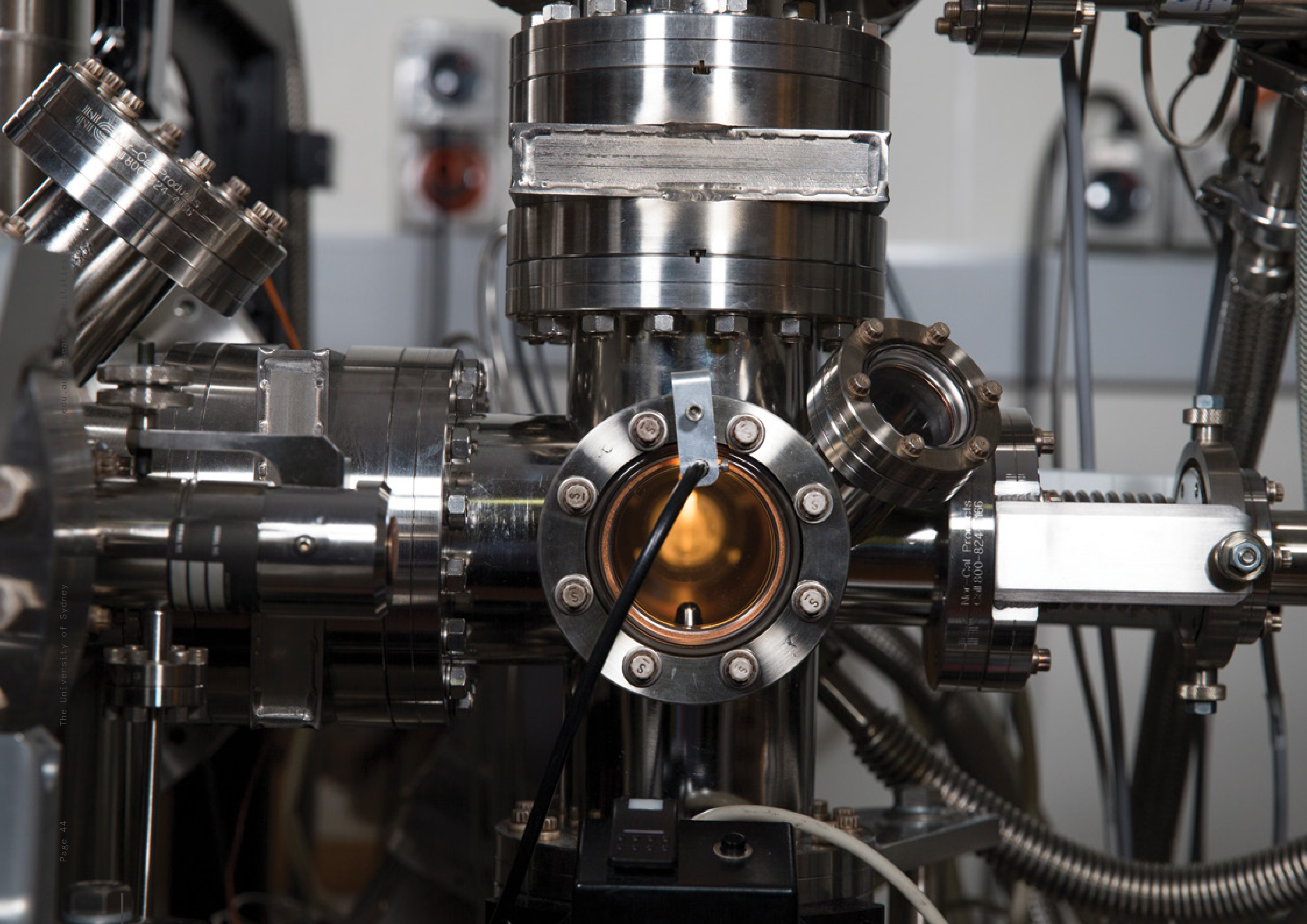
THE UNIVERSITY OF SYDNEY

Core Research Facilities
Sydney Microscopy & Microanalysis
Case Studies



SYDNEY MICROSCOPY AND MICROANALYSIS

Sydney Microscopy and Microanalysis enables insights into how materials work. It explores physical and biological structures at the micro, nano and atomic scale.

New cryo-capability drives research innovation

Steel can become brittle when exposed to hydrogen, and while atmospheric hydrogen is not abundant enough to cause embrittlement, this phenomenon is a challenge for storing and transporting hydrogen fuel sources – which are key to a low carbon emissions future.

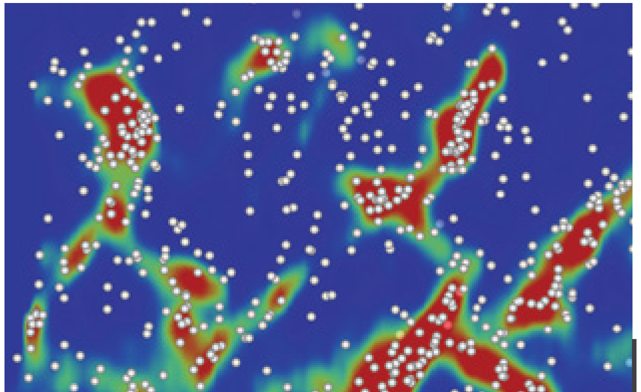
Previous research had observed the unique process of hydrogen accumulation, but up until now researchers have been unable to observe the different microstructural features of hydrogen and steel interactions. A cryogenic sample transfer system established by Professor Julie Cairney and colleagues (School of Aerospace, Mechanical and Mechatronic Engineering, Faculty of Engineering) has made these observations possible and opened up new research into high performance steels, some of which has been published in Science.

The **Sydney Microscopy and Microanalysis** capability provides a cryogenic atmosphere to transfer samples into an atom probe (preventing atmospheric hydrogen from corrupting the samples) for further analysis.

Utilising this ground-breaking technique, researchers have been able to observe that niobium carbides within steel crystals effectively 'trap' hydrogen, preventing it from travelling to a boundary or dislocation within the metallic structures.

This discovery provides a potential path to a solution to the issues currently faced by storage of hydrogen, and the development of embrittlement-resistant steels.

What's more, the cryo microscopy laboratory has built its capabilities over a number of years with successive grants, including a National Collaborative Research Infrastructure Strategy Agility grant in 2017, which enabled the purchase of the cryogenic transfer system. This was followed by an Australian Research Council Linkage Equipment and Infrastructure grant in 2019 to further develop these capabilities.



2-D sliced image of 3-D cryo-APT data. Hydrogen atoms (white) are found to accumulate at microstructural defects of steels that is visualised by the colour-graded carbon concentrations associated with the defects.

MICROSCOPY AUSTRALIA

NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

Find out more

- sydney.edu.au/research/facilities/sydney-microscopy-and-microanalysis

The stars and seas of the Torres Strait Islands

Despite what you feel between your fingers, sand is not a uniform material. Individual grains of sand can be an array of shell and debris and single cell organisms called foraminifera. The composition of sand varies from place to place and can distinguish regions.

In 2020, Indigenous artist, Gail Mabo used the microCT at Sydney Microscopy and Microanalysis to carefully scan individual grains of sand from the beach of Mer (Murray Island), part of the Traditional Lands of the Meriam people.

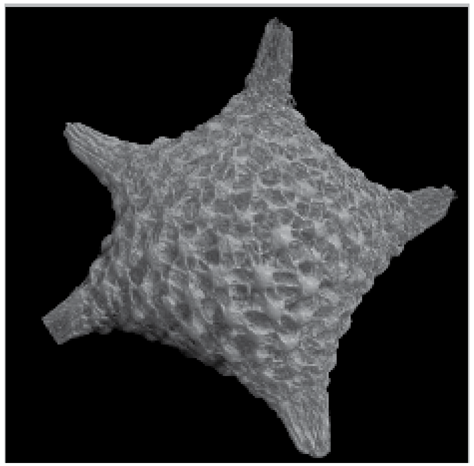
The microCT images revealed the star shaped grains of sand to be foraminifera – a single celled protists, common to shallow water species that form calcium carbonate shells with spindles forming a star shape.

After scanning the sand in the microCT, the image data was processed so that 3D models could be printed of the foraminifera at an enlarged scale. Data processing and sample prints were completed by facility staff in the **Sydney Manufacturing Hub**. Other 3D prints were included in Gail's artwork – a bamboo star-map of the constellation Tagai.

Torres Strait Islander culture and spirituality are closely linked to the stars and the stories of Tagai, whom the Torres Strait Islander peoples recognise as the creator of the world. The knowledge of the stars and sea provide the Torres Strait Islander people with valuable information regarding changes in the seasons, when to plant gardens and hunt for turtles or dugongs, and how to navigate the seas.

Gail Mabo's Tagai artwork was exhibited at the Art Gallery of New South Wales where she was an artist in residence.

Gail Mabo (Australia, b. 1965). Tagai 2020.
Bamboo, cotton, shellac and plastic, 287 x 290 x 15cm
Art Gallery of New South Wales
©Gail Mabo Photo: AGNSW (100.2020)



Rendering of a single grain of sand produced via MicroCT that was used to create 3D prints as part of the Tagai art installation

Ironing out iron imbalance

More than 30% of the world's population lives with an iron imbalance – having too little or too much iron in the blood.

A leading University of Sydney research team led by Professor Hala Zreiqat and Dr Zufu Lu (both School of Biomedical Engineering, Faculty of Engineering) have developed nanoscale probes that allow researchers to monitor iron levels in cells, tissue and body fluids.

Specifically, the team used the two-photon confocal microscope at **Sydney Microscopy and Microanalysis** to measure the depth of the nanoprobes' detectability in biological tissue (observed at 280 micrometres in swine dermis).

The newly developed nanoprobes utilise a fluorescent molecule with negative charges on their surface that preferentially bind to iron ions. When stimulated with UV light, the bound iron interacts with the fluorescent molecules, reducing the fluorescence of the probe. The test is more sensitive and specific than current blood tests for iron disorders, allowing for a more accurate disease diagnosis before the onset of symptoms, potentially allowing for the early treatment and prevention of more serious diseases.

"Our most recent testing demonstrated a rapid detection of free iron ions with remarkably high sensitivity. Iron could be detected at concentrations in the parts per billion range, a rate ten times less than previous nano-probes" said PhD candidate Pooria Lesani (School of Aerospace, Mechanical and Mechatronic Engineering, Faculty of Engineering) who is leading the study.

The University of Sydney

sydney.edu.au/research/facilities
@Sydney_CRF

CRICOS 00026A