

# HENRY ROYCE INSTITUTE

## APPLICATIONS NOTE Atom Probe Tomography



UNIVERSITY OF  
OXFORD

Department of Materials



There are two Atom Probe instruments available at Oxford for UK access through the Henry Royce Institute. These can offer unique insights into the microstructure of a wide range of materials.

### Chemical analysis

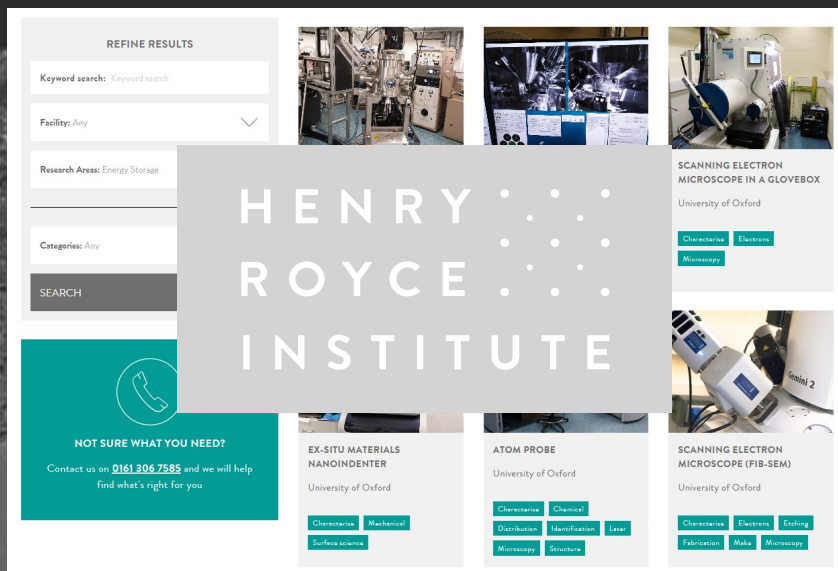
Atom Probe Tomography is equally sensitive to all elements in the periodic table, with ppm sensitivity. This enables identification of trace levels of all species, and with sufficient resolution to distinguish isotopic effects.

### 3D Structural information

APT datasets contain tens to hundreds of millions of ions, producing a 3D reconstruction of all atomic positions, at a sub-nanometre resolution.

### Site-specific specimen targeting

Needle-shaped specimens can be made using Focussed Ion Beam (FIB) tools, enabling key microstructural features to be located and extracted, for later APT analysis. This approach links 3D atomic-scale information with wider-view SEM/FIB analysis.



**Henry Royce Institute**, the UK's national institute for materials science research and innovation, is home to advanced capabilities across nine leading materials research institutions: Universities of Oxford, Cambridge, Imperial College London, Liverpool, Leeds, Sheffield, the hub at the University of Manchester; together with UKAEA and the National Nuclear Laboratory. All Royce-supported and -funded equipment is available for external academic and industrial use.

**University of Oxford** leads on energy storage activities within the Royce.

At Oxford, the **Department of Materials** hosts a suite of state of the art facilities and equipment. Investment through the Royce contributes to the focus on analysis of energy materials and development of next generation energy storage solutions.

Capabilities at Oxford are backed up by scientists based in the **David Cockayne Centre for Electron Microscopy**, the **Oxford Materials Characterisation Service** and the **Atom Probe Group**, along with the battery research groups of **Professors Peter Bruce, Patrick Grant, Mauro Pasta and Rob Weatherup**.

[royce.ac.uk](http://royce.ac.uk)

[royce.materials.ox.ac.uk](http://royce.materials.ox.ac.uk)

## CAMECA LEAP® 5000 XR Atom Probe

This Local Electrode Atom Probe offers improved detector efficiency and incorporates a UV laser. It complements the 3000X HR, which can also be used to analyse micro-tips on flat/wedge samples.

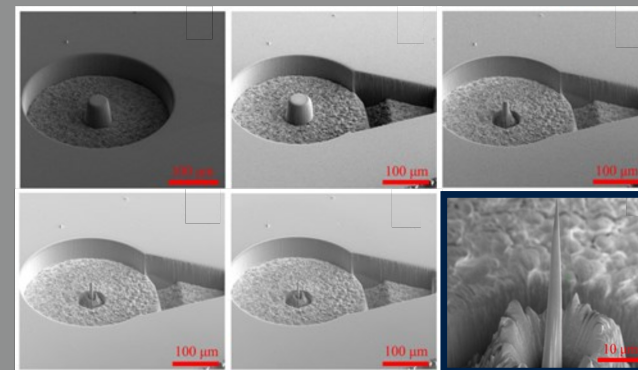


### Atom Probe Tomography (APT)

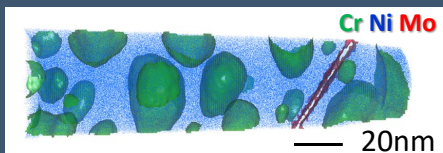
APT is a powerful microstructural technique using position-sensitive time-of-flight mass spectrometry. A sharp needle is produced from the sample material, using either electro-polishing or focused ion beam (FIB). The needle is loaded, cooled to 20–70 K and the atom probe is evacuated.

Using high voltage or laser pulsing, single atoms are field evaporated through a time-of-flight chamber, onto a position-sensitive detector, providing both the chemical identity and 3D spatial location of each atomic species. APT datasets routinely sample specimen volumes ~50 x 50 x 300 nm, offering unique insight into the microstructure of materials.

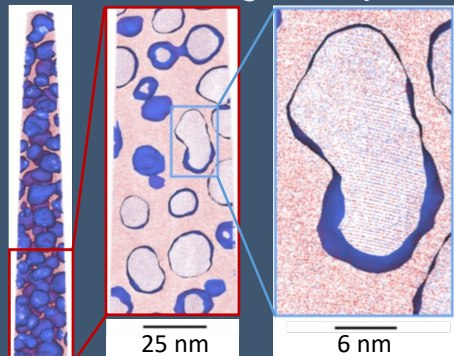
### Specimen preparation using Plasma FIB



### Grain boundary segregation in nickel-based superalloy

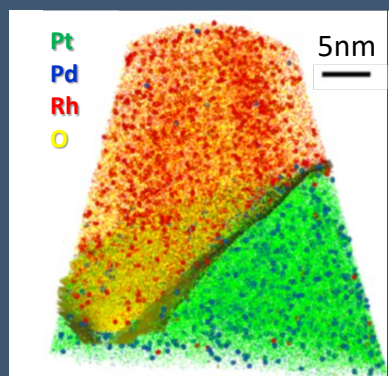


### Ni-rich precipitates in Fe-Ni meteorite showing atomic planes

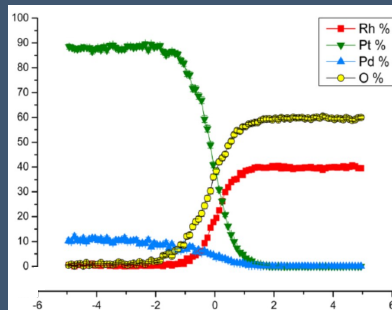


### Oxide-metal interface in Pt-Pd-Rh alloy

Elemental map



Interface analysis



### Key applications and features

Trace element identification, characterisation of phase partitioning  
Irradiation damage (clustering, segregation) in nuclear fission and fusion materials

Examination of interfaces (oxidised alloys, biomaterials)

Evolution of alloy microstructures during thermal ageing

Characterisation of grain boundary segregation

Reaction cell system, for exposure of specimens to controlled environments (air oxidation, hydrogen embrittlement studies)

Correlation with other advanced microscopy techniques (SEM, TEM, TKD) and complementary mechanical testing (pico- and nano-hardness), providing complete characterisation service