Core Research Facilities

Sydney Analytical Case Studies

THE UNIVERSITY OF SYDNEY

SYDNEY ANALYTICAL

Sydney Analytical is dedicated to materials, chemical and biological analysis. Their instruments are operated across four principal sections: vibrational spectroscopy, x-ray techniques, magnetic resonance, and drug discovery.

Supporting cultural heritage research

Spectroscopic techniques such as those employed at **Sydney Analytical** can be used to analyse samples of unknown origin. This is especially useful in the cultural heritage context for two very distinct and important reasons. As the world changes and adapts, the skills and materials used in the making of heritage objects become lost. Often, only scientific analysis can reconnect us with the past methods and their links to cultural heritage. Spectroscopic techniques are non-destructive to precious objects and, in many cases, portable instruments can be transported to the artefact rather than requiring large and/or precious artefacts to be transported to a laboratory.

For nearly twenty years the Sydney Analytical team have been working with the University's museums on pigments, residues and volatile chemicals.

Today, the expertise at **Sydney Analytical** in cultural heritage analysis is world-class, and the team are working with the Chau Chak Wing Museum to make in-depth spectroscopic research public through exhibitions and publications linked to the "Mummy Project". **Sydney Analytical's** instruments were used to analyse the deteriorated decorations on the outside of an ancient Egyptian sarcophagus to help inform a digital reconstruction, as well as examining some of the contents found inside—including samples of fabric, beads, and resin. This ongoing project is in collaboration with the Chau Chak Wing Museum which champion the use of in-depth spectroscopic research in the museum context.

Most recently, **Sydney Analytical** has collaborated in an Australian Research Council Linkage Project awarded to Dr Jude Philip (Senior curator, Chau Chak Wing Museum) and Dr Elizabeth Carter (Sydney Analytical). The project focuses on using a range of spectroscopic techniques to analyse chemical residues on a unique and rare collection of zoological taxidermy specimens to investigate their history and origins.

Sydney Analytical also boasts specialties in the analysis of early photographic, cinematic and X-ray film. Two types of chemical compounds were used to produce film for cameras, movies and X-rays: cellulose nitrate and cellulose acetate. Cellulose nitrate is extremely flammable and unstable, especially as it degrades over time. As such, identifying films made of cellulose nitrate is vital for safety and preservation. **Sydney Analytical** have worked closely with the Australian National Maritime Museum and Brad Swarbrick (School of Chemistry, Faculty of Science) to develop a method that allows for the rapid identification of different film types using infrared spectroscopy to aid galleries, libraries, archives and museums with this material in their collections. These results were recently published in the journal of *Heritage Science*.

Australian Government | ANSTO

Find out more

- sydney.edu.au/research/facilities/sydney-analytical

Developing new drugs to fight Alzheimer's disease

Dementia is the second leading cause of death in Australia with one of the most common forms of dementia being Alzheimer's disease. Alzheimer's disease disrupts the neuronal cells in the brain, leading to progressive loss of memory, language, reasoning, and social behaviour.

While the cause of Alzheimer's disease remains unknown, the molecular and cellular changes that take place in the brain have been well studied, with recent attention being directed to the role of the tau protein. Tau proteins play an important role in the function of healthy neuronal cells, but under some conditions will 'misbehave' and start to stick to each other, forming clumps or neurofibrillary tangles which are the hallmark of Alzheimer's Disease.

Untangling tau

Professor Michael Kassiou and his research team including Dr Jon Danon (both School of Chemistry, Faculty of Science), are researching and developing a new drug that targets the tau protein in Alzheimer patients. The project is focused on a natural product, altenusin, which has been shown to powerfully inhibit tau protein aggregation "in the test tube" but did not have the required properties to penetrate or operate within living neurons. Traditional medicinal chemistry approaches to modify the molecule yielded limited results, so the group turned to the *Fragment-based Drug Design* service offered by **Sydney Analytical**.

Fragment based drug design starts with a library of 1200 molecular 'fragments', testing each one against the targeted segment of the protein. The results provided several fragments that could be 'grafted' into the original molecule, resulting in a drug with greatly enhanced properties for both binding to tau and penetrating the cell.

This important discovery is a critical step on the path to a potential new treatment for Alzheimer's disease and has already generated commercial interest. The next stage of this project is to test the new hybrid drug in animal disease models for effectiveness.

> "The FBDD service provided us with a platform to explore new chemical space that we would not have explored otherwise. Results from the screen directly facilitated the development of new potential drugs that may be used in dementia treatments."

Professor Michael Kassiou

Precision measurement helps discover new material

Coordination frameworks are a new class of materials made up of metal atoms or clusters bridged by organic molecule struts or 'linkers'. Between these linkers are tiny molecule-sized holes, or 'nanopores'. These materials have wide-ranging applications for energy storage molecular sensing and catalysis.

Professor Deanna D'Alessandro's research group including Eleanor Kearns and Lyndon Hall (School of Chemistry, Faculty of Science) have developed a new class of coordination frameworks and, worked with Sydney Analytical to identify and examine their creation.

Normally these linkers are relatively inert, but Professor D'Alessandro's group have developed a class of coordination frameworks in which the linkers can reversibly react with each other under light irradiation, leading to profound differences in the electrochemical, optical and mechanical properties of the material.

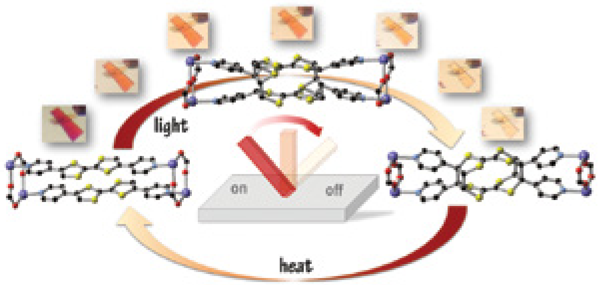
Measuring this new material

To measure and reaffirm this new phenomena, the **Sydney Analytical** team designed custom rigs to measure the material's structure whilst irradiating samples with light in a controlled way. They used X-ray diffraction to elucidate the structural changes, and Raman spectroscopy to study the progress of the reaction.

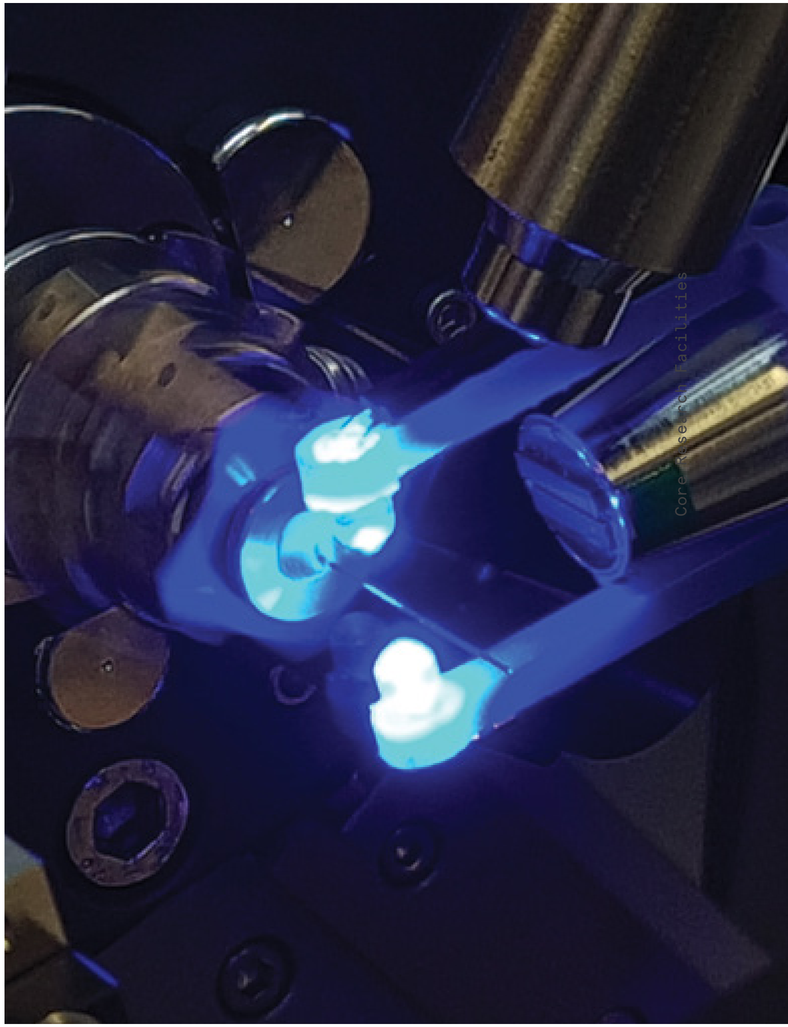
The ground-breaking work was recently published in *Nature Communications* and the team has a provisional patent on the material.

> "Support from Sydney Analytical staff has been invaluable [...] The Vibrational Spectroscopy labs within Sydney Analytical are unique within Australia and offer the opportunity for staff and students to use sophisticated instrumentation under the guidance of expert and dedicated staff. These capabilities truly allow us to 'push the envelope' with our science."

Professor Deanna D'Alessandro



Graphic illustrating the reversible change in structure of a coordination framework with irradiation by blue light.



Custom set up by Sydney Analytical to irradiate samples while simultaneously measuring the molecular structure by X-ray diffraction.

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