The New Australian Gold Rush

High-tech science is helping researchers chase big potential pay-offs in the latest Australian gold rush.

For thousands of years, gold has held a special place in our hearts – and our economies. In Australia, gold was officially discovered in NSW in 1851 and later in the other states.

Now there's a 21st century Australian gold rush. From gold nanoparticles so small that 5000 of them could fit across the width of a single human hair to large-scale mineral processing and exploration technologies, there's money to be made from new gold discoveries.

Just ask Michael Cortie, Catherine Kealley and Jonathan Edgar from the Institute for Nanoscale Technology at the University of Technology, Sydney. They are investigating the formation and growth of gold nanorods, together with Australian company AGR Matthey. The world market for gold nanoparticles in biomedical, pharmaceutical and cosmetic applications is already worth more than $200 million.

Most nanoparticle applications depend on exotic optical properties that vary with particle size, shape and composition. Nanorods exploit the shape-dependence of optical properties, further broadening the range of possible applications.

The UTS researchers are using *in situ* small angle scattering (SAXS) techniques at the Australian Synchrotron to solve some of the mysteries that still surround the synthesis of nanorods. Their aim is to develop ways to synthesise nanorods with optimal properties for specific applications. Synchrotron SAXS offers much better intensity, data quality and time resolution than laboratory SAXS equipment, opening up exciting new areas of research.

"When you're watching nanorods grow *in situ*, the ability to collect information about the system every 5 seconds or so is crucial," Kealley said. "Being able to do this work by travelling interstate rather than overseas means we can come more often, for longer."

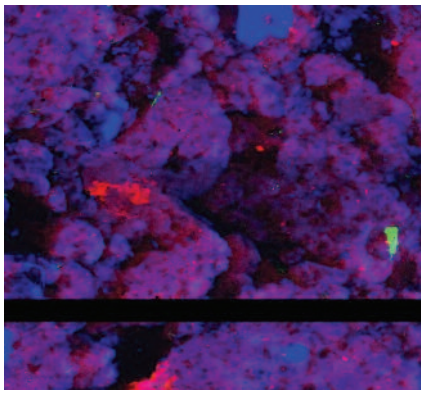
Cortie, who heads the Institute for Nanoscale Technology, has been fascinated by gold–copper–aluminium-based shape memory alloys for 15 years. Gold-based shape memory alloys obviously have potential applications in jewellery manufacture, but their radio-opacity and corrosion resistance also suggest their use in biomedical devices such as stents.

But it wasn't until Cortie came to the powder diffraction beamline at the Australian Synchrotron in October 2008 that he discovered the true nature of the alloy's structure and transformations.

"Over the years I've run plenty of X-ray and neutron diffraction experiments on the material, and have learned much," Cortie said. "When the opportunity came to use the powder diffraction beamline at the Australian Synchrotron I was certainly keen, but perhaps not expecting all that much more.

"How wrong I was. In one nocturnal marathon session of 12 hours or so, the alloy gave up many of its secrets. Pattern after pattern of superb quality scrolled over the screen as we slowly took the alloy up from room temperature into uncharted territory.

"And yes, the results were surprising, and not what I had expected although, with hindsight, entirely logical. These were answers I have sought for over a decade, and which have great practical relevance if the alloy reaches routine commercial production.



Synchrotron image (8000 x 8000 one-micron pixels) showing trace gold (green), rubidium (red) and iron (blue) in a regolith sample.

Image: Chris Ryan and Rob Hough, CSIRO

"With this knowledge, we can now take our alloy in new and exciting directions – and, of course, produce some quality scientific publications. I'll definitely be coming back to the synchrotron."

Making the Most of a Precious Resource

A more traditional user of gold discoveries is the Australian mining industry, which produced A$10.8 billion worth of gold exports in the 2007–08 financial year. Over the past few decades, new exploration technologies and improved processing techniques have boosted the Australian gold industry's performance.

Researchers from around Australia are now lining up to use the unique characteristics of synchrotron X-rays and infrared light to take a micron-scale look at gold-bearing ores, ore contaminants, and even the possible use of gold-munching microbes that could signal the presence of valuable gold deposits.

For example, with the number of gold discoveries in decline, the industry is seeking new technologies to help find gold beneath the regolith, the weathered surface rocks that cover much of Australia. The Australia Synchrotron's new X-ray microprobe and its CSIRO-developed detector will reveal the signatures of buried gold deposits in regolith material at unprecedented scale and resolution.

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