ammrf
Australian Microscopy & Microanalysis Research Facility

Contact and information

Australian Key Centre for Microscopy and Microanalysis (AKCMM)

Madsen Building, F09
The University of Sydney
NSW 2006
Australia

T: +61 2 9351 2351
F: +61 2 9351 7682
E: info@emu.usyd.edu.au
W: www.emu.usyd.edu.au

The University of Sydney

Flagships: Imago Local Electrode Atom Probes

Local electrode atom probes for atomic-level analysis of materials

This world-leading facility provides comprehensive capabilities in atom probe tomography. Voltage-pulsed atom probe and pulsed-laser atom probe, open up this powerful technique to a large variety of applications, from conductive to less-conductive materials.

Scientific Drivers

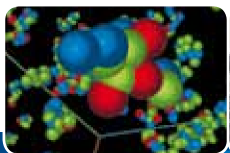
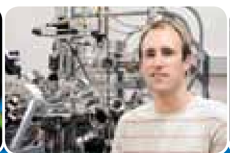
Many current scientific and technological challenges in the modern world require a better understanding of structure-property relationships in materials at the atomic scale. The range of these challenges is highly diverse, and includes designing clusters of solute atoms to strengthen advanced alloys such as light metals and new steels; and understanding how atomic distributions and impurities affect the functional properties of magnetic multilayers, nanowires, quantum dots, spintronic systems, and doped semiconductor devices. Atom probe tomography is without peer as a tool enabling the microscopic 3-D mapping, at the atomic level, of the location and chemistry of all elements of the periodic table, providing unique insights into many scientific and engineering challenges. While the voltage-pulsed system is largely limited to conductive materials, such as alloys and some semiconductors, the pulsed-laser atom probe allows the analysis of materials of very low conductivities, which means that studies involving semiconductors, ceramics and polymers become feasible.

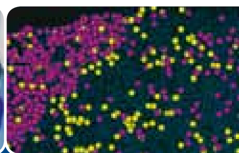
Examples of the research that this platform will enable map across the National Research Priorities and include:

- Opening up entirely new research fields, such as experimentally-based materials informatics.
- Investigating the structures of interfaces within nano-structured advanced ceramics that exhibit dramatic improvements in toughness, often combined with other functional properties such as high ionic conductivity or piezoelectricity for sensors and transducers.
- Contributing to the development of new methodologies to apply this powerful tool to organic and biological materials, one of the stretch goals for the field of atom probe tomography.

Capabilities and the National Research Capacity

Atom probe tomography exploits the phenomenon of field and/or thermal ionisation of atoms at the tip of a sharp specimen when it is subjected to a large electrical potential or to a pico-second laser pulse. By measuring the time of flight of the resulting ions and their spatial positions when they strike the detector, the atom probe allows the original positions and chemical identities of millions of atoms to be determined in a single sample. The sample can then be reconstructed digitally in three dimensions, offering the ultimate in atomic microscopy.

The pulsed-laser atom probe is the only one in Australia and complements the voltage-pulsed atom probe at the University of Sydney. The laser-based platform greatly expands the types of materials available for 3-D atomic-level analysis to include ceramics, semiconductors, organics, glasses, oxide layers, and even biological materials. The wide field of view enables large datasets (many millions of atoms) to be captured. This is essential for the design of materials that rely on subtle atomic interactions.

The atom probe facility is a formidable technology that requires a highly specialised technical environment. Both the atom probes are sited together in the Australian Key Centre for Microscopy and Microanalysis to provide new users with access to a team of experienced technical personnel and researchers.

Essential to optimal and productive use of this system, new users are also able to take advantage of the extensive know-how in advanced specimen preparation techniques, such as site-specific preparation methods, and the novel data analysis methods that have been developed at the University of Sydney. Take-up of the atom probe technology at this node is high, with researchers from universities, publicly funded research agencies and industry in Australia and overseas increasingly making use of the extensive capabilities of these instruments.

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References

F. de Geuser, B. Gault, M. Weyland, L. Bourgeois, B. Gable, S.P. Ringer and B. Muddle, "Atom Probe Tomography and Transmission Electron Microscopy Study of T1 and Precipitation in an Al-Li-Cu-Mg-Ag", Aluminium Alloys Their Physical and Mechanical Properties, Vol. 1, Wiley-VCH Verlag GmbH & Co. KGaA, pp. 724-731 (2008).

B. Gault, F. de Geuser, L.T. Stephenson, M.P. Moody, B. Muddle and S.P. Ringer, "Estimation of the Reconstruction Parameters for Atom Probe Tomography", Microscopy and Microanalysis, 14, 296-305 (2008).

B. Gault, M.P. Moody, D.W. Saxey, J.M. Cairney, Z. Liu, R. Zheng, R.K. Marceau, P.V. Liddicoat, L.T. Stephenson and S.P. Ringer, "Atom Probe Tomography at The University of Sydney", Frontiers in Materials Research (Advances in Materials Research 10), Vol. 10, Springer Berlin / Heidelberg, pp. 187-216 (2008).

P.V. Liddicoat, R. Ferragut, A. Dupasquier and S.P. Ringer, "Analysis of Vacancy Complexes in Al-Zn-Mg(-Cu) Alloys During Early Stages of Age Hardening", Aluminium Alloys Their Physical and Mechanical Properties, Vol. 1, Wiley-VCH Verlag GmbH & Co. KGaA, pp. 808-814 (2008).

R.K. Marceau, G. Sha and S.P. Ringer, "Cluster Hardening in Al-Cu-Mg Alloys: Analysis of Cu-Mg Atomic Clustering", Aluminium Alloys Their Physical and Mechanical Properties, Vol. 1, Wiley-VCH Verlag GmbH & Co. KGaA, pp. 83-90 (2008).

R.K. Marceau, G. Sha and S.P. Ringer, "Understanding Solute Segregation to the Dislocation Loops in Al-Cu-Mg Alloys", Aluminium Alloys Their Physical and Mechanical Properties, Vol. 2, Wiley- VCH Verlag GmbH & Co. KGaA, pp. 1170-1176 (2008).

E. Marquis and B. Gault, "Determination of the tip temperature in laser assisted atom-probe tomography using charge state distributions", Journal of Applied Physics, 104 [8], 084914-1-084914-8 (2008).

M.P. Moody, L.T. Stephenson, A.V. Ceguerra and S.P. Ringer, "Quantitative Binomial Distribution Analyses of Nanoscale Like-Solute Atom Clustering and Segregation in Atom Probe Tomography Data", Microscopy Research and Technique, 71, 542-550, (2008).

M.P. Moody, L.T. Stephenson, P.V. Liddicoat and S.P. Ringer, "Contingency table techniques for three dimensional atom probe tomography", Microscopy Research and Technique, 70 (3), 258-268 (2007).

L.T. Stephenson, M.P. Moody, P.V. Liddicoat and S.P. Ringer, "New Techniques for the Analysis of Fine-Scaled Clustering Phenomena within Atom Probe Tomography (APT) Data", Microscopy and Microanalysis, 13 (6), 448-463 (2007).

I.B. Timokhina, P.D. Hodgson, S.P. Ringer, R.K. Zheng and E.V. Pereloma, "Precipitate characterisation of an advanced high-strength low-alloy (HSLA) steel using atom probe tomography", Scripta Materialia, 56 (7), 601-604 (2007).

I.B. Timokhina, P.D. Hodgson, S.P. Ringer, R.K. Zheng and E.V. Pereloma, "Characterization of nano-scale particles in hot-rolled, high strength low alloy steels (HSLA)", Materials Science Forum, 561-565, 2083-2086 (2007).

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