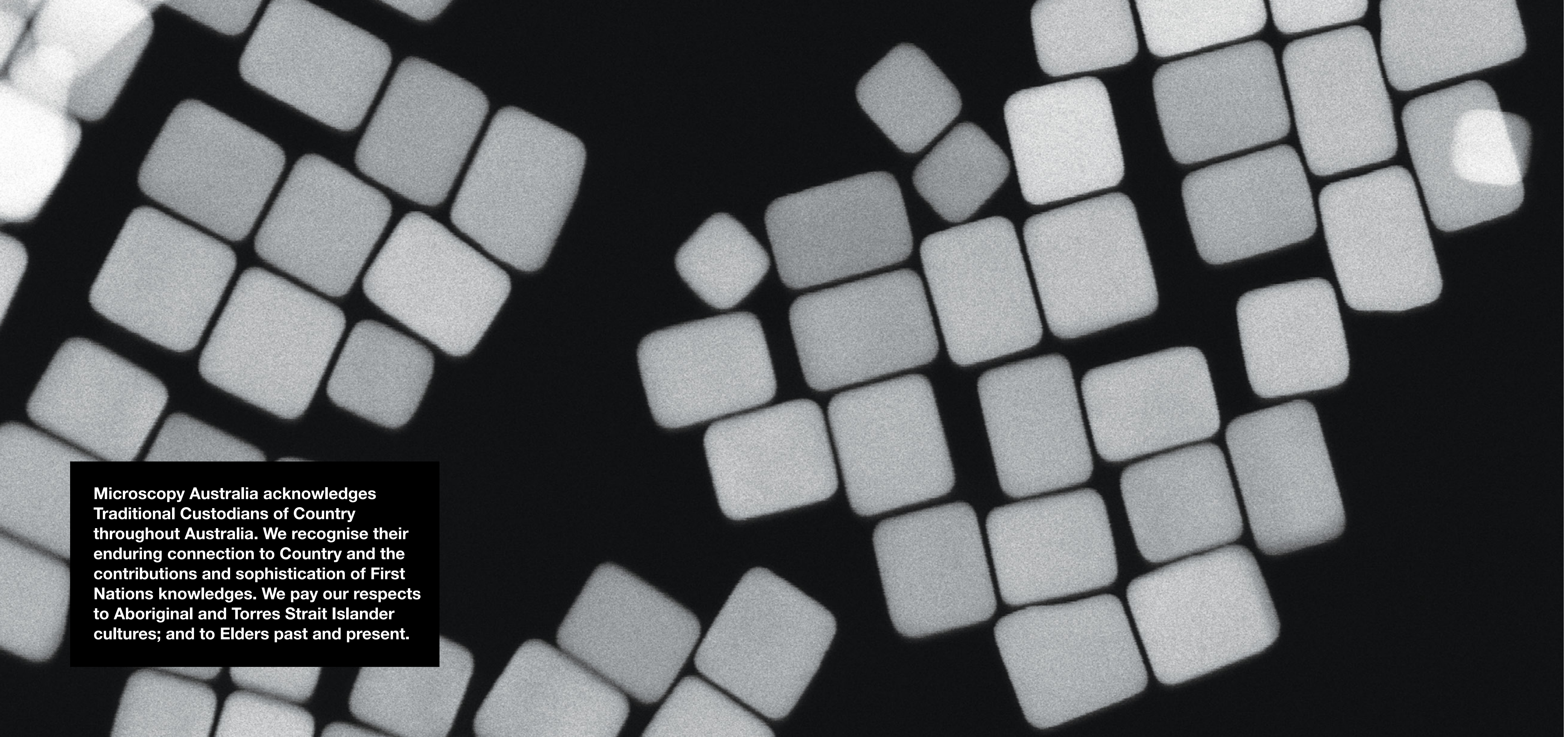
MICROSCOPY AUSTRALIA RESEARCH HIGHLIGHTS 2025



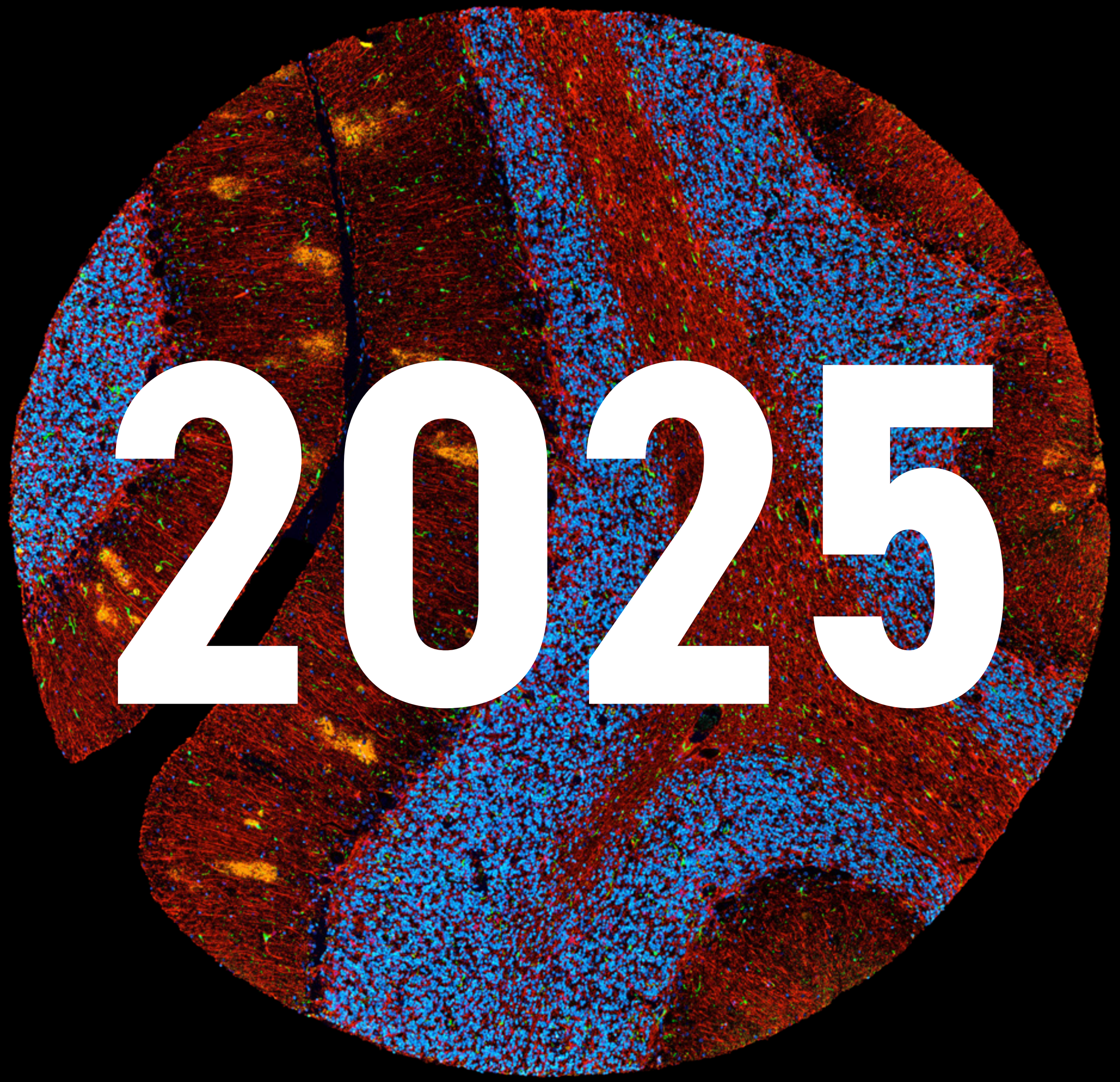
Microscopy Australia acknowledges Traditional Custodians of Country throughout Australia. We recognise their enduring connection to Country and the contributions and sophistication of First Nations knowledges. We pay our respects to Aboriginal and Torres Strait Islander cultures; and to Elders past and present.

Microscopy Australia enables access to high-end microscopes and expertise to underpin Australian discovery and innovation.

CONTENTS

Cover: Fluorescence lifetime imaging microscopy of a two-spotted ladybird (Diomus notescens). Image taken by Dr Angus Rae at the Centre for Advanced Microscopy at the Australian National University.

Left: Symmetry-breaking growth of gold nanoparticles, used in applications ranging from optoelectronics to sensors and catalysis. Imaged using transmission electron microscopy by Dr Weilun Li at the Monash Centre for Electron Microscopy, Monash University. DOIs: 10.1038/s41467-025-68113-5 and 10.1039/d2tc05286e



Fluorescence microscopy of cerebellum from an Alzheimer's disease patient showing the pathological hallmarks amyloid (orange) and tau (yellow), in addition to microglia (green), astrocytes (red) and neurons (blue). Taken by Huang-Tuong Nguyen-Hao at Sydney Microscopy & Microanalysis, The University of Sydney. DOI: 10.1093/jnen/nlaf064

BY THE NUMBERS

310 INSTRUMENTS

186 EXPERTS

4,256 USERS SUPPORTED

435K HOURS BEAMTIME

438 INDUSTRY CLIENTS

120 PATENTS SUPPORTED

1,364 PUBS & BOOKS

86K VIEWS ON YOUTUBE

99% OF USERS REPORTED OUR FACILITIES WERE VALUABLE TO THEIR RESEARCH

99% OF USERS WOULD RECOMMEND OUR FACILITIES TO A COLLEAGUE

96% EXPECT THEIR USE OF MICROSCOPY WILL INCREASE OR STAY THE SAME

Data from 2024 (2025 collection)

48% MATERIALS & ENGINEERING
40% BIOLOGICAL & MEDICAL
12% GEOSCIENCE & ENVIRONMENT

35% MANUFACTURING
31% RESOURCES & ENVIRONMENT
19% BIOMEDICAL
15% OTHER

YEAR IN REVIEW

Dr Lisa Yen
Chief Executive Officer

Welcome to Microscopy Australia's Research Highlights for 2025! This year, Microscopy Australia has yet again enabled an exciting range of research and innovation that has been showcased in this report.

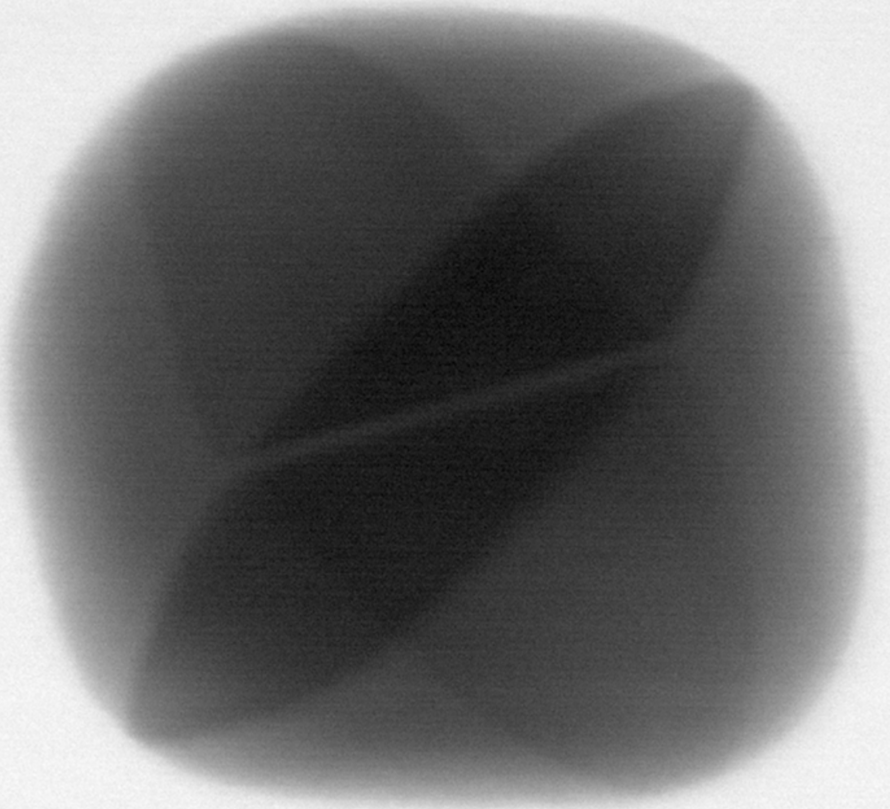
I'd like to thank the incredible Microscopy Australia team, across the facilities and linked labs, our committees, Facility Directors and central staff members. I'm so honoured to work with you, and I know our researchers benefit greatly from the expertise and instruments made available through Microscopy Australia. I'd like to acknowledge and extend thanks to Dr Greg Smith who kindly continued on in his Board Chair role until the end of 2025.

Looking forward, into the new year and beyond, Microscopy Australia is delighted to announce the appointment of Professor Joe Shapter as the new Independent Board Chair. His leadership and expertise will guide future investment plans ensuring Microscopy Australia is best positioned to enable innovation through new technologies, maintain a highly-skilled expert workforce and increase support for automation and AI-enabled data analysis.

Microscopy Australia has engaged deeply with the numerous consultations that have been conducted by government this year, including the 2026 National Research Infrastructure Roadmap and the Strategic Examination of Research & Development (SERD).

The world has been inspired by microscopy through Veritasium's YouTube video, featuring our University of Sydney facility, with over 24 million views. Over 135,000 budding microscopists engaged with our online resources: MyScope and MyScope Explore. We've been present with researchers at many events, such as the Asia-Pacific Microscopy Congress (APMC), AusBiotech, FoundingGIDE, MicroTAS, and participated in 2025 National Science Week. We have supported more than 35 of our staff to participate in masterclasses and staff shadowing exchange visits.

I am sure that you will enjoy reading through the amazing collection of discovery and translation stories that spans critical areas for Australia's future success



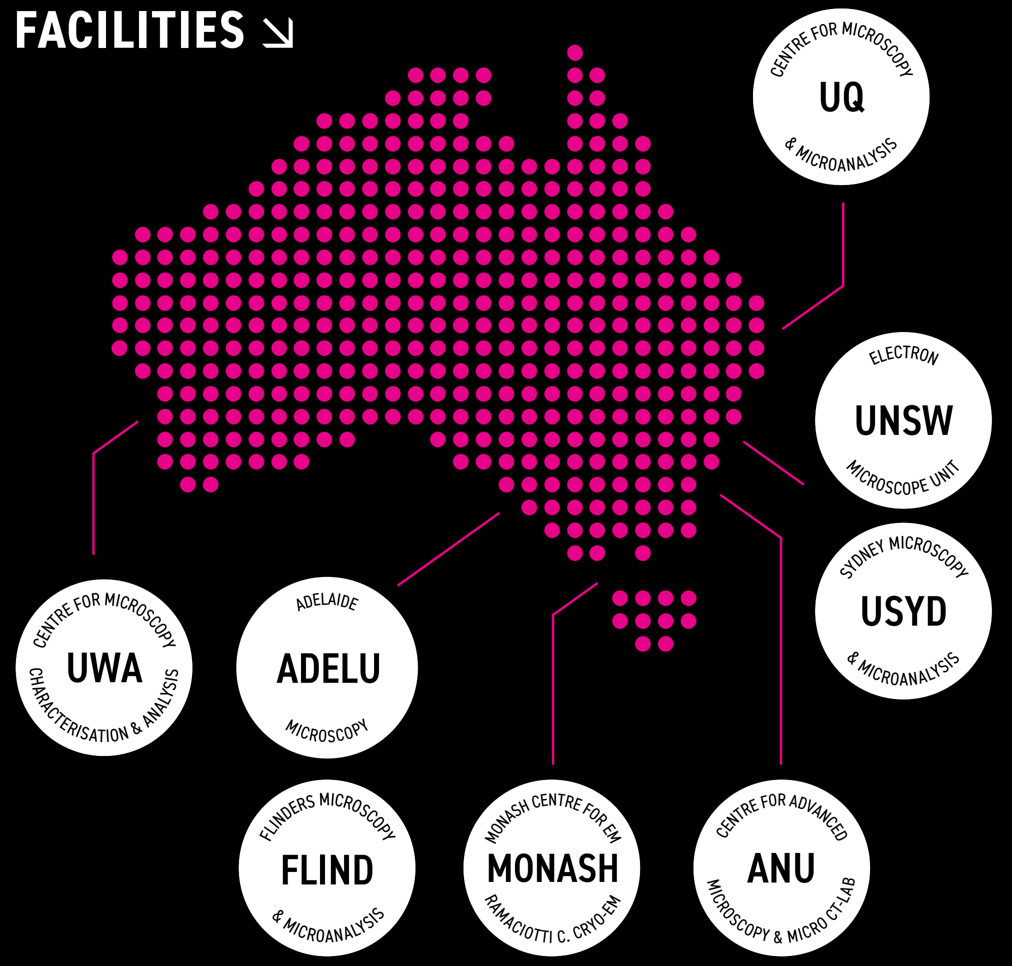
Twin-plane crystal defect within a gold nanoparticle (~30 nm) revealed using transmission electron microscopy by Dr Weilun Li, MCEM, Monash University. DOI: 10.1021/acs.chemmater.1c02459

MICROSCOPY AUSTRALIA

We help researchers see and understand the world at its most fundamental level – whether that's mapping atomic arrangements in quantum devices, revealing the structure of a virus for vaccine development, or tracing the origins of critical minerals.

Our network of university-based facilities is open to all Australian researchers and businesses, offering access to a vast array of advanced techniques and expertise – strategically located to maximise impact and reduce duplication.

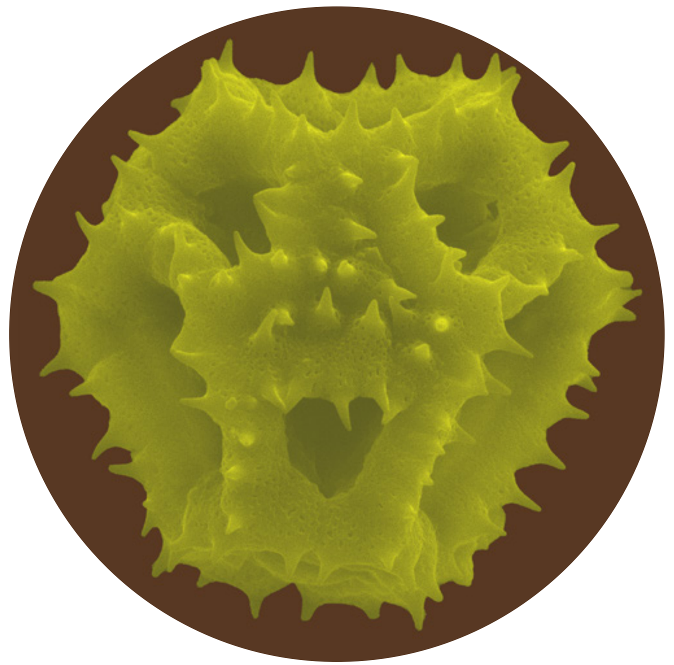
FACILITIES ↘



LINKED LABORATORIES ↘

- Deakin University
- Centre for Disease Preparedness CSIRO
- RMIT University
- Curtin University
- James Cook University
- Queensland University of Technology
- University of Technology Sydney
- University of Wollongong
- University of Tasmania

Dandelion pollen grain by Dr Rhiannon Kuchel and Dr Karen Privat with Community Gardens Australia, captured via SEM at the EMU, UNSW.

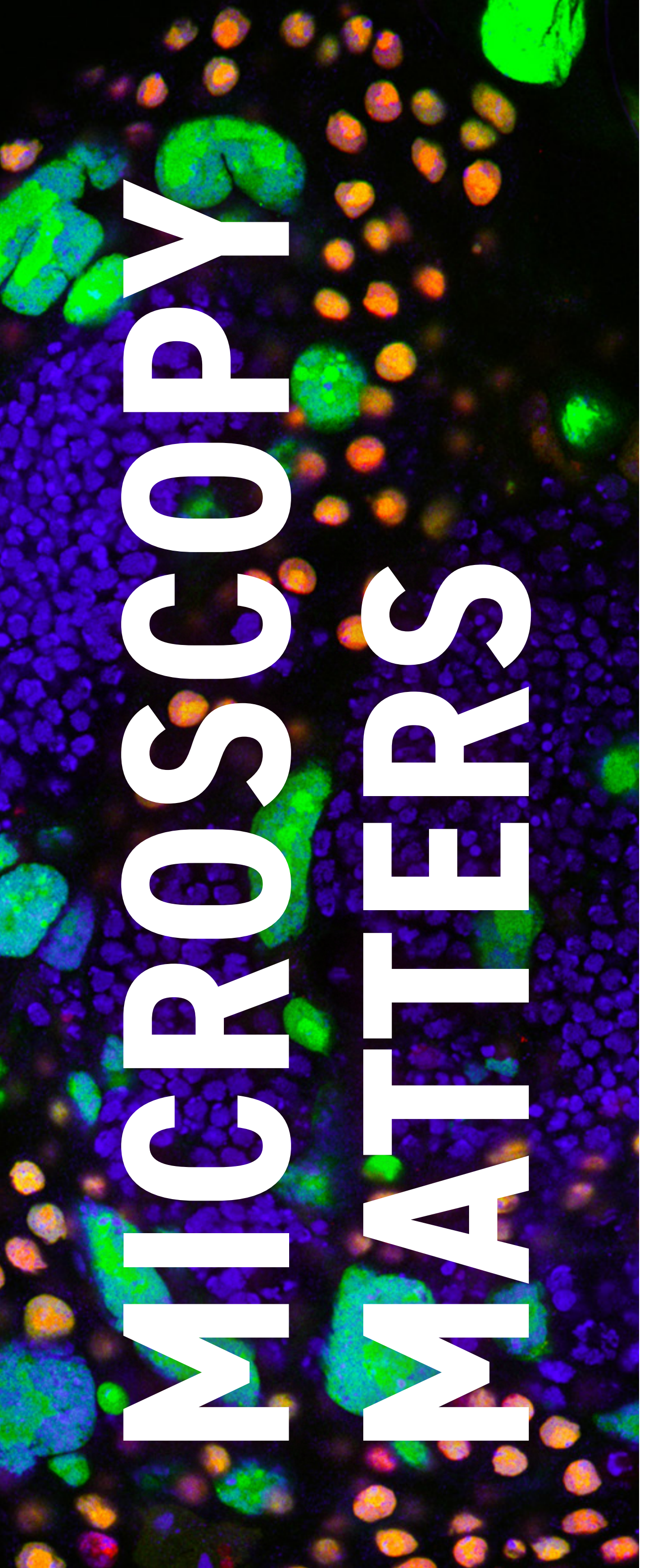


MYSCOPE
MICROSCOPY TRAINING

MyScope is our free online training platform, helping researchers learn a wide range of microscopy techniques through theory and simulated instruments. Thirteen modules cover most major microscopy and microanalytical methods. Complementing this is *MyScope Explore*, which gives the general public a chance to discover over 70 different samples on a scanning electron microscope simulator. **Together, these tools are used by 135,000+ students and researchers every year.**

An international review highlighted: "*[MyScope] is one of Microscopy Australia's most internationally visible and cost-effective investments... There is no comparable resource to MyScope anywhere else in the world.*"

myscope.training | *myscope-explore.org*



WHY IS MICROSCOPY SO IMPORTANT?

Microscopy is a core scientific technique. It reveals the fundamental building blocks of life and materials, right down to individual proteins and atoms.

It is an essential tool that underpins the creation of new knowledge across a huge range of disciplines. **Since 2014, more than 40% of the Nobel prizes for science were given for research that relied on microscopy**. Of those, two prizes were awarded specifically for the development of microscopy techniques.

"Without microscopy, there is no modern science – end of story,"
– Dr Alan Finkel, former Chief Scientist of Australia.

ADDING VALUE TO THE AUSTRALIAN RESEARCH LANDSCAPE

Microscopy Australia plays a critical role in Australia's research landscape. We enable research excellence, with **publications from NCRIS-enabled instruments appearing in top-tier[1] journals at double the rate of the OECD.**

From 2019-2024, our facilities supported 15 Centres of Excellence, 29 Industrial Transformation Training Centres and Research Hubs, and 66 Linkage Projects – almost half the number awarded from 2018 to 2022.

Microscopy is consistently highlighted in surveys of the national research community. In the *2026 National Research Infrastructure (NRI) Roadmap Consultation*, of publicly available submissions, **~20% explicitly mentioned microscopy as a need.**

In the nearly 3,000 responses to the *2021 NRI Roadmap Consultation*, imaging and microscopy were identified as **two of the top NRI that researchers would use more of in the coming years,** with the report specifically highlighting microscopy techniques like multimodal imaging and live-cell imaging. Australian researchers also ranked microscopy as the **top non-digital research infrastructure needed to maintain research excellence**, after an uplift in funding for research infrastructure more broadly.

$502 MILLION
OF RESEARCH GRANTS SUPPORTED BY NCRIS-ENABLED INSTRUMENTS IN 2024

FORTY-FOUR
ARC CENTRES OF EXCELLENCE & INDUSTRIAL HUBS/CENTRES SUPPORTED 2019-2024

$1.6 BILLION
CAPITAL RAISED BY JUST 35 OF THE START-UPS MICROSCOPY AUSTRALIA SUPPORTED

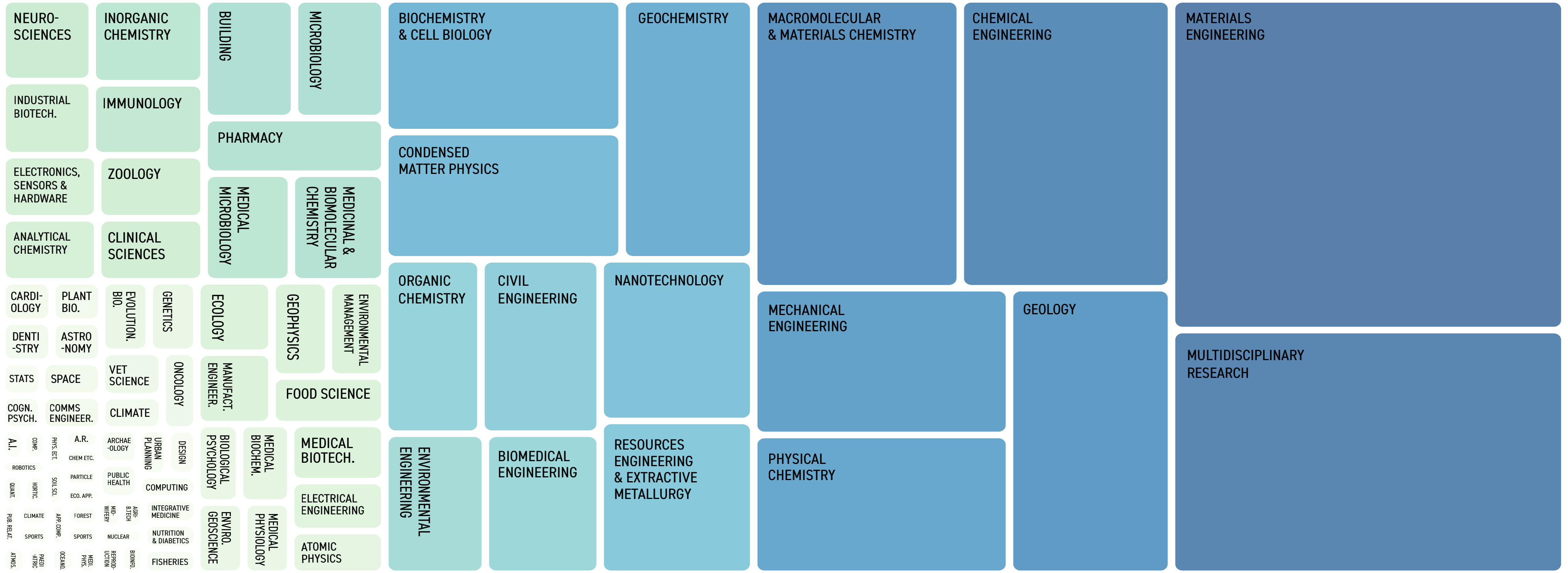
135 THOUSAND
USERS ANNUALLY OF OUR ONLINE TRAINING TOOLS MYSCOPE & MYSCOPE EXPLORE

ONE QUARTER
OF AUSTRALIA'S 100 MOST HIGHLY-CITED PAPERS RELIED ON MICROSCOPY IN 2023

41 PERCENT
OF PUBS FROM NCRIS INSTRUMENTS ARE IN THE TOP 10% OF JOURNALS[1]

[1]Top 10% most cited journals ranked by SNIP, based on 2024 publications. 21% is OECD average.

UNDERPINNING AUSTRALIAN RESEARCH & INNOVATION ACROSS DISCIPLINES



The size of the box represents the number of Microscopy Australia's 2024 publications per ANZSRC Fields of Research. This data is not field weighted.

FOUNDATIONS FOR FUTURE IMPACT

Microscopy Australia works closely with both Australian and international researchers to identify emerging needs across the microscopy landscape. These are some of the key areas that are consistently highlighted.

LEADING EXPERTISE

Any technology is only as good as the skilled staff around it. Microscopy Australia's impact is not delivered by instruments alone, but by expert microscopists who design experiments, develop new techniques, interpret complex data and work alongside researchers and industry. Our strategic plan recognises this expertise as core infrastructure in its own right. By investing in people as well as platforms, Microscopy Australia ensures advanced technology translates into long-term impact.

EMERGING TECHNOLOGIES

As research questions grow more complex, scientists increasingly rely on new microscopy technologies that deliver higher resolution, faster acquisition and richer, multi-modal data. New techniques such as cryo-electron tomography, spatial 'omics, 4D STEM and correlative imaging are transforming research across life and materials sciences. These advances are driving rapid development in vaccines, drug discovery, batteries, solar technologies, agriculture, critical minerals and more.

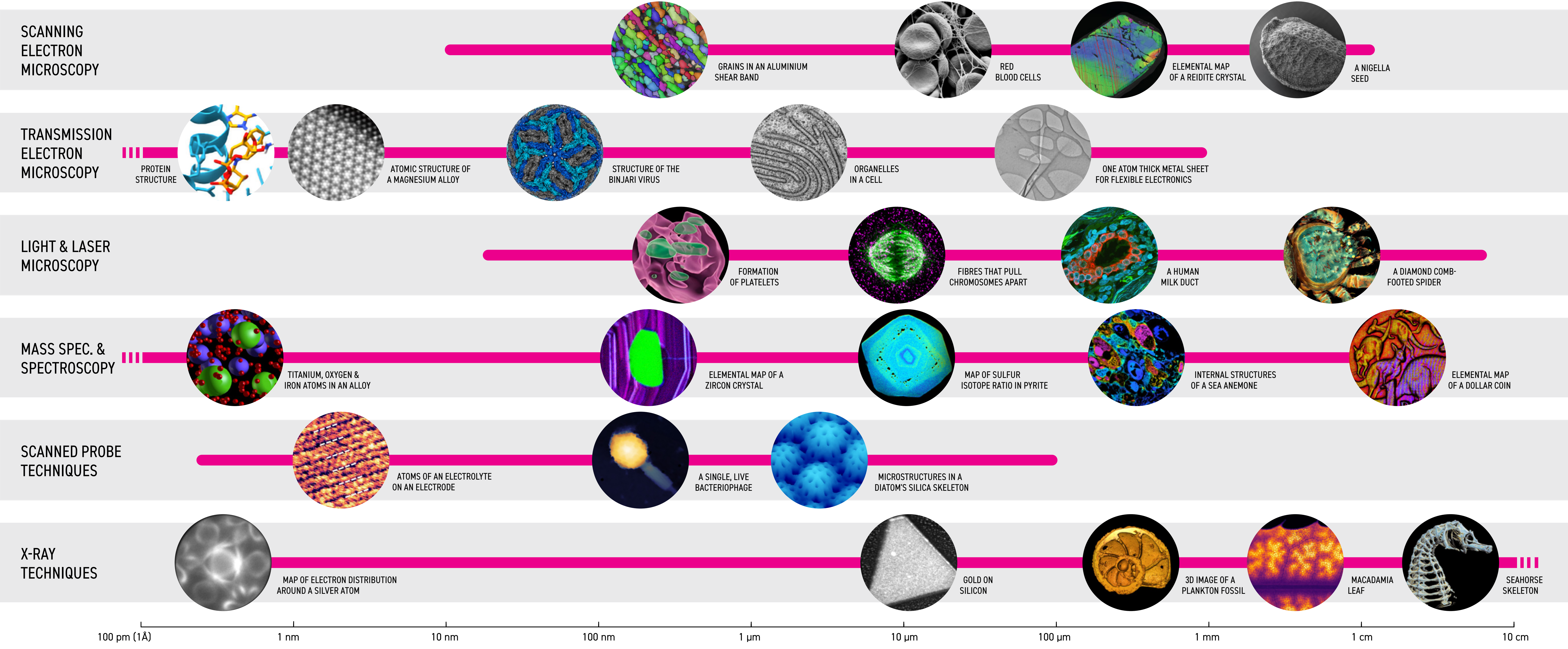
DATA ANALYSIS

As microscopy techniques become more advanced, the quantity of data they produce is growing rapidly, with our facilities generating petabytes of data each year. Researchers increasingly rely on advanced, AI-enhanced methods to interpret these large, complex, multimodal datasets. There is an opportunity to establish a nationally coordinated system to support this work, enabling microscopy data analysis solutions across disciplines and reducing duplication of effort.

TAKE A CLOSER LOOK

OUR EQUIPMENT & EXPERTISE

With the nation's largest range of high-end microscopy and microanalysis platforms, our experts ensure researchers and businesses get the most out of these techniques. Microscopy Australia's facilities can provide solutions across diverse, multi-scale applications. In the graphic to the right you can explore just a fraction of the kinds of samples, scales and techniques our facilities support.



LONG-TERM SUPPORT

FOR LONG-TERM IMPACT

Turning a discovery into a product takes years of iterative testing, refinement and validation, all of which depend on ongoing access to high-quality research infrastructure.

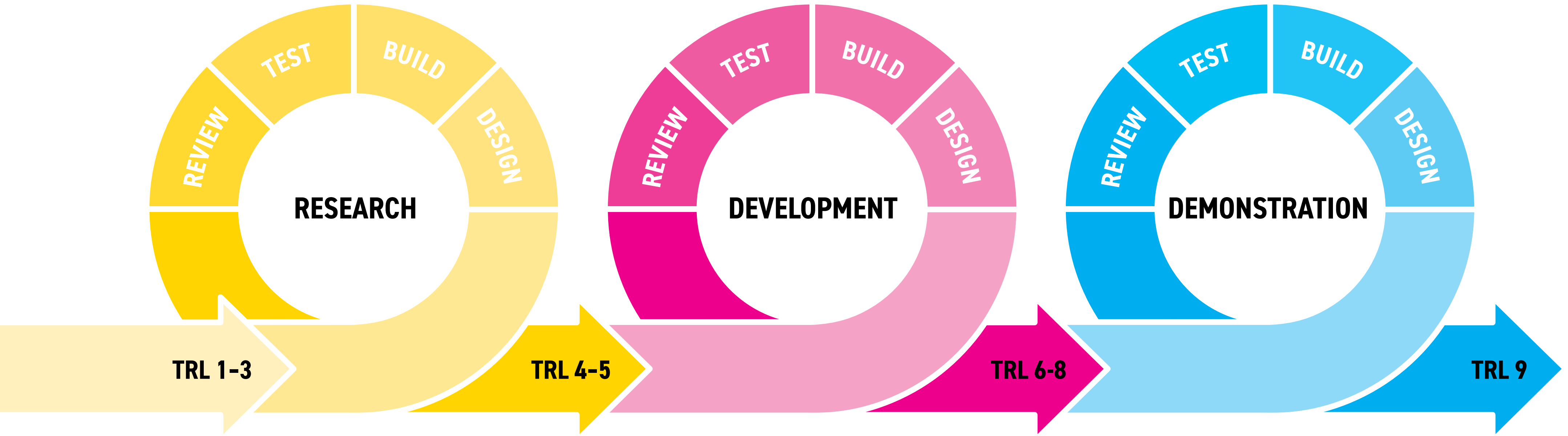
Translation is not linear; it is a long, iterative, evidence-driven process. Microscopy Australia provides essential tools and expert guidance to help ventures move from idea to viable product, delivering critical insights across the entire translation cycle – discovery, proof-of-concept, trials, scaling, manufacturing, quality control, failure analysis and regulatory approvals.

The impact is clear. Just 35 of the start-ups supported by Microscopy Australia have secured over $1.6 billion in external capital investment and even more, over $2.4 billion, in licensing deals and acquisitions.

Many of these companies returned to Microscopy Australia's facilities repeatedly, often over a decade or more. This demonstrates the significant economic value unlocked when researchers and companies have long-term, sustainable access to the right enabling infrastructure.

A strong national innovation system depends on this infrastructure, much of which is enabled by the National Collaborative Research Infrastructure Strategy (NCRIS). Long-term, strategic funding ensures that Australian discoveries can be transformed into high-value products, services and policy solutions that benefit the nation. Without this, Australia can't capitalise on its world-class research.

Microscopy Australia has demonstrated its capacity to strengthen the national innovation and commercialisation ecosystem. Realising this potential, however, depends on sustained investment that matches the ambition of a nation seeking to turn world-leading research into global innovation.



VAXXAS

2009 — **From fundamental research to clinical trials – Vaxxas' team have used our facilities every year since 2009 in the development of their needle free vaccine delivery patch, the HD-MAP.**

2011 – SPIN-OUT
Vaxxas founded to commercialise Prof. Mark Kendall's 'nanopatch'
↑ ALSO SUPPORTED BY ANFF

2015 – RECOGNITION
Vaxxas is named a 2015 Technology Pioneer by the World Economic Forum.

2017 – $25M RAISED & POLIO TRIAL
Raises $25M in Series B financing and awarded a World Health Org. grant to support preclinical research in polio vaccine delivery.

2020 – MERCK DEAL
Merck licenses exclusive commercialisation rights to a vaccine

2020 – U.S. GOVT DEAL
$22M award from the U.S. Government Agency leading pandemic response for COVID-19 and pandemic influenza trials.

2022 – PRE-CLINICAL TRIAL
Covid-19 vaccine, HexaPro, proved effective against all major variants when given to mice via the HD-MAP.

2022 – $34M RAISED
Vaxxas raises $34M to advance their technology including for mRNA vaccines.

2023 – MANUFACTURING FACILITY
Vaxxas opens a state-of-the-art biomedical manufacturing facility in Brisbane, home to over 130 highly skilled staff.

2023–2025 – CLINICAL TRIALS
Pre-clinical and clinical trials for viruses with pandemic potential, and more including influenza, typhoid and bird-flu.
↑ ALSO SUPPORTED BY TIA

2025 – $90M RAISED
$49.22M in new Series D equity and $40 million in debt facilities.

2025 – TGA APPROVAL
Vaxxas receives TGA licence to manufacture the HD-MAP for clinical trials at its Brisbane facility.

HAZER

2010 — **Our facilities were essential for the development of the Hazer process, and continue to be used for R&D. It turns methane and unprocessed iron ore into low-cost, low-emission hydrogen.**

2015 – ASX LAUNCH
Hazer Group launched on the ASX raising $5M in investment for a pre-pilot plant.

2019 – PILOT PLANT SUCCESS
Pilot plant success leads to an agreement with Water Corp for a Commercial Demonstration Plant to convert sewage into hydrogen.

2022–2023 – GLOBAL PARTNERSHIPS
Hazer partner to deliver 2500tpa Canadian hydrogen project for Suncor Energy. They also sign an agreement to develop a plant in Japan.

2024 – COMMERCIAL PLANT
Hazer's commercial demonstration plant is operational. They aim to produce 100t of hydrogen per year.

MICRO-X

2011 — **Micro-X are creating world-first portable X-ray devices. Our facilities enabled the development of their proprietary X-ray technology and now provide ongoing R&D support.**

2015 – FACILITY OPENS
Micro-X open new manufacturing facility in SA, launch on the ASX, and sign a deal with the ADF.

2018–2019 – FIRST PRODUCT
Medical X-ray device manufactured by Micro-X for US company Carestream are installed in hospitals in the US and Australia.

2019 – NEXT-GEN X-RAY TUBE PATENT
Our facilities enabled the development of Micro-X's in-house designed and manufactured X-ray tube. Previous tubes were sourced from a US supplier.
↑ ALSO SUPPORTED BY ANFF

2020 – SECOND PRODUCT
First sales of the Rover, Micro-X's first product using the new X-ray tube, are facilitated by the World Health Org.

2019–2024 – DEFENCE DEALS
Micro-X develop baggage scanners, an X-ray camera for IED detection, and military medical Rover following deals with the ADF, the UK Ministry of Defence, the US Department of Homeland Security and Thales.

2022 – UNITS REACH UKRAINE
~15 battery powered units arrive in Ukraine *"This will save thousands of lives of Ukraine citizens"* – unnamed Kherson Unit Commander.

2024–2029 – WORLD-FIRST PORTABLE CT
Field trials of a world-first, air and road ambulance mounted CT scanner for rapid stroke assessment.

2025 – MILESTONES REACHED
380+ medical X-ray devices in use globally, 35 countries using their proprietary technology, and 450 X-rays taken in a day by a single Rover unit on the Ukraine frontlines.

GMG

2016 — **From product development to quality control, our facilities have provided ongoing support to Graphene Manufacturing Group since 2016.**

2019 – PRODUCTION BEGINS
Production plant launched; microscopy used to monitor daily output.

2021 – BATTERY R&D
Developed graphene–aluminium-ion battery technology with the University of Queensland.

2022 – THERMAL COATING
Graphene-based spray-on thermal coating developed for for more efficient cooling systems and more.

2023 – BATTERY DEAL
GMG–Rio Tinto partnership to further develop graphene–aluminium-ion batteries

2024–2025 – DEVELOPMENT SPRINT
Produced batteries that can be charged in under 6 mins, have a long life cycle, and are safer than lithium alternatives.

FERRONOVA

From the paint industry to a cancer tracer for surgery – our facilities have regularly supported this nanoparticle research since 1999.

1999 – DULUX PARTNERSHIP
RAFT polymerisation method developed for paint: "*There is no better example of industrial collaboration than this,*" Tim Davey, Dulux.

2003–2016 – MEDICINE PIVOT
RAFT method applied for medical use including tracers for lymph-node detection in cancer.

2016 – SPIN-OUT
Joint venture launched between UniSA and Victoria University (NZ).

2022–2026 – CLINICAL TRIALS
Several clinical trials completed, one ongoing, for lymph node mapping in oesophageal, colorectal, and gastrointestinal cancers.
↑ ALSO SUPPORTED BY NIF

2025 – $17.5M RAISED
$6M raised to advance image-guided surgery tracer, bringing total Series A raise to $17.5M.

PATHWAYS TO RESEARCH TRANSLATION

The translation of academic research into useful applications occurs via a variety of pathways. All depend on excellent feed-in research and the initiative and drive of Australian researchers to ensure their discoveries make a difference in the world.

Different technologies lend themselves to different translation approaches, and different researchers have different preferred routes of getting their discoveries to market. Some are drawn to the start-up route, while others prefer to license out their discoveries for commercialisation. Other researchers work directly with industry, applying their scientific expertise to industry problems, leading to productive partnerships that can last for many years. All these routes contribute to a vibrant research and innovation ecosystem.

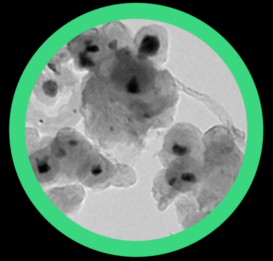
TRANSLATION THROUGH A SPIN-OUT

This is where one or more of the research team form a company that licenses the university IP and works toward commercialisation.

CRITICAL MINERALS: Fast, green lithium extraction and processing are being commercialised by Electralith

HEALTH: Gut health monitoring capsules are being commercialised by Atmo Biosciences

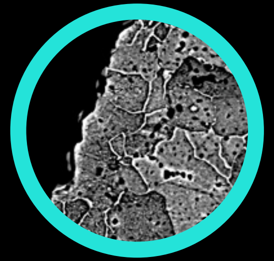
HEALTH: Tissue repair gel is being commercialised by Tetratherix



NET ZERO: Low-emission hydrogen and graphite are being commercialised by Hazer Group

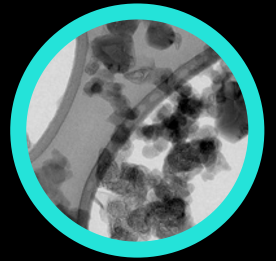
A PARTNERSHIP WITH INDUSTRY

In this situation, a partnership is established between the university researcher and a company to jointly advance an area of research of relevance to that company.



NET ZERO: Green steel – a UNSW Sydney and OneSteel partnership

CRITICAL MINERALS: New mineral dating technique – a MinExCRC and University of Adelaide partnership



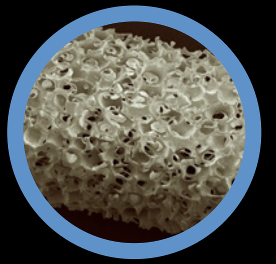
NET ZERO: Graphene–Aluminium batteries – a Graphene Manufacturing Group and University of Queensland partnership

FUTURE TECHNOLOGIES: Innovative polymers for the automotive industry – a University of South Australia and SMR Automotive partnership

IP IS LICENSED OR SOLD

This route leaves the researchers free to continue doing more research without having to negotiate the translation landscape.

NET ZERO: Decorative ceramic tiles for interior design from waste – IP licensed to Kandui Technologies

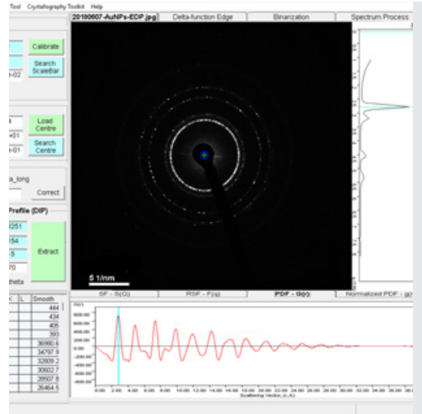


HEALTH: Growth scaffolds for weight-bearing bones – IP sold to Allegra Orthopaedics

ADVANCING MICROSCOPE TECHNOLOGY

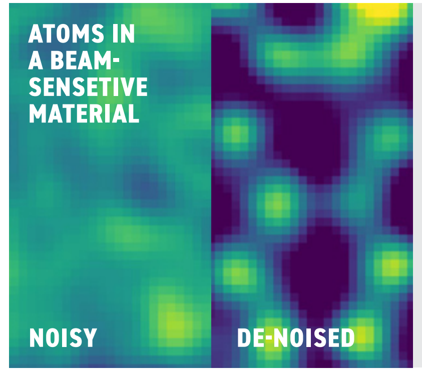
Pushing the boundaries of what microscopy can deliver for researchers relies on the deep knowledge and experience of experts. They apply their knowledge to finding new ways of configuring microscopes, capturing images and data from them, new ways to share and analyse that data, and new applications for the techniques. Microscopy Australia experts do all these things.

DATA ANALYSIS



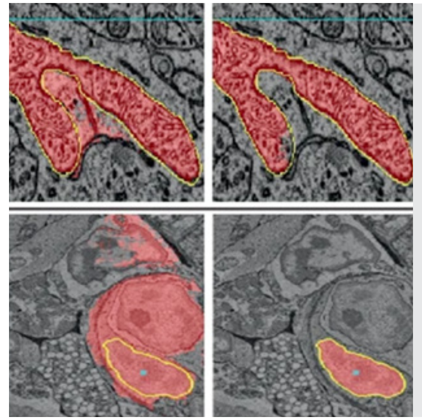
ELECTRON DIFFRACTION DATA MADE EASY

Electron diffraction patterns collected in the transmission electron microscope (TEM) hold a wealth of information. Now scientists at our University of Sydney facility have developed a new software tool (EDP2PDF) to analyse these diffraction patterns more effectively. Their tool overcomes existing challenges encountered when using other methods and provides a much easier way for researchers to understand atomic structures of crystalline and non-crystalline materials. This is now being used by the global TEM community.



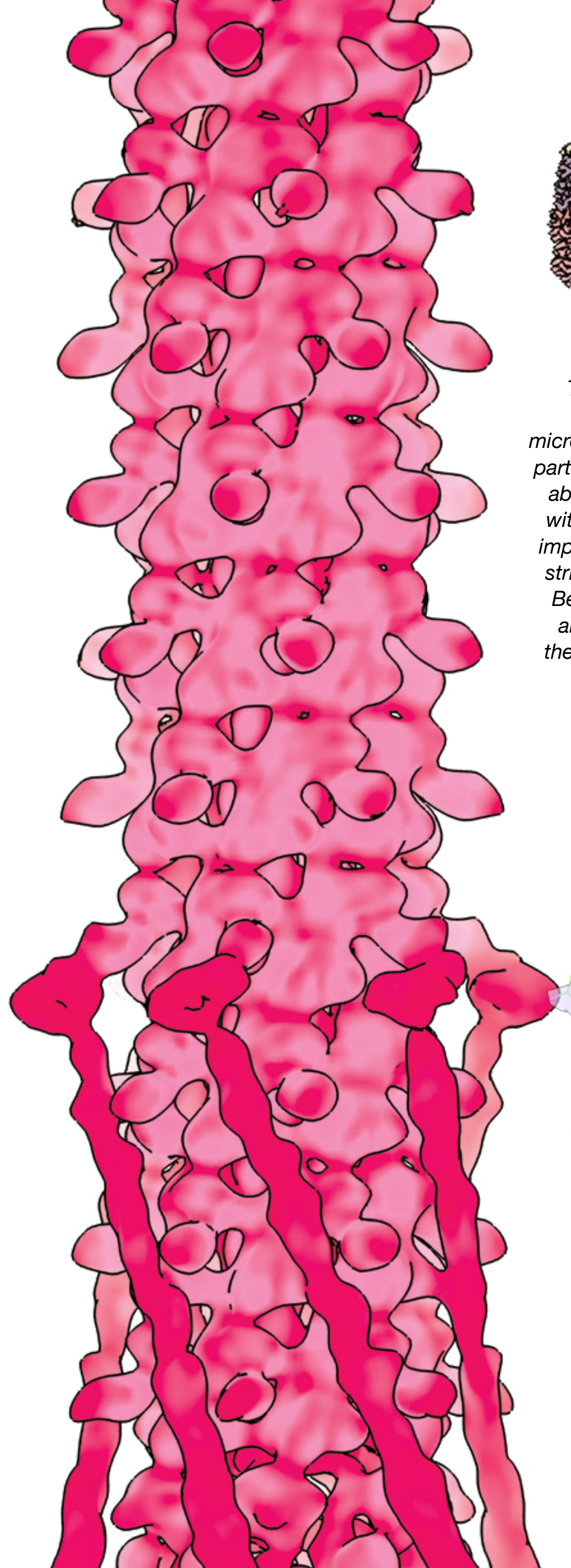
AI HELPING TO MAKE THE UNSEEN SEEN

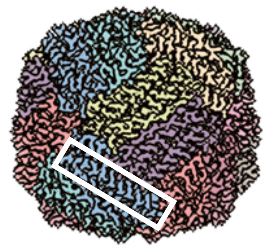
AI and advanced direct electron detectors are making it possible to image beam-sensitive materials that were previously almost impossible to visualise. These new detectors capture weak, noisy signals from the materials, while AI tools, developed in collaboration with our Monash facility, are used to 'de-noise' the data. These materials are critical for green energy technologies like batteries and solar cells, and for emerging quantum applications.



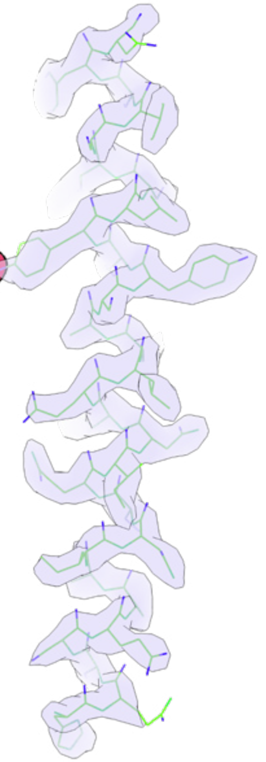
DEEP LEARNING TO SPEED UP SEGMENTATION

Segmentation – highlighting features in microscopy images – is slow when done manually. Developed with input from a Microscopy Australia expert, Segment Anything for Microscopy (µSAM), uses deep learning to segment and track multidimensional microscopy data. Built on the Segment Anything model, it is designed to improve segmentation quality for a wide range of imaging conditions, laying the groundwork for solving complex image analysis tasks in microscopy with a small set of powerful deep-learning models.





These structures were captured on a similar microscope – the left (a phage particle) in 2012, and the one above (apoferritin) in 2025 with the new detector. The improvement in resolution is striking: 2 nm to 0.265 nm. Below is a zoom-in of the area in the white box on the apoferritin, revealing its molecular structure.



INSTRUMENTATION

DEMOCRATISING CRYO ELECTRON MICROSCOPY

CHALLENGE

Cryogenic transmission electron microscopy (cryo-TEM) is crucial to enable researchers to work out the structure of the proteins, viruses and other molecular complexes that underlie all the processes of life and its diseases.

The microscopes needed to get the highest resolutions are extremely expensive and complex, largely due to their high-energy (300keV) electron sources. They sit firmly at the cutting edge of instrument design and operation, often costing around $10M. Even a 'standard' cryo-TEM that is used for the screening part of the structure-determination process is $4–5M. This often makes cryo-TEM prohibitively expensive for many facilities around the world, particularly in resource constrained institutions and nations. A more equitable solution would help to uplift the application of this powerful technology.

RESEARCH

A team at Microscopy Australia's Monash University facility has demonstrated that with the addition of a new detector and cryogenic sample holder, a significantly cheaper "standard" TEM can achieve a seven-fold improvement in resolution, enabling it to determine the structures of proteins.

In work supported by the Chan Zuckerberg Initiative and based on recent findings from Nobel Laureates Dr Richard Henderson and Dr Chris Russo at Oxford, Microscopy Australia Platform Scientist, Dr Hari Venugopal and Facility Director, Prof. Georg Ramm, at the Ramaciotti Centre for Cryo-EM, explored whether a standard TEM (120-keV) with the basic electron source can be upgraded for high-resolution cryo-EM. They showed that even this 'ordinary' TEM, found in many facilities around the world, when fitted with a new ultra-sensitive direct electron detector camera can achieve structures with a remarkably improved resolution over the same microscope in its traditional configuration. It had previously been assumed that higher energy electron beams were better for determining protein structures but this is not actually the case.

The ability to generate the high-resolution structure of a protein depends on the protein's size, stability and symmetry, with the highest resolution structures being achieved from large, symmetrical proteins with a stable structure.

In a partnership with Gatan, the Monash team added a new, ultrasensitive Gatan camera to one of these basic microscopes and set about determining the structures of three different proteins in a variety of instrument configurations. They were able to obtain a 2.67 Å resolution structure for the large, stable, symmetrical protein apoferritin, compared to 1.4 Å on a top-end microscope. For the smaller symmetrical protein, haemoglobin, they achieved 4.33 Å resolution compared to 2.3 Å from on a top-end microscope. As well as these two commonly used standards, they also applied the technique to an asymmetric, flexible, medium-sized protein, GPCR, part of a protein family relevant for many drug targets and which has been a difficult structure to solve. For this, they reached 4.4 Å resolution compared to 2.4 Å on a top-end microscope.

Another feature of the work is that the team achieved those structures from collecting a relatively low number of individual molecules, also making the process relatively quick and inexpensive. These resolution gains could potentially be improved further with more individual molecules feeding into the final structure and further optimisation of the microscope configuration.

IMPACT

The team showed that the high resolution needed for preliminary protein structure determination can now be achieved at a fraction of the cost, contributing significantly to the democratisation of cryo-TEM. This kind of set up will never be able to achieve resolutions better than 2 Å due to the physical limits of the system and so will not replace the current high-end microscopes. Nevertheless, it has shown what is possible and is a huge step forward in making cryo-TEM a more affordable technique and opening it up to a much larger global research community as well as reducing costs for everyone.

H. Venugopal et al. Science Advances 2025
DOI: 10.1126/sciadv.adr0438

LOOKING FORWARD TOGETHER IN 2025

Australia's scientific future is being shaped not just by technology, but by human connections. By prioritising global partnerships and inspiring young minds to pursue a career in STEM, Microscopy Australia is strengthening Australian science for the long term.

FoundingGIDE conference

Global BioImaging Facility Managers Course

GLOBAL CONNECTIONS & LEADERSHIP

In 2025, Microscopy Australia deepened collaboration with key international partners to strengthen ties and keep Australia at the forefront of global best practices.

We co-hosted the Founding a Global Image Data Ecosystem (FoundingGIDE) conference in Brisbane with the National Imaging Facility and Euro-BioImaging, uniting experts worldwide to advance FAIR data sharing and AI-enabled image analysis.

As part of the new NCRIS Health Group, we joined the Australian–European Health Research Infrastructure Symposium in Italy, where our CEO led discussions on workforce training in advanced imaging and artificial intelligence. This trip included visits to world-leading institutes from EMBL Barcelona and EMBL-EBI, to Wellcome and The Francis Crick Institute.

Microscopy Australia also played an active role in Global BioImaging networks, co-hosting a "train-the-trainer" masterclass to elevate microscopy training standards worldwide and sharing expertise at the Exchange of Experience meeting and Facility Managers Courses in Montreal.

These initiatives ensure Australia's researchers benefit from global knowledge, cutting-edge tools, and a skilled workforce well-versed in emerging technologies.

INSPIRING TOMORROW'S INNOVATORS TODAY

While our global partnerships strengthen today's research, Microscopy Australia is equally committed to inspiring the scientists of tomorrow.

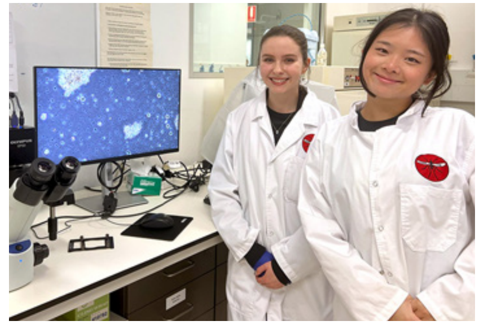
Australia's future workforce is built from today's youth, and early STEM engagement can spark lifelong passion. Dr Gerry Shami, an NCRIS-funded Microscopy Australia specialist helping to drive medical innovation, first encountered microscopy through an outreach program called Microscopes on the Move in the early 2000s: ***"This experience sparked in me a deep curiosity… a pivotal moment that ignited my passion for microscopy and set me on a path to a career in biomedical imaging," – Dr Gerry Shami***

In 2025, we continued this legacy with multiple outreach programs across the country. We welcomed high school students through the National Youth Science Forum at the University of Sydney, a family science open day was hosted at the University of Queensland, our Australian National University facility led a 'Parasite Pandemic' simulation that empowered teens to use microscopes to solve a mock outbreak, and we brought interactive activities to community events like the Indigenous Science Experience @ Redfern Community Centre in partnership with NISEP.

We also continued to support our youth elearning website, MyScope Explore. Check it out here: *myscope-explore.org*

Indigenous Science Experience, UNSW & USyd

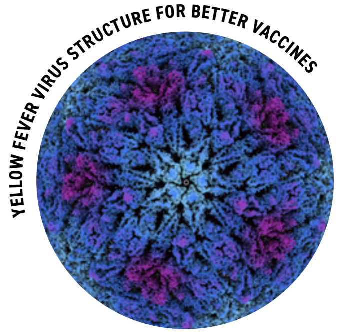
Youth Science Forum, The University of Sydney



Pandemic zoo, Australian National University

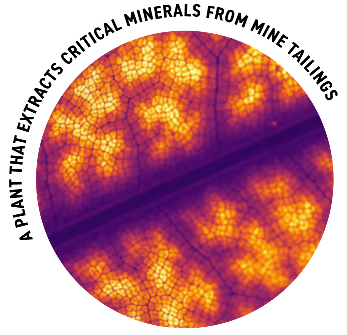
Family fun day, The University of Queensland

TOMORROW'S DISCOVERIES NEED MICROSCOPES TODAY



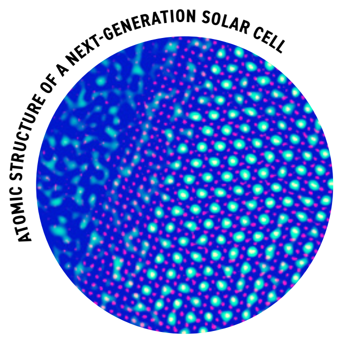
HEALTHIER FUTURES

While many people think of microscopes in a diagnostic lab looking at biopsies and swabs, a much wider range of microscopes and techniques are crucial to vital medical discoveries. These can range from determining the structures of medically important proteins, viruses, drugs and drug-delivery systems, to understanding how they interact with other molecules and structures inside living cells. 3D-reconstructions of microscopy data enables researchers to visualise the intricate structures deep inside cells and tissues. Microscopes also enable researchers to develop new medical devices. These outcomes mean discoveries are made that benefit the health and well-being of all Australians.



CRITICAL MINERALS FOR OUR FUTURE

Critical mineral resources must be found, extracted and processed so they can be incorporated into essential technologies. Microscopes and high sensitivity tools help us understand ore bodies by studying tiny crystals to aid discovery. They also help develop new extraction methods, for instance filter-extraction of lithium, or mining with plants. They are crucial to monitor and optimise processing and to ensure economic viability. Critical mineral recovery from e-waste is also a significant future need, an area where microscopy can add substantial value.

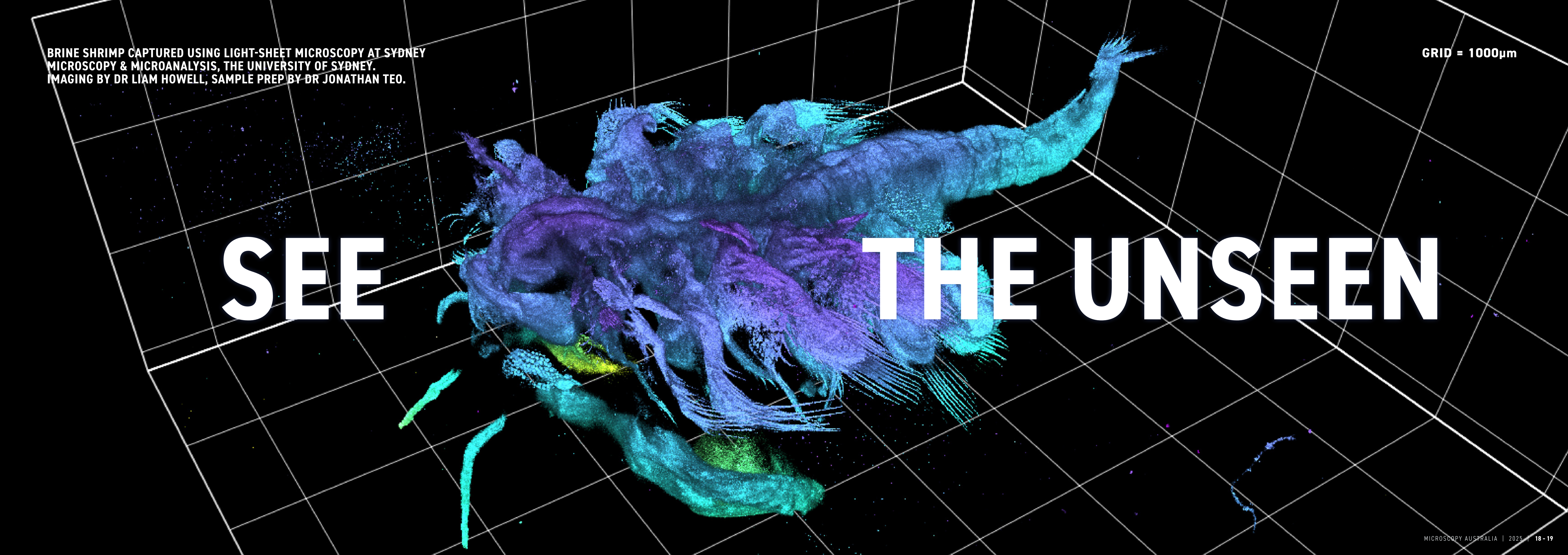


A NET ZERO FUTURE

Progress toward a Net Zero future is being driven by the development and application of new materials, technologies and processes, none of which could happen without a range of sophisticated microscopes to reveal the structures of these materials and how they change at the atomic scale. By the very nature of their chemistry, many of these solar and battery materials need to be visualised with emerging detector technologies so researchers can see essential details and design more efficient and sustainable energy solutions.

FUTURE FOOD SECURITY

Food security needs researchers to understand and improve soils, plants, animals, processes and packaging. All these use microscopes, whether to help develop new methods to produce and use fertilisers more safely and efficiently in different soil types, to improve pest and disease resistance in crops and food animals, or to develop more sustainable packaging that can sense the state of the food inside.



BRINE SHRIMP CAPTURED USING LIGHT-SHEET MICROSCOPY AT SYDNEY MICROSCOPY & MICROANALYSIS, THE UNIVERSITY OF SYDNEY. IMAGING BY DR LIAM HOWELL, SAMPLE PREP BY DR JONATHAN TEO.

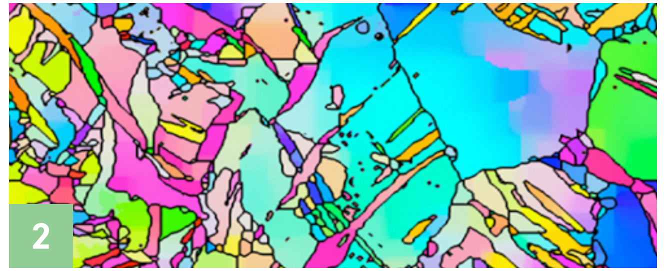
SEE THE UNSEEN

RESEARCH OUTCOMES & IMPACT

Take a closer look at the 2025 research highlights – all enabled by Microscopy Australia. With over 3,500 researchers accessing our facilities annually, here are just a few of their remarkable discoveries.

- HEALTH & AGRICULTURE
- NET ZERO & CLIMATE
- CRITICAL MINERALS
- FUTURE TECHNOLOGIES

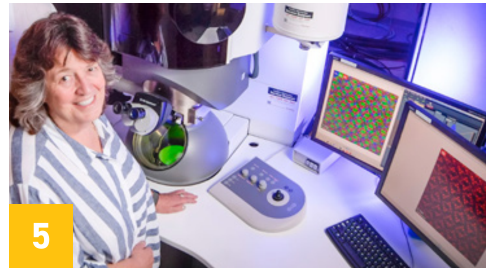
1 MOLECULAR CLAMP: AUSTRALIA'S LARGEST UNIVERSITY IP DEAL



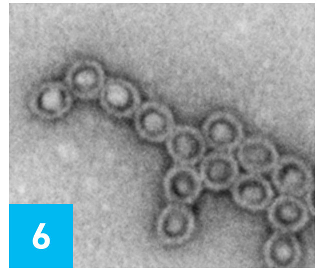
2 A SMARTER FIX FOR BROKEN BONES: DISSOLVABLE ZINC IMPLANTS

3 TETRATHERIX: IMPROVING SURGICAL OUTCOMES WITH INJECTABLE SCAFFOLDS

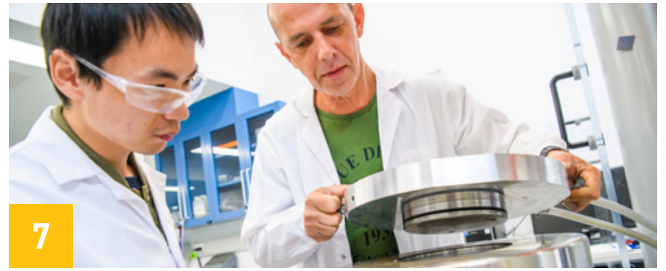
4 RAPID CROP IMPROVEMENT ENABLED BY NANOTECH



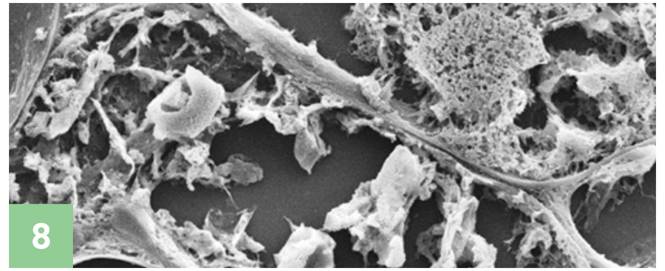
5 WORLD FIRST USE OF TEM TO DEFINE NEW MINERALS



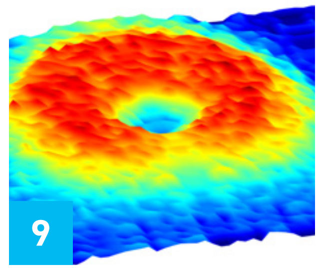
6 ENGINEERING THE FUTURE WITH DNA DINOSAURS



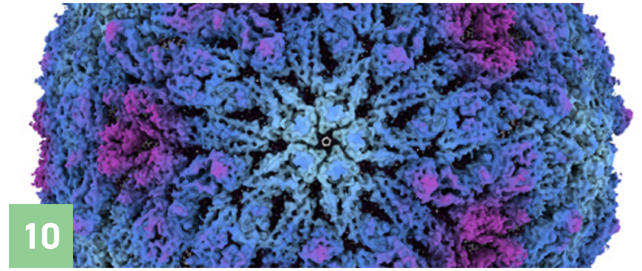
7 NEW EXPLORATION TARGETS FOR CRITICAL MINERALS



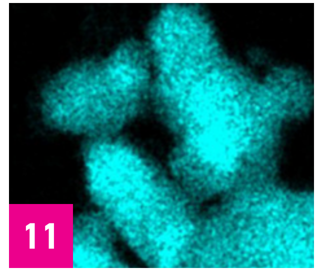
8 NEW CLOTTING MECHANISM EXPLAINS ORGAN DAMAGE



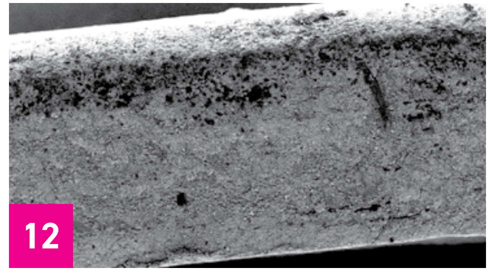
9 ALDENTE GLASS



10 SECRETS OF YELLOW FEVER VIRUS REVEALED



11 HYDROGEN FROM SEAWATER

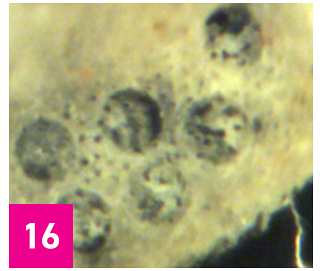


12 NEXT-GEN BATTERY OUTPERFORMS LITHIUM-ION

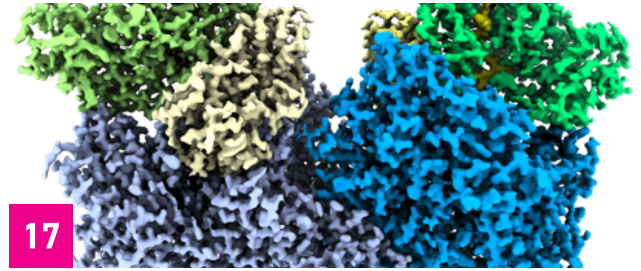
13 THE LAST SUPPER: THE SECRET LIFE OF A 15-MILLION-YEAR-OLD FISH

14 GOLD FROM E-WASTE

15 INDUSTRY COLLAB FOR NEXT-GEN FERTILISER



16 ORGANISMS RECORD ANCIENT OCEAN TEMPS



17 CLEARING THE AIR: HOW BACTERIA TURN TOXIC GAS INTO ENERGY

Inventors Prof. Keith Chappell, Prof. Daniel Watterson and Prof. Paul Young. Photo credit: UQ.

Participants in a clinical study receive the vaccine candidate for COVID-19 in 2020. Credit: UQ.

Flagship Scientist Dr Lou Brillault with the Cryo-Electron Microscope at CMM, UQ.

Sharada Kolekar in the Chappell Group Lab, AIBN, UQ. Photo credit: UQ.

Dr Marianne Gillard in the Chappell Group lab, AIBN, UQ. Photo credit: UQ.

1

MOLECULAR CLAMP TECHNOLOGY SECURES AUSTRALIA'S LARGEST UNIVERSITY IP DEAL

CHALLENGE

The COVID-19 pandemic underscored a critical global need: the ability to develop and deploy effective vaccines at unprecedented speed to contain emerging infectious diseases. Traditional vaccine development timelines – often measured in years – are too slow to respond to fast-moving outbreaks. In 2019, the Coalition for Epidemic Preparedness Innovations (CEPI) recognised the potential of UQ's Molecular Clamp vaccine platform and funded researchers at The University of Queensland (UQ) to help achieve this goal by addressing a key scientific hurdle: how to stabilise viral proteins so they can be used to quickly and reliably create vaccines. Outside of pandemics, the technology was licensed to Vicebio a start-up created by UniQuest and Swiss/UK venture capital investor Medicxi to progress the technology for a range of vaccines.

RESEARCH

Led by Professors Paul Young, Keith Chappell, and Daniel Watterson, the team had developed the Molecular Clamp, a tiny protein-based 'clamp' that locks viral proteins into their original shape. This stabilisation enables vaccines to accurately mimic the virus and trigger a strong immune response. Crucially, it also allows scientists to design vaccines in record time, as demonstrated when the UQ team created a COVID-19 vaccine candidate just 34 days after the SARS-CoV-2 virus's genetic code was released – an extraordinary achievement.

Australia's National Research Infrastructure played a role in enabling this research through two NCRIS Providers: Microscopy Australia and Therapeutic Innovation Australia (TIA).

Cryo-electron microscopy at Microscopy Australia's UQ facility, the Centre for Microscopy & Microanalysis (CMM), was critical to this breakthrough, being used throughout the process to confirm the structures of 'clamped' viral proteins. It enabled the researchers to visualise the structures at near-atomic resolution and confirm they retained their original form, giving confidence to the effectiveness of the resulting vaccine. The team continues to use these facilities in the development of new vaccines.

TIA enabled successful proof of concept by manufacturing a SARS-CoV-2 vaccine candidate at National Biologics Facility and CSIRO Biomedical Manufacturing for two Phase I clinical trials.

Although their initial COVID-19 vaccine showed strong protection in early trials, it triggered false positives in some HIV tests due to the HIV-derived sequences used in the clamp. While not harmful, this diagnostic interference limited its global rollout.

IMPACT

While CEPI funded UQ to develop the Molecular Clamp platform for pandemic preparedness, use outside of pandemics was licensed to Vicebio, which ran in stealth mode before and during the COVID-19 pandemic. The company developed Clamp2, a second-generation version of Molecular Clamp that resolves the diagnostic issue while retaining the original benefits, and progressed a bivalent vaccine into clinic trials – against respiratory syncytial virus (RSV) and for human metapneumovirus (hMPV) – helped with a Series B capital raise of US$100 million in 2024.

The success of Molecular Clamp has led to a historic commercialisation deal: global healthcare leader Sanofi is acquiring Vicebio for AU$1.7 billion (US$1.15 billion), with milestone payments of up to AU$690 million (US $450 million). The acquisition brings a clinical stage combination RSV/hMPV vaccine candidate into Sanofi's pipeline and expands its respiratory vaccine portfolio with a non-mRNA option.

As part of CEPI's mission to develop a vaccine within 100 days of a new threat, the UQ team has recently tested Clamp2's rapid-response potential by developing a vaccine for the rare Bolivian Chapare virus. They're also working on broad-spectrum vaccines for virus families like Henipaviruses, which includes Hendra, aiming for single shots that protect against multiple diseases.

2

A SMARTER FIX FOR BROKEN BONES: DISSOLVABLE ZINC IMPLANTS

CHALLENGE

When bones break, doctors often use stainless steel or titanium plates and screws to hold them in place. While they help bones heal, they can cause discomfort and sometimes require further surgery for their removal. They may also loosen over time or lead to bone loss.

Biodegradable implants offer a better solution. They dissolve safely after healing, removing the need for follow-up surgery. However, current magnesium-based biodegradable implants are not strong enough for weight bearing bones, and can release hydrogen gas, which interferes with tissue repair.

Zinc is a promising alternative. It's safe for the body and helps bone growth, but pure zinc is too weak to support healing in load-bearing bones. Traditional methods to strengthen zinc haven't worked well, making the metal unstable at body temperature.

RESEARCH

Now published in Nature, a team at Monash University led by Prof. Jian-Feng Nie has developed a new zinc-based material that could change how we treat broken bones. Their goal was to create an implant that's strong enough to support healing and then safely dissolves once it's no longer needed.

Instead of using the usual method of shrinking the metal's grain size to make it stronger, the researchers did the opposite. The team discovered that larger grains change how the metal bends and stretches. Instead of breaking apart at the grain boundaries, the metal forms special structures called "accommodation twins" that help it stay strong and flexible.

The new zinc alloy is nearly twice as strong as current magnesium implants and performs better in tests for compression, bending, and long-term durability. It's also safe for cells, which is important for healing.

Microscopy Australia played a key role in supporting this research. Using advanced imaging tools at the Monash Centre for Electron Microscopy, the team was able to study the metal's grain size and orientation in detail. These tools helped them understand how the grain structure formed and how the grain structure behaved under load.

IMPACT

This breakthrough could transform orthopaedic care. The new zinc alloy offers a safer, smarter alternative to permanent implants. It supports healing and then disappears, reducing complications and healthcare costs. The research has paved the way for a new spin-out from Monash University, with the aim of bringing these next-generation implants to market.

C. Wu et al., Nature 2025
DOI: 10.1038/s41586-024-08415-8

Left: Electron backscatter diffraction map of grains in a zinc alloy after being put under load. It shows many high-angle grain boundaries and accommodation twins (black lines).

PUBLISHED IN NATURE

Will Knox (CEO) and Dr Ali Fathi (CTO) celebrate Tetratherix's launch on the ASX.

3 TETRATHERIX: IMPROVING SURGICAL OUTCOMES WITH INJECTABLE SCAFFOLDS

Surgical recovery often involves long healing periods – up to eight weeks for procedures like jaw reconstruction – during which patients face physical and dietary restrictions. Dr Ali Fathi, during his PhD at the University of Sydney, developed Tetramatrix, an injectable tissue scaffold designed to dramatically reduce these recovery times. Tetramatrix is a temperature-sensitive liquid that hardens at body temperature, providing structural support while immobilising local biologics and progenitor cells to signal the body to repair tissues. The scaffold's components can be customised to alter hardness, elasticity and structural stability, making it adaptable for various surgical applications.

To advance the technology, Dr Fathi co-founded Tetratherix with Terence Abrams in 2015. Recently listed on the ASX, the company has raised over A$39 million, holds a robust portfolio of 36 patents, and operates a Sydney-based manufacturing facility creating local jobs and contributing to Australia's advanced manufacturing sector.

Microscopy Australia played a pivotal role in the R&D journey, supporting Tetramatrix from early development to clinical trials. Techniques like environmental scanning electron microscopy, transmission electron microscopy, confocal microscopy, X-ray microtomography, and light microscopy were used to study scaffold structure, cell interaction, and tissue regeneration.

Tetramatrix has already shown clinical utility in five applications and successfully completed trials for bone healing after tooth extraction. It has the potential to reduce recovery times from eight weeks to just two, improving patient outcomes and reducing hospital stays.

> **"Start-ups have to be cognisant of where their money is spent. To have organisations like [Microscopy Australia] helps with business growth"**
>
> – Terence Abrams, COO, Tetratherix

4 RAPID CROP IMPROVEMENT ENABLED BY NANOTECH

Researchers have developed nanoparticle technology that can deliver RNA and DNA into a wide range of plant cells, opening a new pathway for rapid crop improvement.

The University of Queensland team, led by Profs Zhi Ping Xu and Neena Mitter, showed that this technology can effectively deliver RNA and DNA into the cells of a wide range of plants through their roots, leaves, pollen and cultured tissues. The breadth of plant species and tissues successfully targeted by the enhanced nanoparticles is something that has not been previously achieved with a single, easy-to-use technology. These coated nanoparticles provide a broadly applicable method with huge potential to rapidly modify the features of a wide range of crops.

In the face of a changing climate, now more than ever, we need methods to rapidly improve and adapt our key crops to changing conditions to ensure future food security.

However, traditional plant breeding and genetic modification methods are time-consuming and expensive, and can take many generations to produce a new crop variety.

The protein-coated nanoparticles have been patented by UQ's commercialisation company UniQuest, which is now seeking partners to further develop the technology.

This research was supported by Microscopy Australia and ANFF, both enabled by NCRIS. Access to Microscopy Australia's UQ facility allowed the team to precisely monitor the size and shape of the nanoparticles. Microscopy Australia has also supported Prof. Neena Mitter and her team as they develop mRNA-based pesticides and anti-fungal treatments for plants, some of which also make use of clay delivery systems.

J. Yong et al., Nature Plants 2025
DOI: 10.1038/s41477-024-01882-x

5 WORLD FIRST USE OF TEM TO DEFINE NEW MINERALS

In a world first, electron microscopy has been used to identify and structurally define a new mineral: ehrigite.

When a new mineral is discovered, there is a thorough and lengthy process to confirm that it is indeed new and to describe its distinctive characteristics. This identification depends on verifying its crystal structure, which is usually done using X-ray diffraction of a single crystal of the mineral. This technique needs the crystal to be perfectly homogeneous and large enough to analyse. When such crystals aren't available, atomic-resolution transmission electron microscopy (TEM) provides an effective alternative.

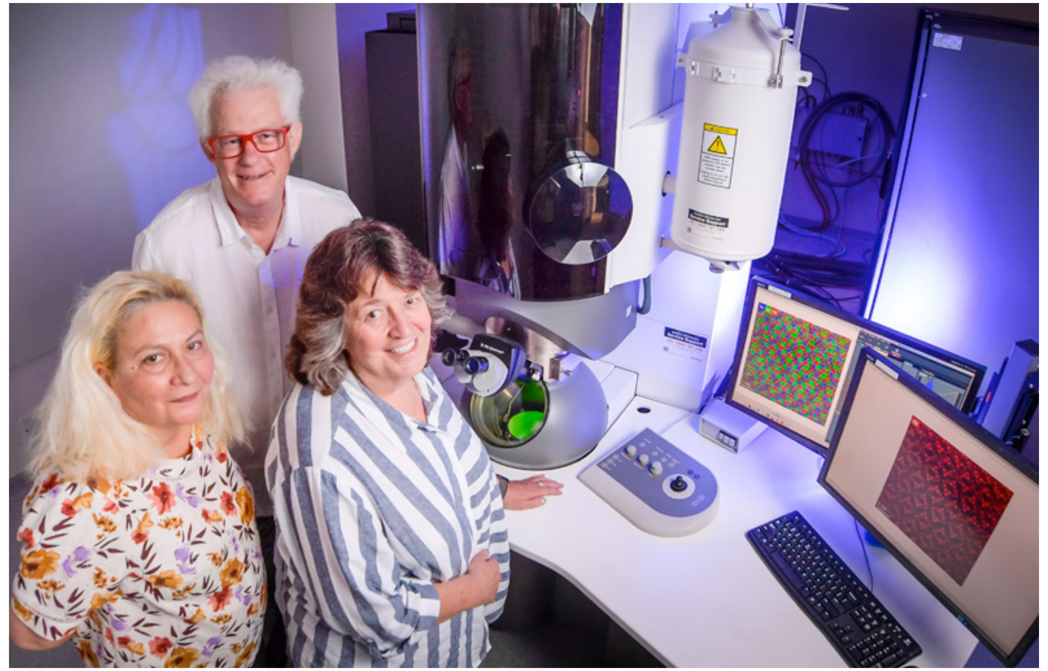
Adelaide University researchers, A/Prof. Cristiana Ciobanu and Prof. Nigel Cook, have identified and structurally defined a new mineral by using atomic-resolution TEM data. Microscopy Australia's TEM Platform Scientist, Dr Ashley Slattery at Adelaide Microscopy, Adelaide University, collaborated with the team to get the best results that show the mineral's crystal structure as clearly as possible.

The new mineral, ehrigite, is named after the world-renowned, South-Australian-based BHP metallurgist, Dr Kathy Ehrig, in recognition of her contributions to metallurgy. The atomic-resolution instrument allowed the team to visualise the unique arrangement of atoms in a tiny sample of this new mineral, showing it was different to all other known structures. It is made up of bismuth and tellurium with the formula Bi_8Te_3.

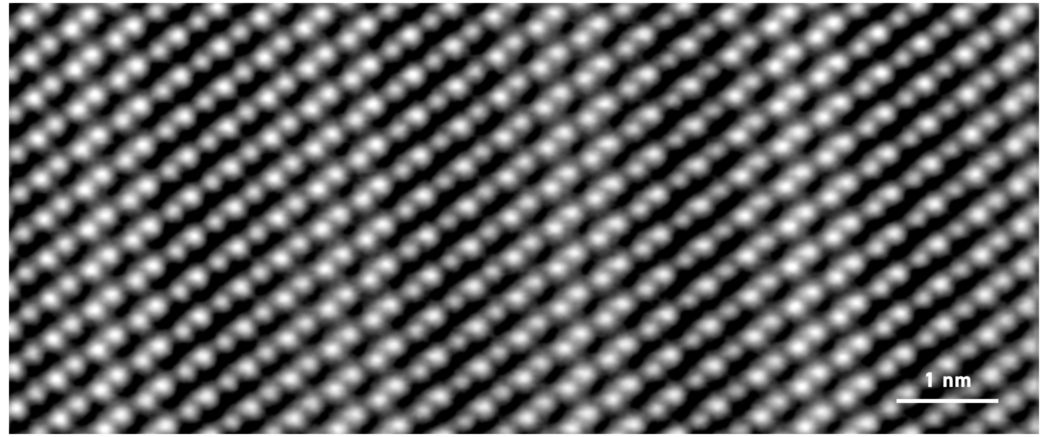
Since ehrigite was accepted as a new mineral by the International Mineralogical Association Commission on New Minerals, Nomenclature and Classification, the same team has also used TEM to also officially define clogauite, and are now doing the same for two further new minerals, with applications to the Commission expected in 2026.

C. Ciobanu et al., The Canadian Journal of Mineralogy and Petrology 2024. DOI: 10.3749/2400023

N. Cook et al., Mineralogical Magazine 2024
DOI: 10.1180/mgm.2024.46



A/Prof. Cristiana Ciobanu, Prof. Nigel Cook and Dr Kathy Ehrig with the transmission electron microscope at Microscopy Australia's Adelaide University Facility, Adelaide Microscopy.



Transmission electron microscope image shows the relative positions of atoms (white dots) in crystals of ehrigite, where the larger, brighter dots are bismuth and the smaller dots are tellurium.

6

ENGINEERING THE FUTURE WITH DNA DINOSAURS

Dr Minh Tri Luu and A/Prof. Shelley Wickham using the transmission electron microscope at Sydney Microscopy & Microanalysis. © Stefanie Zingsheim, The University of Sydney

CHALLENGE

Modern science is pushing the boundaries of what's possible at the nanoscale. One of the most ambitious goals is to create molecular robots – tiny machines built from biological materials that can perform tasks inside the body or help manufacture new materials. A promising approach is DNA origami, which uses the natural folding properties of DNA to build custom nanostructures.

However, current methods face major hurdles, including:

- **Low efficiency in assembling large, complex structures.**
- **Limited flexibility in changing shapes once built.**
- **High costs and time for designing new configurations.**

To truly enable advanced applications like targeted drug delivery or smart materials, researchers need a way to build complex, reconfigurable DNA nanostructures quickly and reliably.

RESEARCH

A team at the University of Sydney Nano Institute, led by Dr Minh Tri Luu and A/Prof. Shelley Wickham, has made a breakthrough. Published in Science Robotics, they have developed modular DNA origami "voxels"—tiny building blocks that can be assembled like 3D LEGO.

Their innovation lies in a "velcro" DNA system: each voxel has programmable binding sites that only connect with matching partners through DNA base pairing. This allows for precise, high-yield assembly of diverse shapes, demonstrated by creating a nano-dinosaur, a dancing robot, and even a mini-Australia just 150 nanometres wide.

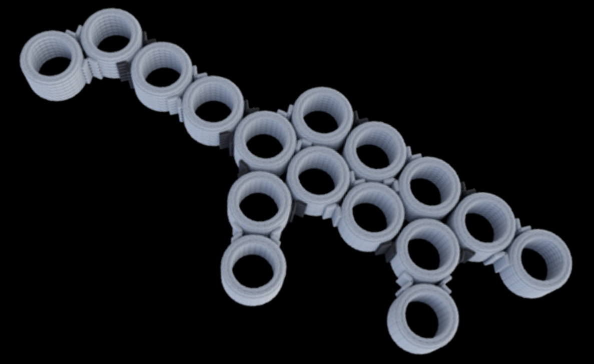
Even more impressive, these structures can be reconfigured on demand. The team demonstrated that they could switch shapes rapidly and reversibly, a key step toward adaptive molecular robots. They also developed an assembly process that increased yields by 100-fold, making previously impossible designs achievable.

This pioneering research was made possible by Microscopy Australia's University of Sydney facility, Sydney Microscopy & Microanalysis. At only 30 nm across, the voxels are far too small to be seen with conventional microscopes. Advanced techniques, like cryo-transmission electron microscopy, were used to reveal the structure of the voxels in 3D. It was also crucial in evaluating the shape and rigidity of the voxels, and confirming design accuracy and assembly success.

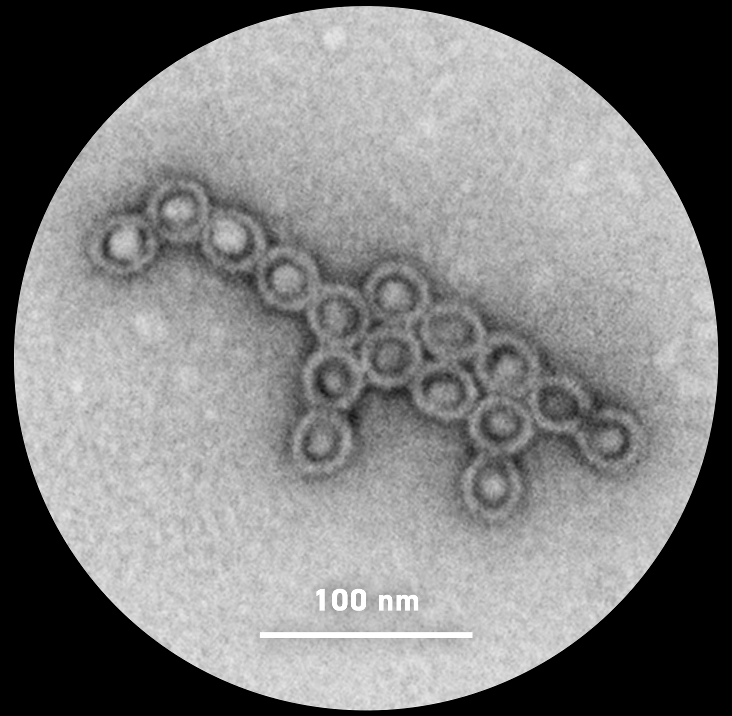
IMPACT

This breakthrough in modular DNA origami offers a powerful new platform for building and reconfiguring nanoscale structures with speed and precision. Inspired by the principles of protein folding, the research provides fresh insight into how complex molecular systems can self-assemble, paving the way for smarter, more adaptive nanotechnologies. The potential applications are far-reaching, with the team now exploring applications from targeted drug delivery systems that minimise side effects, to smart materials that respond to their environment, and energy-efficient optical technologies. This work lays the foundation for innovations across healthcare, smart materials, and advanced manufacturing.

M. T. Luu et al., Science Robotics 2024
DOI: 10.1126/scirobotics.adp2309



3D model of DNA origami voxels (round shapes) connected into the shape of a dinosaur using programmable binding sites.



Cryogenic transmission electron microscope image of the DNA origami dinosaur. It is similar in size to a typical virion – a single viral particle.

7

NEW EXPLORATION TARGETS FOR CRITICAL MINERALS

CHALLENGE

The transition to Net Zero requires more of metals such as copper, rare earth elements and cobalt than are currently available from known types of mineral deposits, so new sources need to be found. The more we know about the different ways in which these minerals might be formed, the more likely it is that we can find new sources that may not yet have been explored.

RESEARCH

New results from researchers at the Australian National University (ANU), Macquarie University and the University of Western Australia, with international collaborators, predict probable locations for critical minerals: essential for the metals that enable a green economy.

Published in Nature, their most recent findings identified that critical metals appear to accumulate close to the edges of dense, heavy parts of the continental crust called cratons. This builds on earlier work from ANU, Geoscience Australia, and collaborators at Cambridge and Harvard Universities.

Molten rock ('melts') in the Earth's mantle flows upwards and outwards around the edges of these cratons towards the surface, making volcanic activity more common there.

As part of an ARC Laureate program, led by Prof. Stephen Foley with the assistance of Dr Chunfei Chen, lab-based high pressure experiments were conducted enabling identification of the mechanisms by which the critical metals accumulate where they do. It was known that at depths of 150-250km the mantle is composed of carbonated silicate melts. The new experiments reacted this type of melt with fragments of solid mantle rock from the base of the cratons, and showed that this interaction causes the silica content of the melt to fall, leaving almost pure carbonate in the molten material. It is these molten carbonates that move up and around the edges of the cratons, carrying the critical minerals with them. As they do so, the critical metals drop out as sulfide minerals. These minerals are now positioned in regions prone to volcanic activity so when volcanoes do occur, the accumulated metals are carried to the surface, where they solidify.

Analysis of the experimental products with scanning electron microscopy at Macquarie University, and an electron microprobe at Microscopy Australia's ANU facility revealed the chemical changes that occur when the rocks and melt interact. This allowed the team to work out the processes occurring in the Earth's mantle deep beneath the cratons.

Prof. Foley explained that the relatively young carbonate-bearing volcanic rocks formed by this process appear in linear arrangements around the old cratons and provide new and exciting targets for mineral exploration. Currently, most known deposits are found in much older rocks but most of those have already been discovered.

IMPACT

Potential new sources of critical minerals will be of significant economic importance as we move towards achieving Net Zero. There are many sites in Australia, particularly in WA and NT with the geology described above that could be explored for critical minerals to enhance our sovereign capability and potential export markets.

C. Chen et al., Nature 2025
DOI: 10.1038/s41586-024-08316-w
Correction DOI: 10.1038/s41586-025-08911-5

Images: Dr Chunfei Chen and Dr Slava Shcheka conducting a high-pressure experiment. Behind this is an aerial image of a major mining project within a craton in Australia (Google Earth © 2025 AirBus).

PUBLISHED IN NATURE

8 NEW CLOTTING MECHANISM EXPLAINS ORGAN DAMAGE

In heart attacks, stroke, sepsis and severe COVID-19, the tiniest blood vessels in the body become blocked. This stops oxygen getting through to the tissues, ultimately leading to serious organ damage or death.

A large team at the University of Sydney, including Dr Mike Wu, Imala Alwis and Ethan Italiano have investigated the process leading up to this organ damage and discovered a previously unknown clotting mechanism that occurs in these micro blood vessels. Their findings could lead to possible new ways to treat these serious diseases.

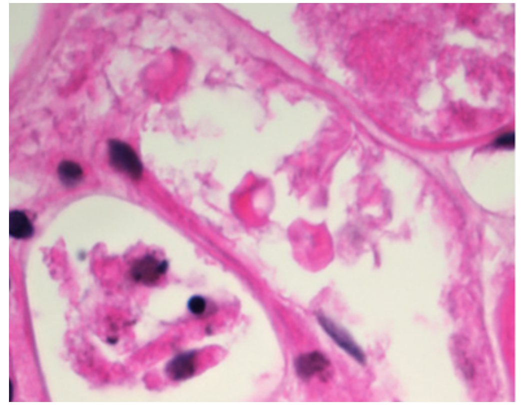
The lack of oxygen and nutrients damages a range of tissues and organs, including the micro blood vessels themselves, causing them to get leaky. The team found that once the endothelial cells that line the blood vessels become damaged, a chain reaction ensues that causes surrounding red blood cells to burst open like balloons. Their sticky remnants then pile up on the damaged endothelial cells, preventing bleeding from the area. However, this process can go too far and the sticky clot can grow big enough to block the micro blood vessels, causing further tissue damage.

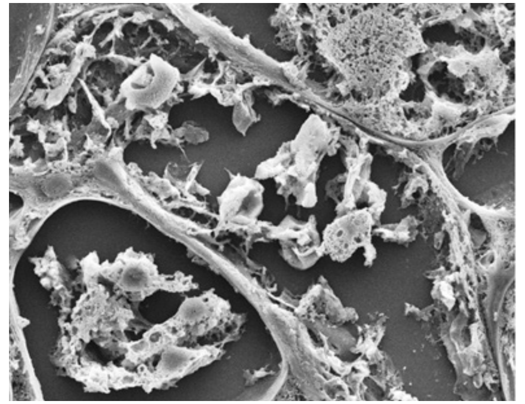
The team used multiple human and mouse samples to investigate major human diseases associated with organ damage, including severe COVID-19, heart transplantation and ischemia-reperfusion injury. Extensive multimodal microscopy techniques at Microscopy Australia's University of Sydney facility were used to unravel the details of this new clotting mechanism.

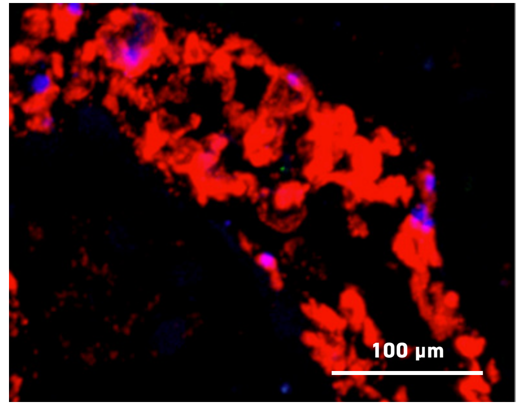
Their findings also explain why treatments that target only conventional forms of blood clotting are not always successful in treating these diseases, especially later in the process. The additional secondary clotting step could be another pathway that could be targeted with new forms of treatment. The challenge here, would be to strike a balance between blocking up the leaks from the damaged blood vessels without clogging our most vital micro blood vessels.

M. Wu et al., Nature 2025
DOI: 10.1038/s41586-025-09076-x

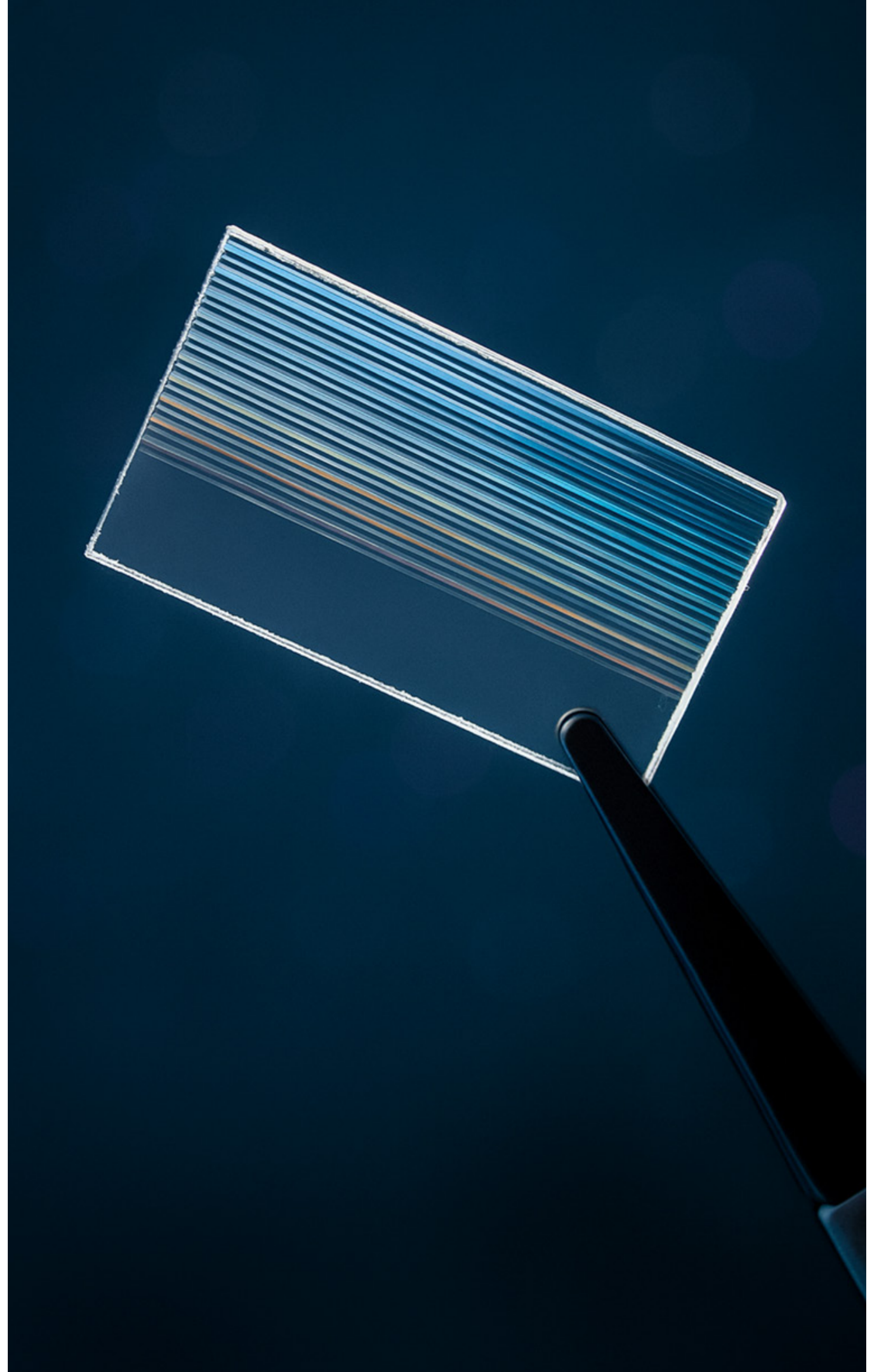
PUBLISHED IN NATURE







Images: Multimodal imaging showing light microscopy (top), scanning electron microscopy (middle), and confocal fluorescence microscopy (bottom) all visualising damaged red blood cells (RBCs) becoming deposited on the blood vessel walls. In the top two images, these damaged RBCs are the fairly formless wispy structures and in the bottom image the damaged cells are indicated by the intense red staining.



9 ALDENTE GLASS

A team of researchers has developed a precise method for designing glass with properties tailored for quantum and optical communications. This innovation enables the creation of ultra-efficient photonic circuits: devices that use light instead of electricity to transmit information.

The collaboration between Dr Toney Fernandez, Dr Simon Gross, and Prof. Michael Withford from Macquarie University, and Dr Karen Privat from Microscopy Australia's UNSW Sydney facility, resulted in a process that allows fine control over the chemical properties of glass, enabling the fabrication of vastly improved waveguides – tiny channels that guide light with minimal loss.

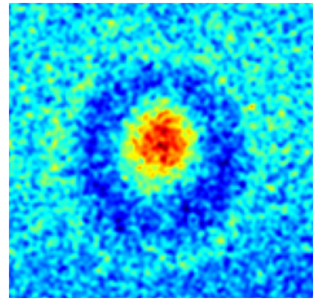
Waveguides are essential components in photonic circuits. They work by creating a path with a different refractive index than the surrounding material, effectively trapping and directing light. These channels are formed using ultrafast laser treatment, and their shape is critical: the rounder the channel, the better it performs. Thanks to the team's optimised glass recipe, these channels are now significantly more circular, resulting in exceptionally low light loss.

This advance supports the development of complex 3D photonic chips that outperform traditional electronic chips. Along with quantum computing, such chips are vital for energy-efficient, high-speed computing which is becoming increasingly critical as AI adoption drives demand for faster, scalable data processing.

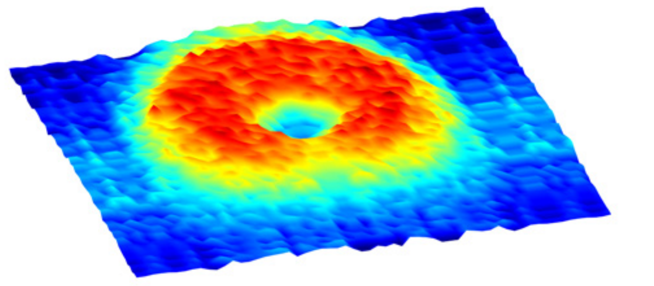
Microscopy Australia enabled access to the advanced techniques of electron microprobe analysis and spectral cathodoluminescence which, when combined with Dr Privat's expertise, were key to understanding and refining glass composition. They allowed the glass to be optimised for both production and performance. The most optimal recipe generates what they call "Aldente" glass, ideal for ultra-low loss photonic chips and ultrafast laser inscription.

Modular Photonics, a Macquarie University spin-out, is now commercialising Aldente glass (patent pending). The 2021 publication of the team's findings attracted attention from global glass manufacturer Schott (Germany), which has recently secured a non-exclusive licence from Modular Photonics to use the technology. Other companies are also showing interest in this Australian innovation. The Australian National Fabrication Facility also contributed to this project.

T. Fernandez et al., Adv. Functional Materials 2021
DOI: 10.1002/adfm.202103103



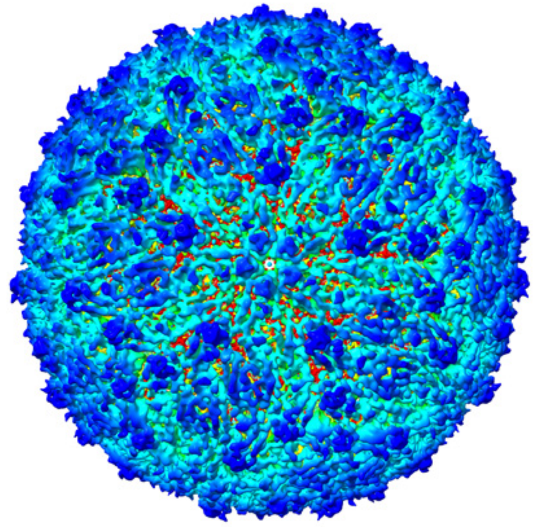
Electron microprobe image revealing structural/compositional variations in the waveguide area.



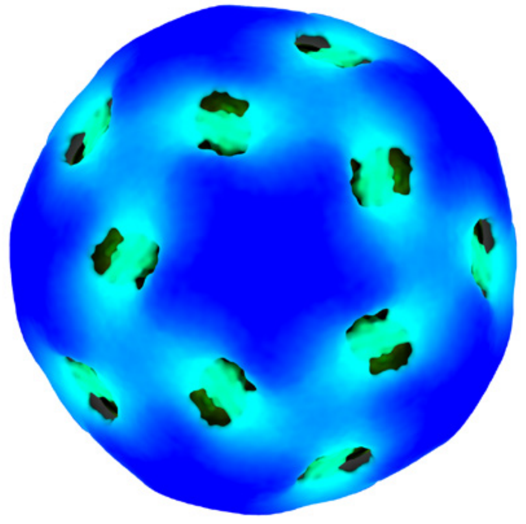
Spectral cathodoluminescence image of the waveguide in glass allows location and identification of various defects formed by interactions of the ultrafast laser with the glass matter interactions.

10

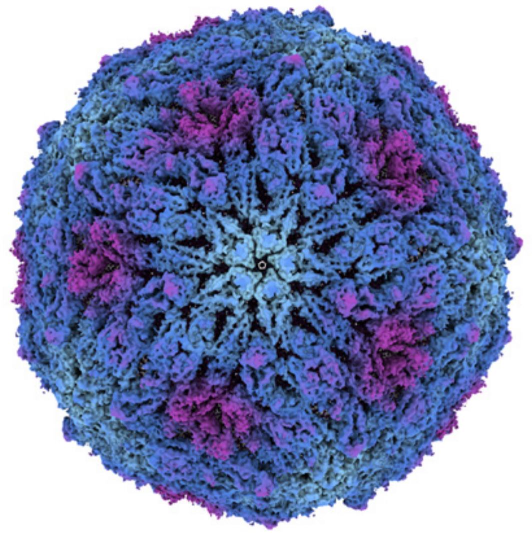
SECRETS OF YELLOW FEVER VIRUS REVEALED



Detailed cryo-EM structure of the vaccine strain. ~40 nanometres wide.



Cryo-EM of the virulent strain. The surface is too flexible to be imaged in detail by cryo-EM.



Cryo-EM of the virulent strain with the mutant amino acid replaced by that from the vaccine strain.

CHALLENGE

Yellow fever is re-emerging as a serious disease threat, moving into urban areas of tropical and sub-tropical Africa and South America. It is caused by a mosquito-borne flavivirus that can lead to severe liver disease and, in some cases, death. Although researchers have been investigating the yellow fever virus for over a century, its structural details remained elusive. There are no approved drug treatments for yellow fever, and it is mainly controlled by mass vaccination campaigns with a non-infectious version of the virus. However, the strain currently used to make the vaccine is not proving to be as effective against emerging virulent strains of the disease as it has been in the past. A better understanding of the viral structure could help reveal the cause and a potential solution to this problem.

RESEARCH

The first high-resolution structures of yellow fever virus have been revealed by cryo-electron microscopy (cryo-EM) at Microscopy Australia's University of Queensland (UQ) facility. A collaborative team led by Drs Summa Bibby, James Jung, Naphak Modhiran and Prof. Daniel Watterson at UQ, created a hybrid flavivirus based on the harmless Binjari mosquito virus. The Binjari core was coated with surface proteins from different strains of yellow fever virus. The cryo-EM data revealed surprisingly stark differences between the surface appearance of the vaccine strain and the virulent strain currently infecting people. The surface proteins of the two strains were known to differ by several amino acids and the cryo-EM structural studies made it clear that just one of these was responsible for the large structural changes in the two strains.

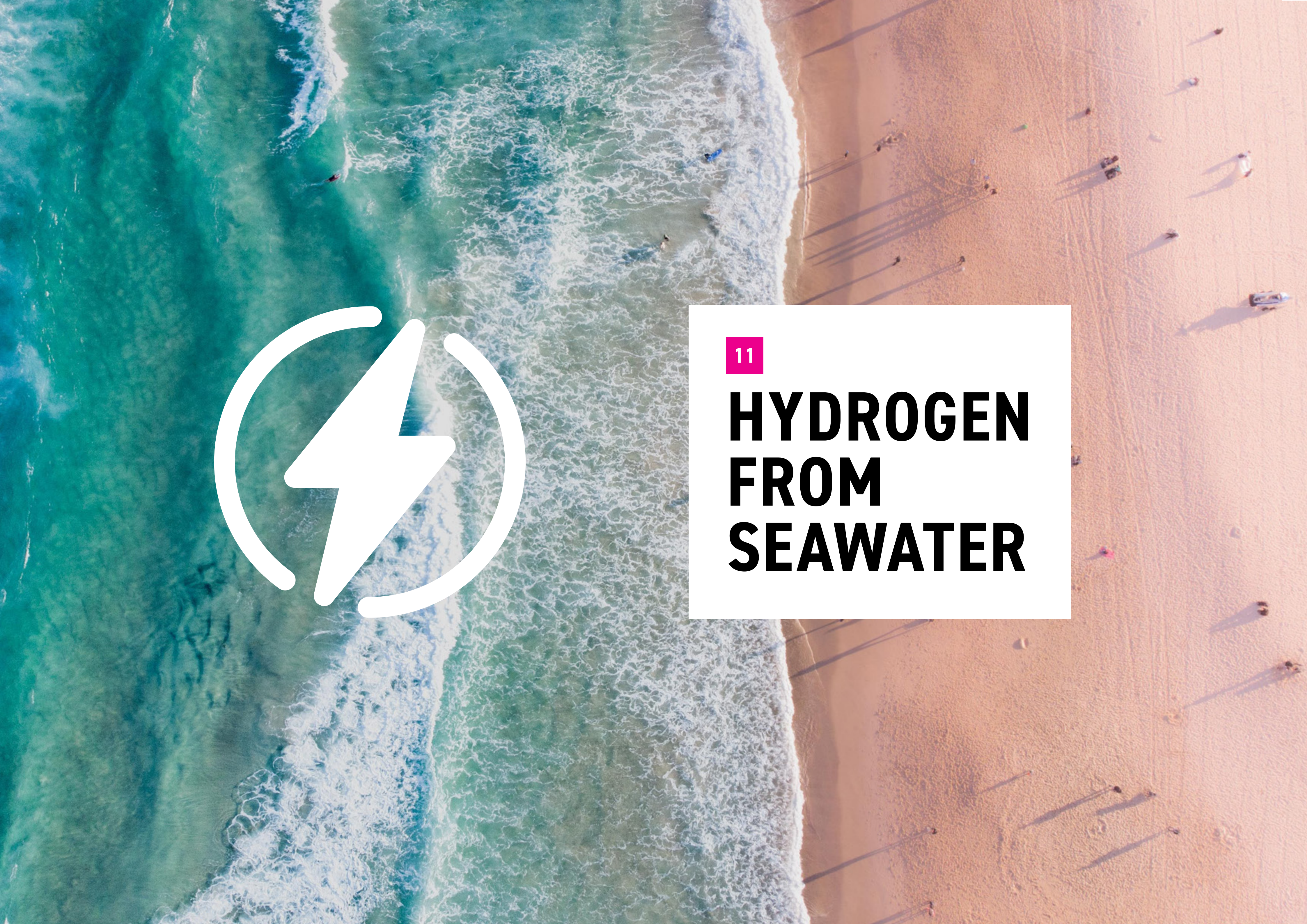
Cryo-EM is a powerful tool with which researchers could identify not only the structure of the yellow fever virus surface protein but also how the 180 individual copies of it fit together on the outside of each virus particle. Cryo-EM also enabled the team to determine how and why that one amino acid caused the altered structure. In the vaccine strain, all the different surface proteins lock together in a stable arrangement, mediated by that one amino acid. However, in the virulent strain, that single amino-acid difference prevents the proteins from locking together properly. This leaves them unconstrained and free to wave around on the surface. This in turn presents a surface that looks quite different to what the patient's immune system has been prepared for by the vaccine. It is therefore not surprising that the current vaccine is less effective against the virulent strains.

IMPACT

These findings have provided crucial knowledge that will enable the research team to design more effective yellow fever vaccines and ones that don't rely on a live, although inactive, virus. Potentially this knowledge could also enable development of valuable treatments. These outcomes will help to:

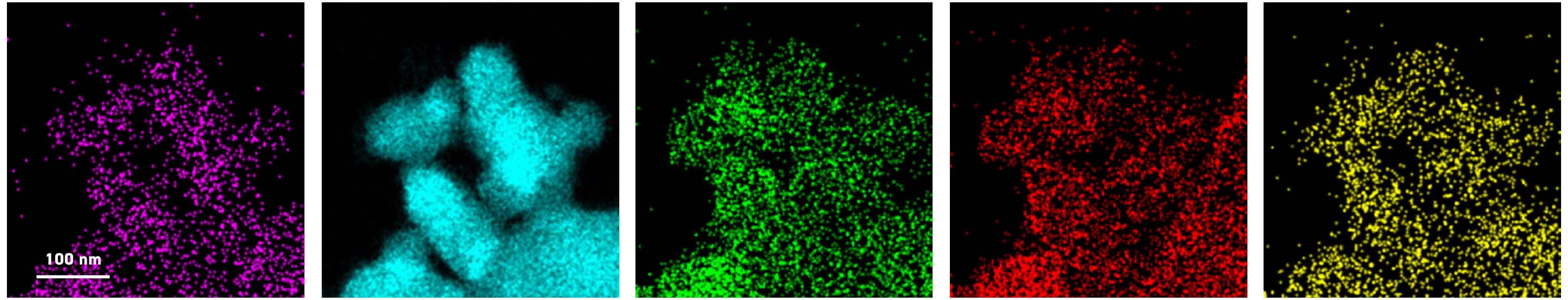
- prevent and possibly treat outbreaks to protect vulnerable populations
- build vaccine capability made in Australia
- provide opportunities to translate this research into new business and exports for Australia

S. Bibby et al., Nature Communications 2025
DOI: 10.1038/s41467-025-63038-5

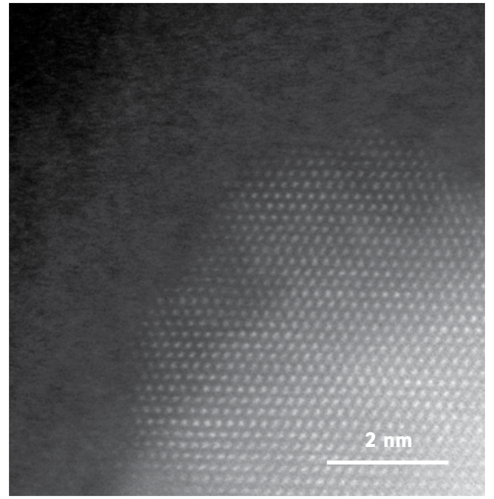


11

HYDROGEN FROM SEAWATER



Scanning transmission electron microscope with energy-dispersive X-ray spectroscopy confirming the elements present in the nanoparticles (L–R: Cobalt, copper, nitrogen, carbon, potassium).



Atomic-scale transmission electron microscope image showing the regular crystal structure of the copper core of a nanoparticle surrounded by a faint fuzzy coating made up of the non-crystalline carbon–nitrogen–cobalt shell.

CHALLENGE

Hydrogen has a central role to play in the green energy transition, and Australia's Hydrogen Strategy aims to place us at the forefront of the hydrogen economy. Now, an efficient catalyst that converts seawater into hydrogen using only sunlight could help enable this transition.

Traditionally, hydrogen production uses electricity to break water molecules apart into hydrogen and oxygen. This is normally done using a source of fresh water. As freshwater resources become increasingly scarce, however, seawater presents an attractive alternative – if it can be effectively harnessed. Furthermore, approaches that eliminate the need for electricity and instead rely on catalysts could significantly enhance the sustainability and energy efficiency of hydrogen production.

RESEARCH

The researchers, led by Prof. Zongyou Yin at the Australian National University, in collaboration with experts at our UNSW Sydney facility have met these challenges. They designed and constructed unique and intricate catalyst nanoparticles consisting of copper spheres coated with a layer of nitrogen and carbon that also contains dispersed single atoms of cobalt. Sunlight interacts with the particles to make them very reactive and efficient at splitting water into hydrogen and oxygen. These particles don't need the rare and expensive precious metals that many other approaches depend on and are also exceptionally stable in the long term.

The superior performance of these unique catalytic nanoparticles is due to two key factors. Firstly, the enhancement of the reaction by sunlight. Secondly, the reaction is further enhanced by the salts in the seawater.

The efficiency of the catalysts relies on the atomic configuration and interactions between the copper and the cobalt at the nanoscale. Accurate high-resolution imaging and elemental analysis were essential to confirm the composition and to visualise the structure of the nanoparticles. Amongst a suite of analytical techniques, the team used the atomic-scale transmission electron microscope at our UNSW Sydney facility.

IMPACT

These catalytic nanoparticles have the potential to be translated into a sustainable technology to enable the production of green hydrogen from just seawater and sunlight.

Z. Sun et al., Advanced Materials 2025
DOI: 10.1002/adma.202406088

12 NEXT-GENERATION BATTERY OUTPERFORMS LITHIUM-ION

Australia is on a path to a renewable energy future, but storing this energy efficiently and safely remains a key challenge. Current lithium-ion batteries, while widely used, are expensive and rely on limited resources. Aqueous zinc–iodine batteries – made from materials abundant in the earth – offer a promising, safer, and more sustainable alternative, but they currently have limited performance.

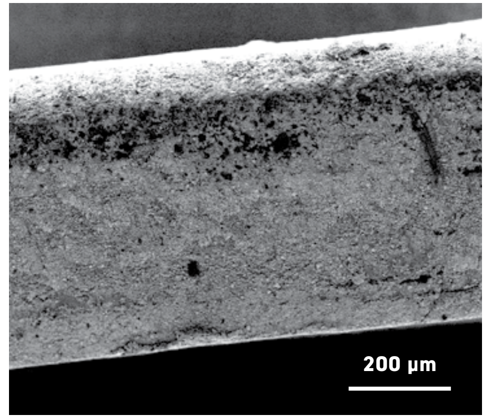
Researchers at the University of Adelaide, led by Prof. Shizhang Qiao, have made a breakthrough in zinc–iodine battery technology. They developed a scalable 'dry electrode' fabrication method that significantly enhances battery performance. This innovation allows for much higher energy capacity, surpassing previous zinc–iodine batteries. The dry method also creates a dense electrode, reducing energy loss and improving stability.

To further boost battery life, the team also introduced a simple chemical, 1,3,5-trioxane. This additive forms a flexible protective film on the zinc anode, preventing dendrites: sharp, needle-like structures that can short-circuit the battery and degrade its performance.

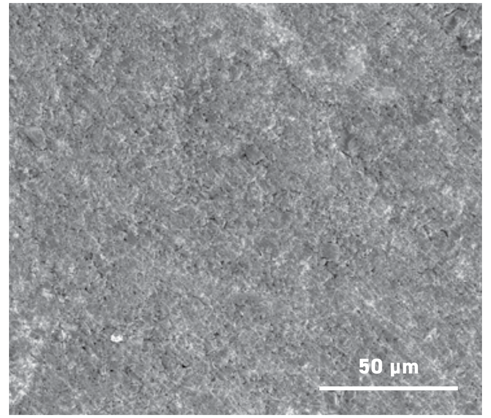
These advances enabled a pouch cell delivering twice the charge per unit of surface area – or areal capacity – of conventional lithium-ion batteries, while retaining 88.6% of its capacity after 750 cycles. This is a significant step towards reliable, low-cost, grid-scale energy storage. Importantly, this dry-processing technique is adaptable to other battery chemistries, broadening its impact.

This research was supported by Microscopy Australia through Adelaide Microscopy's advanced instruments and expertise, which allowed the researchers to closely examine the physical characteristics of battery components. This direct observation revealed that dry-processed electrodes were smoother, denser, and free of voids and cracks compared to their wet-processed counterparts – all important for their performance. Researchers also used microscopy to investigate the formation and stability of the protective film on the zinc surface. These insights were crucial for validating the breakthrough and accelerating the development of next-generation energy storage technologies for Australia.

H. Wu et al., Joule 2025
DOI: 10.1016/j.joule.2025.102000



Cross-section of the dry electrode, imaged using scanning electron microscopy



Surface structure of the dry electrode imaged using scanning electron microscopy

13 THE LAST SUPPER: THE SECRET LIFE OF A 15-MILLION-YEAR-OLD FISH

A remarkable fossil discovery in central New South Wales has revealed a new species of ancient fish, *Ferruaspis brocksi*, which lived around 15 million years ago.

Found at McGraths Flats, these fossils are exceptionally well preserved in a type of iron-rich rock called goethite. This kind of fossil preservation is rare and has revealed more about Australia's prehistoric freshwater rainforest environments.

Thanks to this exceptional preservation, the team led by Dr Matthew McCurry (Australian Museum) and A/Prof. Michael Frese (University of Canberra) was able to determine the stomach contents of several specimens – midge larvae, winged insects, and small shellfish – a similar diet to its modern relatives. Even more extraordinary, they were able to reconstruct the original colour pattern. The fish had a darker back, a pale belly, and two stripes along its sides. One of the fish also had a parasitic freshwater mussel larva, called a glochidium, attached to its tail. *Glochidia* attach themselves to fish to travel through river systems, suggesting that the body of water at McGrath Flats may once have been connected to a larger river network.

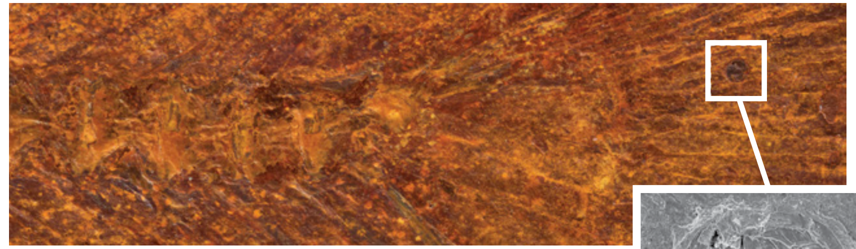
"Using a powerful microscope, we were able to see tiny colour-producing structures known as melanosomes. Fossilised melanosomes have previously enabled palaeontologists to reconstruct the colour of feathers, but melanosomes have never been used to reconstruct the colour pattern of a long extinct fish species," said A/Prof. Frese.

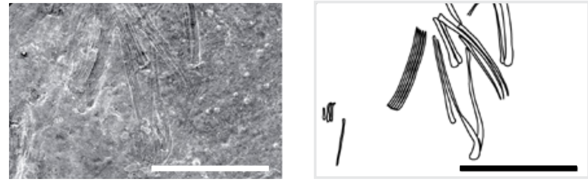
This research was made possible through access to microscopes at the Centre for Advanced Microscopy at the Australian National University, a Microscopy Australia facility. Using scanning electron microscopy and light microscopy, the team uncovered otherwise invisible microscopic details, revealing the species' colour pattern, identifying parasites, and analysing its diet and feeding behaviour.

These details provide a rare glimpse into the diet and habitat of ancient freshwater species related to today's Australian grayling and smelt, and also highlights the critical role of microscopy in unlocking Australia's prehistoric past.

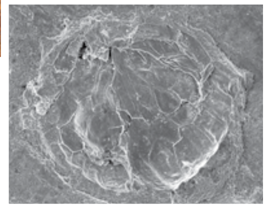
M. McCurry et al., Vertebrate Paleontology 2024
DOI: 10.1080/02724634.2024.2445684

A school of Ferruaspis brocksi is feeding on larvae of the phantom midge Chaoborus abundans while being chased by Obdurodon, an extinct toothed platypus. © Alex Boersma



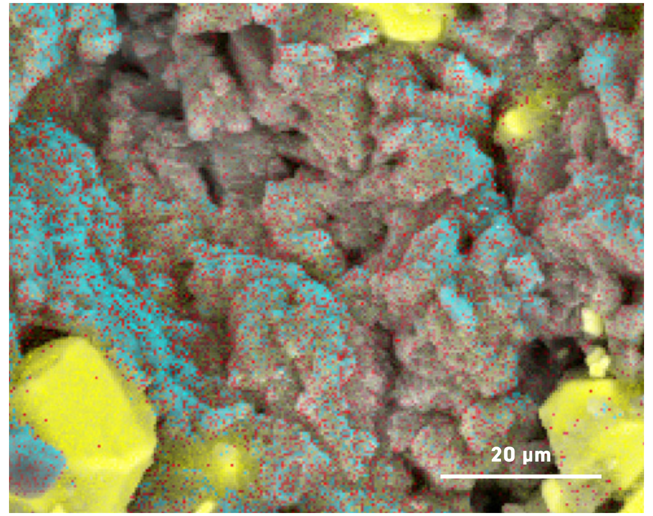


Stomach contents of the fish showing parts of a midge. Scale bar equals 400 μm.



A parasitic freshwater mussel larva attached to the tail of one of the fossil fish.

Dr Lynn Lisboa sorting through electronic waste used in the project. Photo credit: Dr Max Mann



Scanning electron microscope image of the sulfur-based polymer (sulfur: yellow, carbon: blue) showing bound gold (red).

14

GOLD FROM E-WASTE

CHALLENGE

Gold is important in many parts of human life and society: not only as a currency and in jewellery but it is critical in electronics, medicine and aerospace technologies. Unfortunately, gold mining has many negative impacts on the environment such as CO_2 emissions, deforestation, and the use of highly toxic substances such as cyanide and mercury for gold extraction. Mercury in gold mining is one of the largest sources of mercury pollution on Earth. At the same time, gold-containing e-waste from discarded electronics is a complex but largely untapped resource—one that could be harnessed if safe and efficient recovery methods were available.

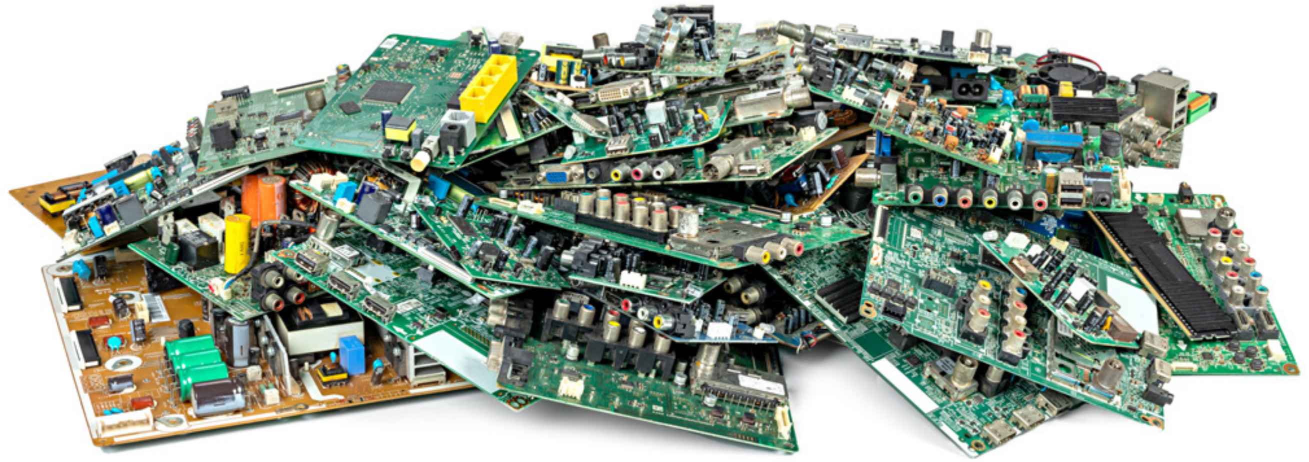
RESEARCH

An interdisciplinary team from Flinders University, led by Prof. Justin Chalker, has developed a safer and more sustainable approach to extracting and recovering gold, both from ore and, importantly, from e-waste.

Their patented process first uses a low-cost and safe chemical compound to dissolve the gold. This is then isolated by binding it to the team's unique polymer. The solubilising chemical, called trichloroisocyanuric acid, is currently used in water sanitation and disinfection. When activated by salt water it can dissolve gold and some other metals. Once dissolved and bound to the unique sulfur-rich polymer beads developed by the Flinders team, the polymer–gold complex can be filtered out of the solution. The gold is then released by triggering the polymer to "unmake" itself back to the monomers, which can then be reused.

The team demonstrated that this integrated method delivers high-yield gold extraction from many sources including printed circuit boards in discarded computers, ore from mines and even the trace gold in scientific waste.

The researchers relied on scanning electron microscopy at our Flinders University facility to visualise the structure of the polymer beads and verify that gold was bound to it. The Australian National Fabrication Facility also contributed to this project.



IMPACT

The team collaborated with partners in the US and Peru to successfully demonstrate that this method would support small-scale mines that would otherwise rely on toxic methods to extract the gold, with the associated potential risks to wildlife and the broader environment. The team plan to work with mining and e-waste recycling operations to trial the method on a larger scale to:

- enable a sustainable value-add for the huge e-waste stream
- provide alternative gold recovery methods that are safer than mercury or cyanide
- provide new manufacturing opportunities and jobs
- support the many uses of gold, while lessening the impact on the environment and human health.

M. Mann et al., Nature Sustainability 2025
DOI: 10.1038/s41893-025-01586-w

"This paper shows that interdisciplinary collaborations are needed to address the world's big problems managing the growing stockpiles of e-waste."
– Dr Max Mann, Flinders University

15 INDUSTRY PARTNERSHIP FOR NEXT GENERATION FERTILISER

Farmers around the world rely on potassium fertilisers, but much of the applied potassium goes unused, often washing out of the soil before it can be absorbed. This inefficiency drives up costs and contributes to overall environmental stress.

A new alternative, polyhalite, is changing that. This naturally occurring mineral fertiliser delivers potassium along with calcium, magnesium, and sulfur in a single product. It avoids the drawbacks of conventional options: it doesn't increase soil salinity like potassium chloride, and it requires minimal processing compared to potassium sulfate. The result is a fertiliser with a low carbon footprint and broad nutritional profile.

Anglo American is producing polyhalite fertiliser in the form of granules (POLY4®). To understand how these perform in real-world conditions, Anglo American partnered with researchers from the University of South Australia (UniSA) and the University of Queensland. Using X-ray techniques at Microscopy Australia's UniSA facility, the team studied how POLY4® and polyhalite chips behave in different soil types compared to standard potassium fertilisers.

Their findings show that both the polyhalite fertilisers release nutrients slowly and steadily, improving uptake and reducing waste when compared to the potassium fertilisers. Once the soluble nutrients are released, the remaining gypsum continues to support soil health. Together, these insights highlight polyhalite's potential as an efficient fertiliser while contributing to healthier, more resilient soils.

16 ANCIENT ORGANISMS RECORD >100 MILLION YEARS OF OCEAN TEMPERATURES

A common marine microorganism could provide new ways to monitor ocean health and understand climate change. A new study led by an international team, including researchers from The University of Western Australia (UWA), has discovered that the microscopic sea creatures have unique characteristics that make them an excellent, long-term recorder of environmental conditions. The organisms are a type of foraminifera called *Textularia agglutinans*. They build a shell around themselves made of sand grains embedded in a calcium carbonate inner shell. The team discovered that the composition of this inner calcium carbonate layer changes depending on the temperature of the water in which the animal grows.

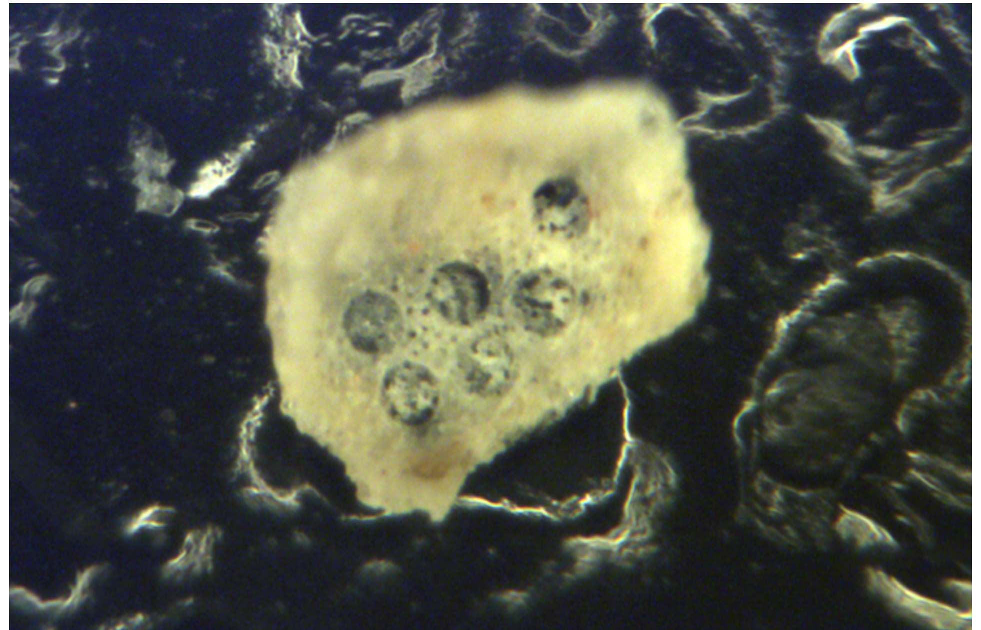
In warmer water more magnesium gets incorporated into the inner shell. Dr Aleksey Sadekov and Dr Hua Li from our UWA facility were part of the research team and used high-sensitivity analytical tools to measure the magnesium. They were able to detect even small changes in levels resulting from just a few degrees of temperature change.

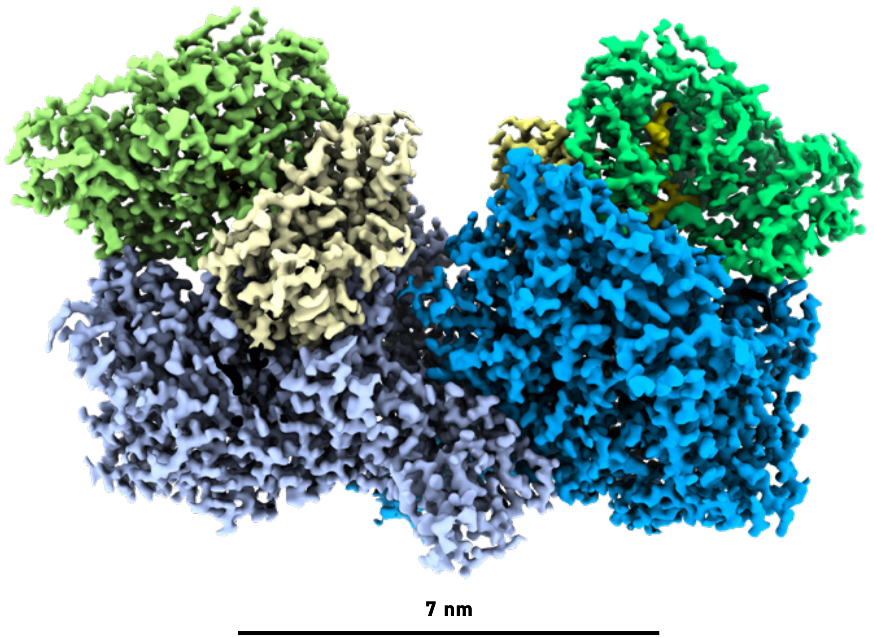
They also measured other elements such as lead, zinc and manganese as these provide a record of pollution from human activity. Their measurements were very consistent, providing excellent reference data for future comparisons.

T. agglutinans lives in shallow coastal waters down to about 120 metres and has existed for more than 100 million years. This is longer than many other types of foraminifera used to measure ocean temperature, which makes this species ideal for connecting present-day coastal observations with deep-time climate history. By measuring magnesium levels in ancient, fossil *T. agglutinans*, researchers can reconstruct ocean temperatures at different time periods – from recent centuries back to the early Cretaceous period.

T. Sosnitsky et al., PNAS 2025
DOI: 10.1073/pnas.2413054122

Below: Light microscopy image of a piece of the inner shell of a T. agglutinans showing the locations (large holes) analysed for elemental composition.





17 CLEARING THE AIR: HOW BACTERIA TURN TOXIC GAS INTO ENERGY

Each year, over two billion tonnes of carbon monoxide is released into the atmosphere from natural and human sources. Despite its toxicity, average concentrations remain low. This is in part thanks to bacteria, which consume around 10–15% of this carbon monoxide annually. However, until now, the intricacies of how bacteria do this was not well understood.

New research from Monash University has solved part of this puzzle. The team revealed, at near atomic scale, how a bacterial enzyme converts carbon monoxide into energy. Led by first authors Dr Ashleigh Kropp and Dr David Gillett, with senior co-authors Prof. Chris Greening and Dr Rhys Grinter, the study revealed that a protein called CoxG acts like an energy courier, transferring power from the enzyme to the cell's metabolic machinery.

This breakthrough was achieved using cryo-electron microscopy, which captured the enzyme's structure in three dimensions at near-atomic resolution. The work was supported by expert platform scientist and co-author Dr Hari Venugopal at the Ramaciotti Centre for Cryo-Electron Microscopy, a Microscopy Australia facility.

The findings provide a clearer picture of how Earth's atmosphere is regulated and underscore the vital role bacteria play in protecting human health and the environment. They also remind us how much there is still to learn about the natural systems that regulate life on Earth.

A Kropp et al., Nature Chemical Biology 2025
DOI: 10.1038/s41589-025-01836-0

Above: 3D reconstruction of cryo electron microscope data showing the bacterial enzyme that oxidises carbon monoxide. This structure is approximately 140 hydrogen atoms wide.

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Large area, high precision and resolution imaging of a zebra fish embryo created by stitching together 64 scanning electron micrographs. By Dr Elliot Cheng and Rick Webb, taken at CMM, the University of Queensland.

FUNDED BY

NCRIS National Research Infrastructure for Australia – An Australian Government Initiative; NSW Government; Queensland Government; Government of South Australia; The Government of Western Australia; Victoria State Government

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