Integrated Sample Preparation and Analysis Platform for Site-Specific Multi-Instrument Comprehensive and Complementary 3D Chemical Imaging

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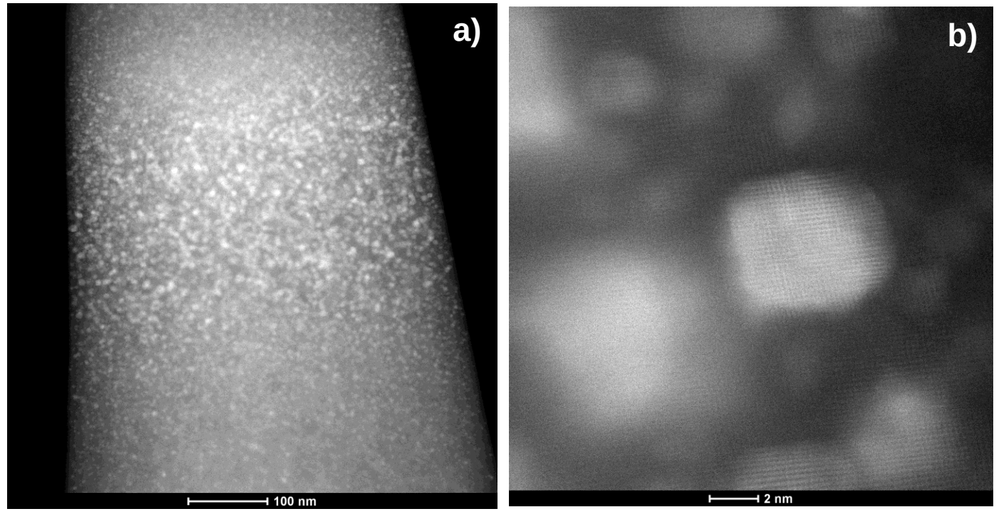
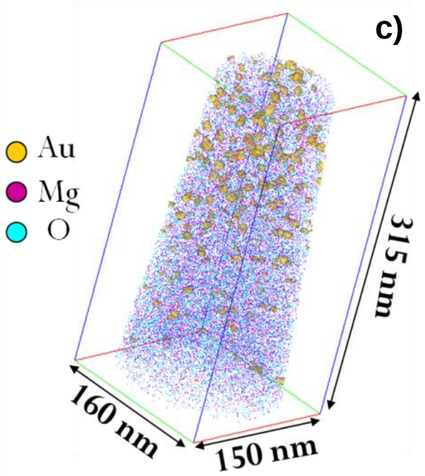
Purpose

Develop capabilities that drive the atomic-level 3D chemical imaging

Probe 3D chemical composition of nanoclusters embedded in a matrix and correlate with high-resolution atomic-scale images

Establish the strengths of correlative microscopy, spectroscopy and theoretical analysis for chemical imaging





Interesting observations.
a & b) Highly coherent, sharp images of the interface between Au-nanoparticle and MgO.

c) 3D-APT shows nanoparticles contain Au, Mg, O.

Expected Outcomes

New platform that preserves registry among APT, TEM, and SEM/FIB, allowing site-specific analysis on the same samples

Establish methodologies to determine the 3D positions and chemical identity of individual atoms in any materials system

Study buried interfaces, grain boundaries, free-standing and suspended nanoparticles utilizing 3D chemical imaging

Progress Made So Far

- HRSTEM, EDX mapping, and APT analysis on SIMILAR tips
- The dimensions of Au-nanoclusters embedded in MgO in all three cases agree very well

Path Forward

- Microscopy, mapping, and analysis on SAME tip
- Validate composition of Au-nanoparticles in MgO
- Compare STEM tomography and APT
- Apply to buried interfaces and grain boundaries
- Identify requirements for the desired holder

Accomplishments to Date

- Invited: 3 talks; organized 4 PNNL seminars
- 11 abstracts/presentations; submitted manuscript

Progress Towards External Funding

- GE Global Research Center ($100K/yr)
- DTRA ($300K/yr project)
- Helping EMSL user (CMU) on DOE LED project

Why It Matters

- HRSTEM/APT “sees” buried interfaces, grain boundaries
- Material science, geosciences, and electronic materials will benefit

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