Sydney Analytical

Core Research Facilities

THE UNIVERSITY OF SYDNEY

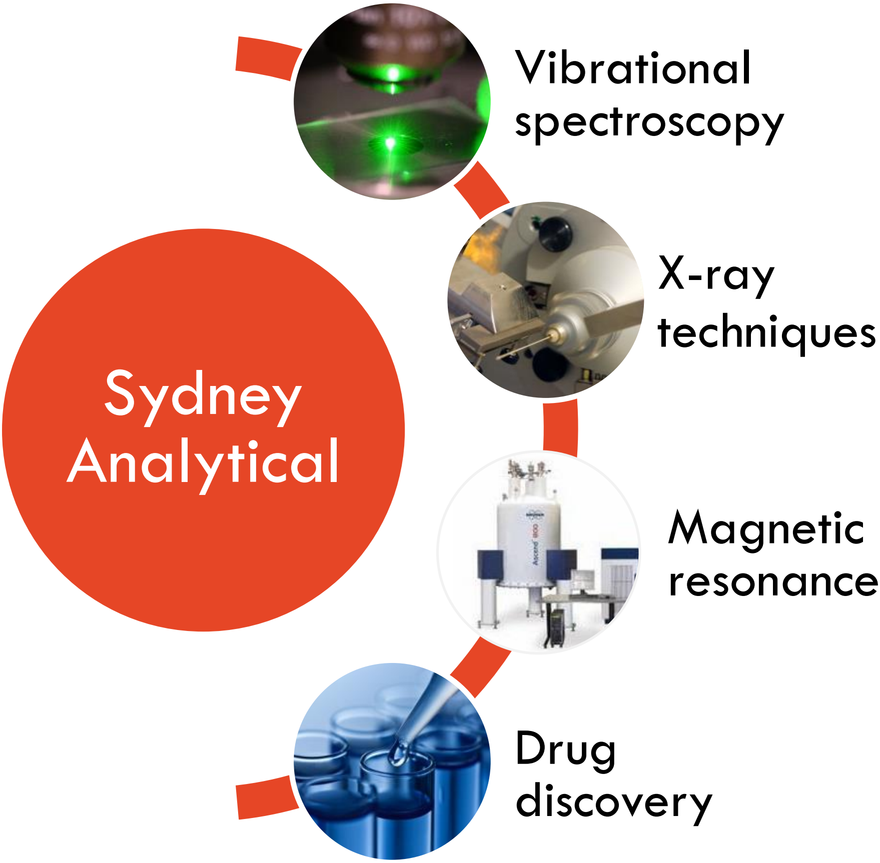
Director's Welcome

Peter Lay
Academic Director
Sydney Analytical
Core Research Facilities

Sydney Analytical is a multidisciplinary facility supporting research excellence across the University. Its state-of-the-art research infrastructure will support University research and development in fields spanning: nanoscience; clinical medicine; medical and life sciences; chemistry; physics; agricultural, environmental and veterinary sciences; engineering, pharmaceutical sciences; geosciences; and museum and cultural studies.

With over 30 high-end instruments, many of which are the most advanced of their kind in Australia, Sydney Analytical has already begun to engage extensively with industry, including a collaboration with ANSTO to support neutron and synchrotron research.

sydney.edu.au/sydney-analytical


Sydney Analytical
Vibrational spectroscopy
X-ray techniques
Magnetic resonance
Drug discovery

Sydney Analytical

Vibrational spectroscopy

- Infrared and Raman spectroscopy
- Non-destructive analysis
- Portable equipment
- Macro → Nano capabilities
- 2D and 3D mapping, imaging, depth profiling
- Controlled-environment techniques
- Cutting and polishing capabilities

X-ray techniques

- Powder and single crystal diffraction
- Small angle X-ray scattering
- X-ray Photoelectron Spectroscopy/Ultraviolet Photoelectron Spectroscopy
- Portable and benchtop X-ray Fluorescence
- Controlled-environment techniques

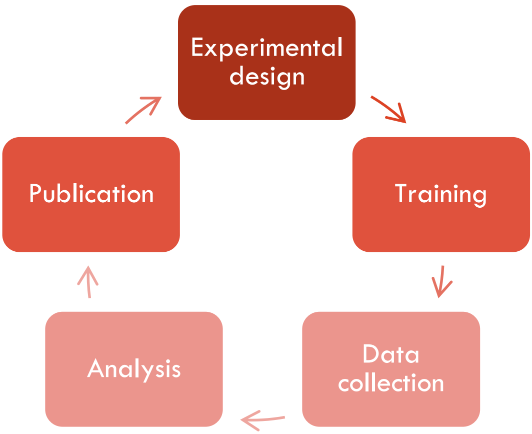
Drug discovery

- Protein expression and purification services
- Bacterial, insect, and mammalian cell expression
- Advice on protein production
- Protein crystallography
- Fragment based drug design
- Automation and robotics
- Cyclic peptide display screening

Magnetic resonance

- Reaction mechanisms and kinetics
- NMR metabolomics analysis
- Multi-nuclear chemical characterisation
- Non-destructive and quantitative
- 3D structure determination at atomic resolution
- Electron paramagnetic resonance (EPR)
- Temperature dependant studies

Expertise and Services



Sydney Analytical provides a range of services and expertise to assist researchers with all stages of their project starting with experimental design right through to publication. We can advise on external capabilities available to researchers such as beamlines at the Australian Synchrotron through ANSTO.

Grant Advice

Sydney Analytical staff can also provide specific information about instrumentation, expertise and pricing to assist in the preparation of grant applications.

Access our facilities

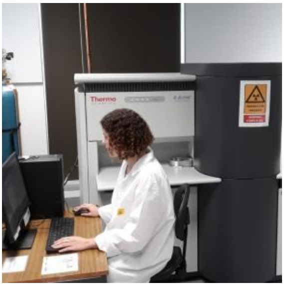
If you have a research project that requires Sydney Analytical capabilities, please visit our website and submit a project enquiry through the 'Access our facilities' page. Our staff will get in touch to discuss your requirements along with registration and training in more detail.

User access scheme

The Core Research Facilities User Access Scheme has been developed in order to invest in, and drive research excellence across the University by providing small grants to support access to the facilities for internal academic research staff.

For further information and to apply online visit:
sydney.edu.au/research/facilities/user-access-scheme

Applications

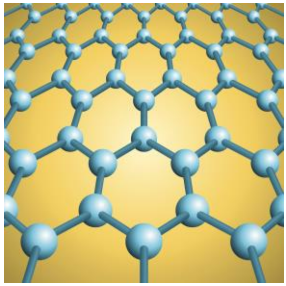


Surface characterisation

X-ray photoelectron spectroscopy (XPS) provides information on elemental composition and oxidation states, with a depth resolution of ~10 nm to ~1nm. Our system is also capable of ultraviolet photoelectron spectroscopy (UPS) enabling the analysis of valence bands and electronic states.
Topographical and chemical information from surfaces can be obtained using our combined AFM-IR and AFM-Raman systems.

Nanoscale characterisation

Sydney Analytical has two combined vibrational spectroscopy and atomic force microscopy (AFM) systems for the analysis of molecules and chemical interactions at a spatial resolution of up to 10 nm. The AFM-Raman system provides users with tip-enhanced Raman spectroscopy (TERS) capabilities, while the AFM-IR system enables the collection of near-field FTIR spectra, as well as near-field amplitude and phase images at single wavelengths.

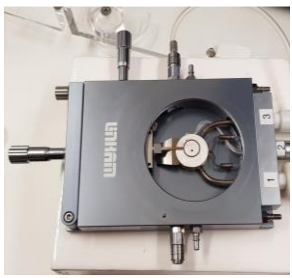


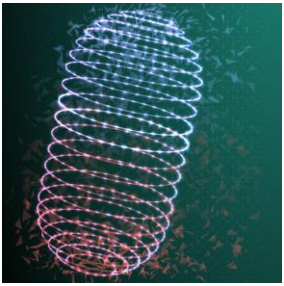
Mineral identification and analysis

X-ray fluorescence and diffraction techniques enable identification and quantification of elements and crystalline phases present in mineral samples. Our expertise in Rietveld refinement enables both identification of individual mineral phases and quantification of the populations of these in a sample.

Controlled environment studies

Specialised sample stages can be used to control sample temperature (as low as 12 K and as high as 2000°C), pressure (to 50 GPa) and chemical environment. This makes possible the in-situ investigation of molecular and structural changes, phase transformations, high-temperature reactions and material degradation by both vibrational and NMR spectroscopy and X-ray diffraction.



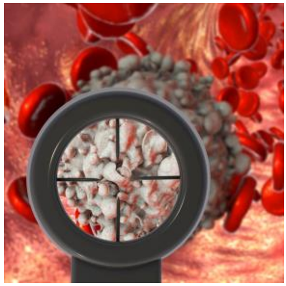


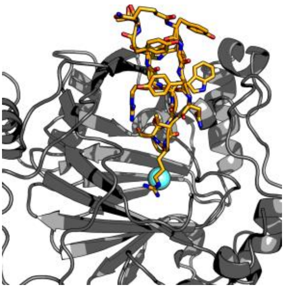
Design of novel drugs

Antibiotic resistance is a significant problem in 21st century medicine. Fragment based drug discovery (FBDD) provides a new strategy to target bacterial or fungal proteins of interest. Once produced the structure of these novel antibiotics and antifungals can be characterized with a range of techniques including NMR spectroscopy. This same process can be applied to designing other groups of drugs including anti-cancer and anti-diabetic agents.

Biospectroscopy

Biological samples are fundamentally composed of molecules that can be probed and analysed using spectroscopy. Sydney Analytical is well equipped to study many types of biological samples including fixed/live cells, freeze dried tissue sections, protein solutions, biological fluids (blood, plasma, serum), plant material, fibres, vesicles and many more. Bulk, micro and nano-scale measurements are currently available.



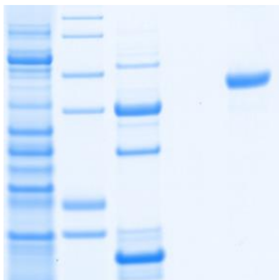


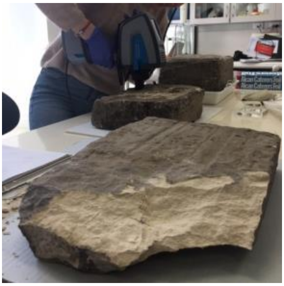
Cyclic peptide display screening

Small cyclic peptides can be large enough to block protein-protein interactions but small enough to display drug-like properties, making them ideal candidates for drug discovery. Cyclic peptide display screening (CPDS) allows for the rapid parallel synthesis and screening of trillions of molecules against virtually any expressible protein target, yielding diverse ligands with very high affinity (typically low nM) and selectivity.

Protein expression, purification & structural analysis

All features in an organism are a consequence of its proteins. To gain a detailed understanding of a biological process, you will need to study the proteins involved. Sydney Analytical offers expertise in expressing and purifying these proteins, as well as NMR spectroscopy and X-ray crystallography. This can enable visualization of molecular architecture of the purified protein providing atomic detail on critical binding sites and mechanism of action.





Analysis of cultural heritage objects

Modern and non-destructive analytical techniques are enabling new insights to be gained from items in museum and art gallery collections. Chemical and morphological analyses are contributing to continually redefine research questions in order to solve difficult problems in archaeology, palaeontology, art, collection conservation and many other areas.

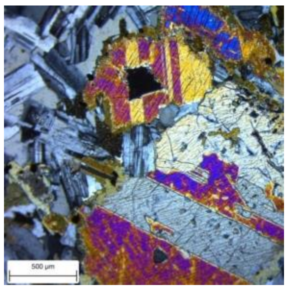
Analysis of agricultural products

Near infrared (NIR) spectroscopy, XRF and NMR are well-established techniques that have been applied to the analysis of a wide array of agricultural products including animal feed, oils, dairy, fruits and grains. NIR is particularly sensitive to the composition of raw products backed by robust and accurate calibration models.

Residual stress in biomaterials

Concentration of residual stress in dental ceramics is a serious problem due to the risk of failure, thus causing injury. Using a state-of-the-art Raman spectrometer and software, 3D maps reveal spatial distribution and relative intensity of residual stress, based on shifts of specific Raman bands.

Cutting and polishing capabilities



The CAP Laboratory at Sydney Analytical provides sample preparation across a wide range of analytical instrumentation. Our capabilities span from cutting and grinding to polishing of bulk samples, prepared mounts and sections, with the ability to adapt every step in the preparation process to individual needs and a focus on quality and quick turnaround times.

Research Impact: Microplastic pollution in our environment

Globally more than 280 million tonnes of plastic are used each year. This material enters and persists in environments from the poles to the equator and down to the depths of the sea. Slow degradation of plastic debris into ever smaller particles means that microplastics (<1 mm) are accumulating in the environment. Laboratory trials indicate this material is likely to be present in animal tissues and food webs.

FTIR-ATR spectroscopy has been used to identify microplastics found in the guts of multiple fish species from Sydney Harbour. The most common microplastics found were fibres of polyester (PET), acrylic-polyester blend and rayon. When clothes are worn and washed, they emit fibres into the environment via sewage and stormwater inputs that result in the global dispersion of clothing fibres.

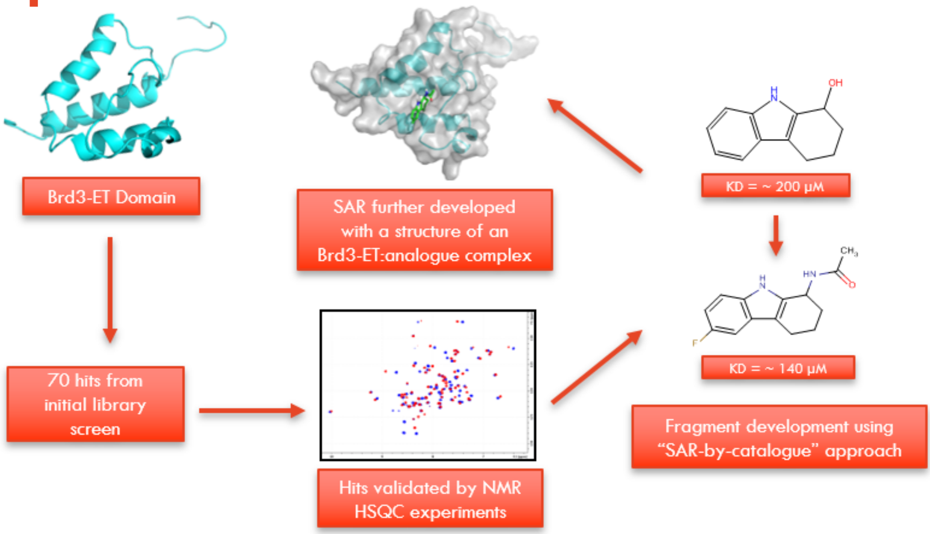
The findings indicate that government and industry should be implementing strategies to reduce the inputs of these polymers to the ecosystem, given that they are entering the food webs via ingestion by recreationally and commercially important fish species in estuaries.

Impact outlook

"Clothing fibre pollution is an unsolved global problem in part because of a lack of an evidence-based roadmap for mitigating emissions and ecological impacts."

Dr Mark Anthony Browne
University of NSW

Research Impact: A new strategy for the development of BET-family protein inhibitors



Bromodomain and extra-terminal domain (BET) proteins are common throughout nature, and bind acetylated lysines, found on histones and transcriptional regulators. As such, BET proteins have an important role in gene transcription, and are also key players in cancer biology.

Small molecules that inhibit the interactions between the bromodomains of BET proteins and their acetylated substrates are promising anti-tumour agents. However, a significant drawback is the highly conserved nature of the bromodomains across different family members. The ET domain from BET proteins have been found to bind to a variety of regulatory proteins and represent an alternative drug target.

One of these ET domains was screened against the Sydney Analytical fragment library. The initial screen resulted in seventy hits, with validation assays identifying one strongly binding fragment. A SAR-by-catalogue approach for this fragment was pursued, purchasing analogues, and improving the affinity for Brd3-ET. In collaboration with Monash University, a medicinal chemistry approach is underway to further improve the affinity for the target.

Research Impact: Novel treatments to accelerate wound repair

Full-thickness and chronic dermal wounds significantly impact the quality of life of patients and add considerable treatment and cost burden to health services worldwide. Novel advanced wound treatments that accelerate wound repair are vitally required to improve clinical outcomes.

Research from Professor Tony Weiss's laboratory in the Charles Perkins Centre has led to the development of implantable tropoelastin-based materials that promote full-thickness dermal wound repair. These implants recapitulate in part the native extracellular matrix environment with in-built biological cues that can modulate the surrounding tissue to augment the wound healing process. Key to the technology is the use of a novel heat based, stabilized form of human tropoelastin which allows for tunable resorption. Tropoelastin is the monomeric precursor to the elastic, cell-signaling, human protein elastin. To form these biomaterials a synthetic replica of human tropoelastin is purified through recombinant DNA technology and bacterial fermentation. Vibrational spectroscopy techniques are used to validate the molecular structure of the protein.

Impact outlook

"The technology can potentially enhance the quality and speed of wound healing. Shorter residence times in hospital and improved medical outcomes have the potential to deliver substantial impact through desirable healthcare outcomes."

Professor Anthony Weiss
University of Sydney

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"Excellence in research is increasingly linked to excellence in capability, and that is what our core research facility program is all about."

Professor Simon Ringer
Director Core Research Facilities