# EXTREME COOKING

**The build-up of scale in your kitchen kettle is annoying but easily fixed. However, you've got a much bigger problem if your kettle is 30 metres high and you're cooking bauxite in caustic soda at high temperature and pressure – like Australia's $12 billion aluminium export industry. Fortunately synchrotron scientists are on the case.**

**Investigating scale: Kia Wallwork helps Matthew Rowles set up his experiment.**

Matthew Rowles was one of the first scientists to use the powder diffraction beamline – the third of nine planned beamlines at the Australian Synchrotron. Rowles, a postdoctoral fellow with CSIRO Minerals, is tackling the issue of scale in the giant pressure cookers used to turn bauxite into alumina.

"Bauxite is cooked in caustic soda at high temperature and pressure to create alumina," he says. "Unfortunately the clays and quartz in the bauxite also react. Over time the cookers get clogged up with scale. It's similar to the problem of scale in a kitchen kettle, but it's expensive to clean."

Rowles used the synchrotron to investigate the reactions that lead to scale. "The next stage will be to look at ways that we can inhibit the reactions," he says. "Small improvements in production efficiency can make a big difference.

"It was exciting to be one of the first users of the beamline – and it worked like a dream," Rowles says. "We turned up, plugged in our equipment and got useful results straight away."

## Reactions You Can Watch

Rowles' CSIRO colleague Nicola Scarlett is using powder diffraction to assist the nickel industry.

"Most of the world's nickel is in laterite ores, but less than 3% of the ore is nickel and that's locked up in a range of minerals," she says. "To retrieve the nickel, the ore is heated to 250°C in sulfuric acid in giant pressure cookers. However, we don't fully understand the chemical reactions that are taking place.

"I can recreate the industrial conditions in a 1 mm diameter quartz glass capillary at the powder diffraction beamline. Using synchrotron light I can make observations of the mineral changes every 2 seconds throughout the duration of the experiment. What we're learning about these reactions will help mining companies understand their processes, making them more efficient."

Scarlett is no stranger to synchrotrons, having used UK and Swiss instruments, but there is a huge advantage to having a synchrotron around the corner. "We were travelling to Europe with 30 kg of specialised equipment. There was always a risk of getting there and discovering that a critical component was missing or damaged and could take weeks to replace."

## Young Scientist Takes Lead

Kia Wallwork's career in synchrotron science has already taken her to Japan, the US, France and Switzerland. And in 2005, just 2 years after completing her chemistry PhD, she was recruited to set up the $5.9 million powder diffraction beamline at the Australian Synchrotron. With the beamline up and running, she now works with visiting scientists to design and carry out their experiments.

Wallwork first became interested in the potential of synchrotron light during her PhD at Flinders University in South Australia. A postdoctoral fellowship took her to ANSTO – Australia's nuclear science organisation – where one project involved using powder diffraction to solve the crystal structure of a uranium-based ceramic material developed by ANSTO as a potential storage medium for radioactive waste.

"In another project we travelled overseas to look at kidney stones to try and better understand their structure, but we couldn't get the answers because the X-rays destroyed the samples too quickly. If we did the same experiment on the powder diffraction beamline at the Australian Synchrotron, I'd expect to get a lot more insight because we have a detector that collects data in less than 1 second. Powder diffraction is ideal for structural investigations when you can't get large single crystals or you want to understand rapidly changing processes."

## Looking Forward

Use of the new beamline will swiftly increase over the coming months, according to University of Sydney chemist Brendan Kennedy, who chairs the beamline's user committee.

Kennedy says researchers will use the beamline for a variety of challenging projects, such as investigating the stability of the small metal oxide crystals used in electronic devices and computer hard disks. Other uses might include looking at how to store hydrogen as fuel in metal–organic molecular honeycombs, how to use similar honeycombs to test for dangerous gases in mines, and how to make better ultrahard materials such as metal nitrides for non-stick surfaces and drill bit coatings. "The potential applications of this beamline are endless," he says.

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