

Microscopy capabilities at the Australian Synchrotron

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Microscopy capabilities at the Australian Synchrotron include Infrared Microscopy (IRM) and X-ray fluorescence microscopy (XFM) [1].

Infrared Microscopy or Fourier Transform Infrared (FTIR) spectroscopy can provide spatially resolved spectroscopic information on organic and inorganic compounds. High brilliance synchrotron IR enables high signal-to-noise ratios at spatial resolutions between 3–8 μm , making IRM ideally suited to the analysis of microscopic samples, single cells and complex biological systems. IRM can employ Attenuated Total Reflection (ATR) to enable analysis of more difficult samples, e.g. samples that cannot be microtomed or do not adequately reflect. ATR offers enhanced spatial resolution below the diffraction limit.

XFM can provide elemental and chemical microanalysis across millimeter to nanometer length scales. XFM is ideally suited to quantitatively map trace elements within whole and sectioned plant, biological specimens and environmental samples. High elemental sensitivity coupled with deep penetration allows investigation of diverse samples in situ or under environmental conditions. Elemental maps can be acquired rapidly which enables higher-dimensional studies including fluorescence tomography [2], X-ray absorption near edge structure (XANES) imaging, and XANES tomography. The speed and efficiency of the technique ensures the lowest possible dose and can avoid radiation damage.

Transmission FTIR spectroscopy was used to examine single live cells in aqueous media [3,4]. Bone disease was studied by examining bone quality after drug treatment using reflectance IRM [5,6]. Insights into lipid composition of brain neurons in brain tissue without the need for staining have been provided by macro ATR-FTIR [7].

X-ray fluorescence XANES imaging investigated in vivo coordination environments of metals in biological specimens [8]. Copper coordination chemistry within *Drosophila melanogaster* was visualised with fluorescence XANES tomography [9]. XANES imaging can be applied to fresh and hydrated plants, e.g., selenium speciation imaging in wheat and rice roots and leaves [10].

High-resolution coherent imaging at XFM brings together X-ray ptychography, spectroscopy and X-ray fluorescence to reveal morphology and speciation at nanometer resolution [11].

Increasingly, researchers use the combined capabilities of IRM and XFM to provide powerful correlative analysis, e.g. to provide understanding of the chemical and elemental composition of latent fingerprints. [12].

Future microscopy capabilities include the BRIGHT Nanoprobe beamline providing versatile X-ray microscopy with sub-70 nm spatial resolution.

References

- [1] D. Paterson et al., AIP Conference Proceedings 1365 (2011) 219.
- [2] M. D. de Jonge et al., Optics Express 25 (2017) 23424.
- [3] M. J. Tobin et al., Vibrational Spectroscopy 53 (2010) 34.
- [4] K. Petrou et al., Frontiers in Marine Science 5 (2018) 110.
- [5] C. Vrahnas et al., Bone 93 (2016), 146.
- [6] C. Vrahnas et al., Calcified Tissue International 103 (2018) 625.
- [7] J. Vongsvivut et al., Analyst 144 (2019) 3226.
- [8] S. A. James et al., Scientific Reports 6 (2016) 20350.
- [9] S. A. James et al., Chemical Communications 52 (2016) 11834.
- [10] P. Wang et al., Journal of Experimental Botany 66 (2015) 4795.
- [11] M. W. M. Jones et al., Chemical Communications 55 (2019) 1052.
- [12] R. E. Boseley et al., Analytical Chemistry 9 (2019) 10622.

Level of Expertise

Expert

Do you wish to take part in the poster slam

No

Travel Funding

No

Speakers Gender

Male

Primary author: Dr PATERSON, David (Australian Synchrotron)

Co-authors: HOWARD, Daryl; DE JONGE, Martin; KEWISH, Cameron (Australian Synchrotron); Dr TOBIN, Mark (Infrared Microspectroscopy Beamline, ANSTO Australian Synchrotron); REINHARDT, Juliane; VONGSVIVUT, Jitraporn (Pimm) (Australian Synchrotron); Dr BAMBERY, Keith (ANSTO); JAMES, Simon (Australian Synchrotron); MARTIN, Danielle (Australian Synchrotron); AFSHAR, Nader (Australian Synchrotron)

Presenter: Dr PATERSON, David (Australian Synchrotron)

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