Nuclear Materials Atom Probe (NuMAP) Facility

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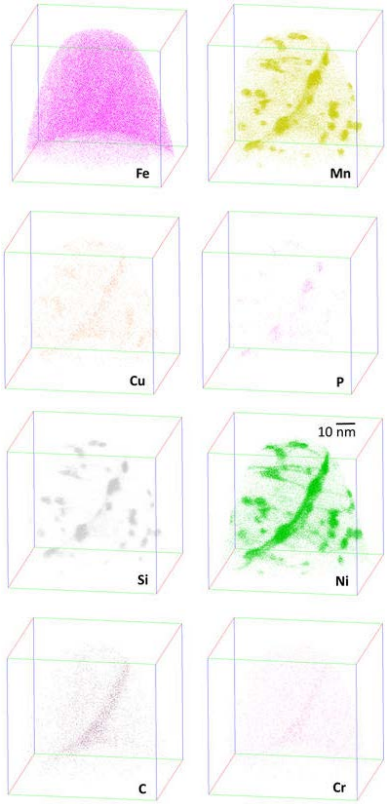
A new state-of-the-art atom probe user facility has been established to routinely deliver atomic-scale characterisation of active nuclear materials. Working closely with the UKAEA Materials Research Facility (MRF), the Department of Materials at the University of Oxford can provide the UK's nuclear research community with fully supported access to atom-by-atom characterisation generated by Atom Probe Tomography (APT).



Atom Probe Tomography analysis of an ion-irradiated steel. APT images show a distribution of irradiation-induced Ni-Mn-Si clusters, P clusters, solute segregation to irradiation-induced dislocations and solute segregation to a grain boundary.

Courtesy of James Douglas

Many aspects in the design of new materials, and assessment of their performance in harsh reactor environments, need to be addressed at the atomic scale; and in many cases APT is now considered an essential characterisation tool. Hence, APT is increasingly needed to underpin research across all stages in the nuclear energy cycle: materials design for new reactor manufacturing, component safety/failure analysis, waste/storage and accident investigation.

Unique nanoscale insights can be provided by APT: atomic-scale solute clustering, segregation to microstructural interfaces, and locating low concentration transmuted elements – vital information for developing engineering materials for nuclear applications.

NuMAP offers a streamlined procedure to request user access and support across every stage of APT analysis. The key to this is synergy between the MRF and Oxford. The MRF provides vital expertise and equipment to receive active materials that Oxford cannot process, such as neutron-irradiated materials from UK or overseas partners, and prepare active APT samples. The close proximity of the two institutes enables efficient exchange of researchers/expertise and ready transport of APT samples.

This process is underpinned by a dedicated Atom Probe Scientist: the single point of contact for users, providing ongoing, tailored experimental support. This ranges from training new users to guiding more complex experimental programs, along with undertaking industrial commercial work.

Our strategy is optimised to remove barriers for non-expert users, promote the technique and rapidly expand the facility user-base. This, combined with enhanced capabilities to address increasingly challenging scientific topics, aims to encourage diversification of research projects in the UK underpinned by APT, including materials for geological disposal, Gen IV reactors, fusion candidates and even fuels.

Services provided by the facility

- **Tailored experimental design** – users are given expert advice on how APT characterisation can assist their work.
- **Specimen preparation** – the facility facilitates and supports access to a dual-beam FIB instrument managed by the UKAEA MRF, dedicated to sample preparation of active materials. The Atom Probe Scientist provides consultation, training and specimen fabrication tailored to the needs and expertise of the user.
- **Active sample handling** – users receive assistance in all aspects of radioactive material handling, including support from MRF health physicists and waste management advisors during sample preparation and radiation transport advisors for transfer to Oxford.
- **Atom probe** – users are provided with access to the latest atom probe instruments. Expert support is provided to optimise material specific analysis.
- **Data analysis** – raw experimental data is reconstructed into a 3D atomistic map using proprietary software, with visualisation and statistical tools used for data interpretation. Facility users are provided with supported access to imaging and analysis software.
- **Training** – for ongoing users of the technique the facility provides expert level training in all aspects of the technique.
- **Commercial services** – the facility undertakes bespoke packages of APT analysis upon commission by industrial partners. We provide imaging, data analysis and formal reports.

Availability

The NuMAP Facility is currently scheduled to be available for access by external users from January 2021. While COVID-19 restrictions remain in place, we cannot currently undertake hands-on training within the facility. However, we are strongly committed to supporting the research of new users with experiments performed by NuMAP scientists. Up-to-date information about availability, in light of the COVID situation, is available at **https://www.nnuf.ac.uk/nuclear-materials-atom-probe-facility**.

Contact details

Please email **james.douglas@materials.ox.ac.uk** to discuss your potential project.