

The Laboratory is a recognized world leader in analyzing and studying actinides, a set of elements on the frontier of scientific inquiry.

Actinide Analytical Chemistry

Analytical chemistry identifies and quantifies the chemical and isotopic composition of materials. Since the Manhattan Project, timely and accurate chemical analyses have supported Los Alamos National Laboratory's mission. Today, actinide analytical chemistry tasks at the Laboratory range from analyzing samples that help assess the impact of potential exposures to hazardous materials, to certifying that a material is suitable for its intended use, to measuring nuclear stockpile performance. Actinide analytical chemistry also plays an important role in detecting clandestine research, guarding against illicit production of weapons of mass destruction, and analyzing samples to verify that nuclear materials are kept under appropriate safeguards.

Our focus is chemical and radiochemical analyses of materials where actinide elements make up a significant portion of the sample matrix. These analyses encompass major component analyses and trace measurements of impurities spanning over seven orders of magnitude of measurement and detection capability.

We use our capabilities in support of national security. By meeting current demands and preparing for future needs within the nuclear community, we

play a vital part in ensuring national security through nuclear science and technology. Key to our national role is our status as

a recognized leader in the international nuclear community for providing high-quality analytical data. Our role in safeguards measurements and stockpile support and our expertise in supplying data for threat reduction and nuclear forensic arenas make actinide analytical chemistry a critical part of the nation's nuclear chemistry capability.

Programs and Activities

- Stockpile stewardship
- Mixed oxide fuel
- Pit disassembly
- Nuclear forensic analysis
- Global Nuclear Energy Partnership (GNEP)
- Plutonium stabilization and disposition
- Actinide research and development
- ^{238}Pu heat sources
- Fabrication and certification of high purity Pu metal and nondestructive analysis standards
- Pu exchange program



Plutonium metal assay



Capabilities

Plutonium Assay. Plutonium assay is a primary tool for material control and accountability. It uses a suite of wet chemistry techniques to provide assay of plutonium (Pu), uranium (U), and neptunium (Np) as well as iron determination, loss-on-ignition, free acid determination in Pu solutions, special dissolutions, bulk and trace isotopic composition, and preparation of standard solutions.

Interstitial Gas Analysis and Ion Chromatography. Interstitial gas analysis provides carbon, hydrogen, oxygen, moisture, and tritium content at trace levels in a variety of matrices. Ion chromatography is routinely used to analyze samples for fluoride, chloride, nitrite, nitrate, phosphate, sulfate, and oxalate anions.

Radiochemistry. Radiochemical separations and counting are performed for low to medium levels of radioactivity, actinide chemistry, alpha, beta, and gamma spectroscopy, and direct nondestructive instrumental measurements.

Periodic Table

| | | | | | | | | | | | | | | | | | | | | | | | | |
|----|----|-----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|---|----|
| 1A | 2A | | | | | | | | | | | | | | | | 3A | 4A | 5A | 6A | 7A | 8A | | |
| H | | | | | | | | | | | | | | | | | Li | Be | B | C | N | O | F | Ne |
| Na | Mg | | | | | | | | | | | Al | Si | P | S | Cl | Ar | | | | | | | |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr | | | | | | | |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe | | | | | | | |
| Cs | Ba | La* | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn | | | | | | | |
| Fr | Ra | Ac* | Rf | Db | Sg | Bh | Hs | Mt | Ds | Uub | Uuq | Uup | Uuq | Uuo | Uuq | Uuo | Uuo | | | | | | | |

Lanthanide Series*

| | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu |
| Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |

The Actinides

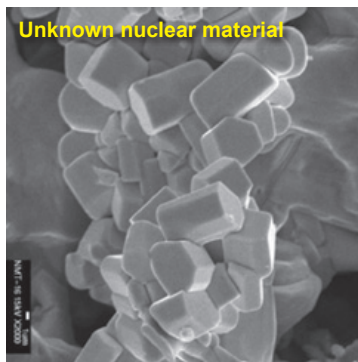
| | | | | | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|
| 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
| Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |
| 90.024 | 91.024 | 92.024 | 93.024 | 94.024 | 95.024 | 96.024 | 97.024 | 98.024 | 99.024 | 100.024 | 101.024 | 102.024 | 103.024 |

Plasma Spectroscopy. In addition to assaying major components, the ability to measure minor components is critical to material performance. Impurities analysis is performed using inductively coupled plasma mass spectrometry (ICP-MS), laser-ablation ICP-MS, ICP-atomic emission spectroscopy (AES), and direct current-arc spectroscopy. Together, ICP-MS and ICP AES can measure virtually any element from the Periodic Table within an actinide matrix.

X-Ray Fluorescence (XRF). XRF is an excellent analytical method for those elements present in concentrations above the working range of trace analytical techniques. Techniques are non-destructive, leaving samples intact for other analytical techniques. Wavelength dispersive x-ray fluorescence portable energy dispersive x-ray fluorescence detectors are available for specific projects.



Mass Spectrometry. Mass spectrometry capabilities include two multicollector thermal ionization mass spectrometers (TIMS), one of which has negative ion capabilities, a magnetic sector high resolution gas mass spectrometer, and a newly purchased TIMS equipped with an energy filter and ion counting capabilities; making it ideal for measuring isotopic compositions of minor isotopes at the part-per-million level. In addition, mass spectrometry has two dedicated wet chemical separations laboratories. These facilities are used to perform high precision isotopic ratio determinations and assay measurements of actinides as well as most other elements (including noble gasses). Isotopics are also vital to materials control and accountability, and establishing age and how a sample was processed.



Actinide Chemistry for Nuclear Forensics

To identify illicit sources of nuclear material and shut down illegal pathways, we must be able to determine the sources of a range of different nuclear material (weapons-grade U and Pu, reactor fuel, fission products, radioactive waste, etc.). Physical, chemical, and radiological properties can potentially provide fingerprints and determine the key variables that discriminate age, process, and source. Our growing capabilities in this vital national security area include the following:

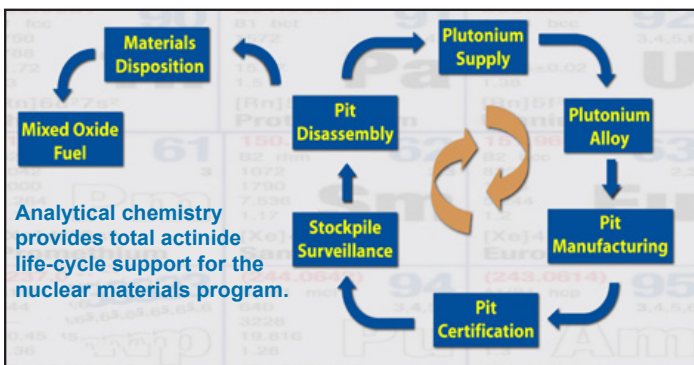
- Nondestructive and destructive analysis of both bulk and particle samples for the isotopic compositions of actinides to determine age, origin, and processing history
- Large analytical dynamic range: analysis of ultra-trace to kilograms of nuclear material, gases, tritium, trace elements, stable isotopes, and nonnuclear materials
- Ultra-trace level analysis for national security (105 atoms of ^{239}Pu , ^{106}Xe , 0.1ppm in ^{30}Ci ^3H ; 10ppm ^{85}Kr)
- Medium sample range (1014 to 1022 atoms of ^{239}Pu) for the Defense Threat Reduction Agency-Domestic Nuclear Event Attribution, Enhanced Test Readiness
- High sample range (>1022 atoms of ^{239}Pu) for material interdiction needs
- Forensic facilities at Technical Area (TA) 03, TA-48 (RC-1 and RC-45), and support for the Nuclear Emergency Response Team



Facilities – Chemistry and Metallurgy Research Replacement

A much needed facility for radiological research is under construction and will replace the aging infrastructure where much of our current activities take place. The Chemistry and Metallurgy Research Replacement (CMRR) Building is scheduled to be completed in 2018 and will answer our national need for a best-in-class actinide research facility and center for excellence in plutonium science.

- 22,500 ft² for a security category 1, hazard category 2 facility dedicated to analytical chemistry, materials characterization
- Equipped with state-of-the art instrumentation
- 19,500 ft² for hazard category 3 radiological lab work
- Office space for 350 employees
- Training center with classrooms
- Simulated laboratory space



Los Alamos National Laboratory is operated for the Department of Energy's National Nuclear Security Administration by Los Alamos National Security, LLC, a team of Bechtel National, the University of California, The Babcock & Wilcox Company, and Washington Group International. LALP 08-066 **Information Contact:** (505) 667-4087