NewSpec, and Ken Mason from Ardennes Analytique kft for making this happen.

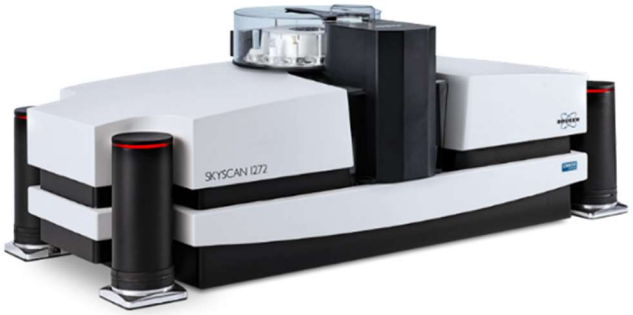


Left: A backscattered SEM micrograph with crosses indicating EDS analysis locations. Right: Segmentation of sample grains processed in AMICS.

Coming in 2024 - X-ray Micro Computer Tomography

We are in the process of acquiring two new benchtop X-ray Micro Computer Tomography (MicroCT) instruments, a Bruker Skyscan 1272 and a Bruker Skyscan 1273. These systems will replace the aged Skyscan 1072 MicroCT currently in use at the AMCF. The Skyscan 1272 will allow us to run samples at higher resolution and includes a 16-position auto-sampler, while the 1273 can run larger and denser samples. Having both instruments is a great combination that should ensure that the AMCF is able to provide MicroCT analysis on a wide variety of samples. Stay tuned for our upcoming newsletter where we will share the latest updates on these instruments. Feel free to reach out to AMCF staff for an update on these instruments.

Some highlight features we are excited about:



Bruker SKYSCAN 1272

Operation Voltage: 40-100 kV

Max. Power: 10 W

Max. Scanned Volume: 75 mm ⌀, 80 mm in height

Detector Size: 16 Mp

Resolution: <0.45 µM voxel

Advantages: This high resolution microCT can detect sub-micron details in samples. This instrument will also be coming with a 16-position sample changer, complete with auto adjustment of magnification and scanning Protocols.

Both the 1272 and 1273 instruments can be fitted out with other optional stages (e.g. for heating, cooling, compression/tension testing).

Bruker SKYSCAN 1273

Operation Voltage: 40-130 kV

Max. Power: 39 W

Max. Scanned Volume: 25x25 cm, but chamber can fit up to a 30x50 cm sized sample

Detector Size: 5.9 Mp

Resolution: 5 µM voxel

Advantages: With its ability to go to higher power, this microCT scanner will be perfect for denser materials, such as concretes, steels and composite materials to name a few. It also makes use of high aspect ratio scanning, which can make scans 4x faster than regular scanning protocols.

The large chamber means large samples can be scanned, such as a whole small plant in a pot.

IMPORTANT DATES

Christmas/New Year Closures

The AMC Facility will be closed for the mandatory Christmas to New Year leave period, from Friday 15th of December (12pm) until Wednesday 3rd of January 2024. Instruments will either be shut down or placed in standby mode during this period, therefore cannot be used/booked. All instruments should be up and running again by Thursday 5th of January 2024.

- Friday 15th December, 2023: Last day AMCF labs are open for regular use.
- Wednesday 3rd January, 2024: Instrumentation start-up and checks.
- Thursday 4th January, 2024: AMCF labs open again for regular use.

UPCOMING EVENTS

If you have been using the AMCF'S electron microscopes for imaging, EDS and XRM analysis, then the Australian Microbeam Analysis Society's (AMAS) upcoming symposium is for you!

AMAS XVI 2024

THE SIXTEENTH BIENNIAL SYMPOSIUM

5-9 FEB 2024 | QUT + UQ, BRISBANE QLD

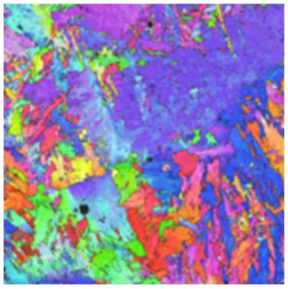
www.amasconference.org

Currently accepting abstract submissions in the fields of:

- Energy storage and generation
- Urban mining and critical materials recycling
- Advanced manufacturing
- Automated Mineralogy
- Emerging Technologies and Techniques in Microanalysis
- Biomaterials
- Geochemistry, mineralogy and petrology of earth and extra-terrestrial materials
- Facility Management
- Catalysis
- Other Microanalysis techniques

Currently accepting workshop registrations on:

- EM Maintenance
- Microanalysis of Biomaterials
- What to do at the Australian Synchrotron, and how to get beamtime
- Fundamentals of Analytical and Transmission Electron Microscopy (TEM/STEM/AEM)
- Cathodoluminescence: Turning Colours into Science
- Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS)
- Introduction to Imaging Mass-Spectrometry (SIMS)
- Monte Carlo modelling – theory and applications
- Focused Ion Beam: Techniques and Applications (FIB)



Jessica Barnes
University of Arizona, USA
Keynote Speaker

Paul Carpenter
Washington University, USA

Kathy Ehrig
University of Adelaide, Australia
Keynote Speaker

Raynald Gauvin
McGill University, Canada

Yang Liu
Jet Propulsion Laboratory | California Institute of Technology, USA

Nestor J. Zaluzec
Argonne National Laboratory | University of Chicago, USA

Rebecca Johnson
National Museum of Natural History, USA
Keynote Speaker

RECENT PUBLICATIONS

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