

Argonne's Fuel Cycle Capabilities



MARK A. WILLIAMSON
Division Director
Chemical & Fuel Cycle Technologies

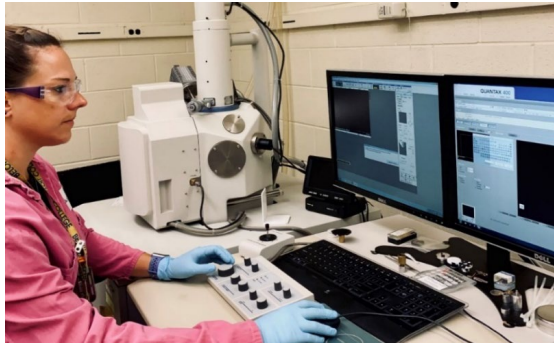
Briefing to Gain Visitors

MAY 20, 2026

Infrastructure supports Radioactive Materials RD&D



Process Development & Testing



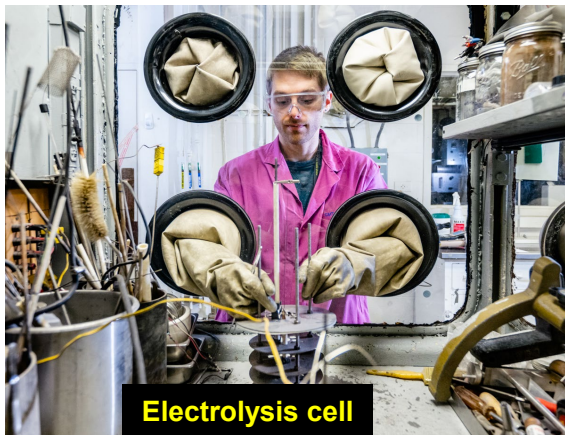
Material Development, Interaction Testing, and Performance Modeling



Process Demonstrations and Scale-Up

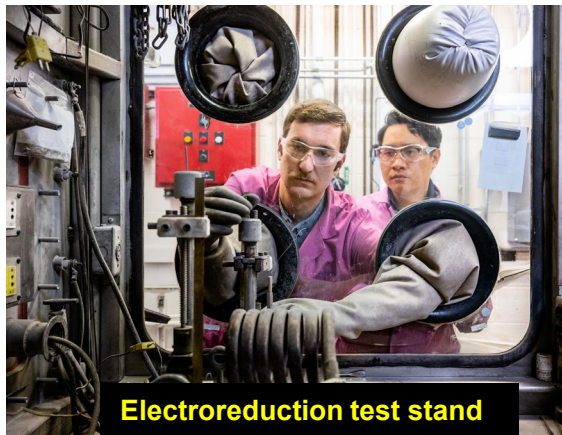
Pyrochemical Process Engineering

Process Chemistry



- Innovative process development
- Fundamental thermodynamic and kinetic property measurements
- Electrochemical property measurements
- Chemical separation factor determinations

Engineering



- Equipment prototyping and testing with simulated or lightly irradiated fuels containing actinides (U, Np, Pu)
- System scale-up and operation
- Materials compatibility assessments

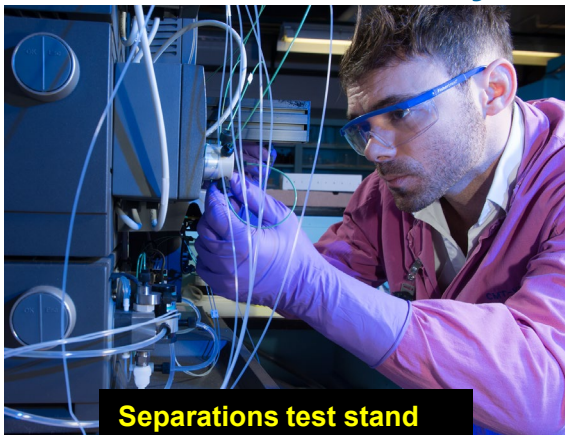
Pilot-scale Testing



- De-risking equipment design and operation
- Integration and operation of systems at scale
- Industrialization of pyroprocess operations

Radiochemistry

Process Chemistry



- Developer of innovative chemistries such as ALSEP, UREX+, and TRUEX
- Exploring disruptive technologies such as direct dissolution, voloxidation and fluorination processes
- Measurement and modeling of mass transfer kinetics
- Microfluidic separation device fabrication to facilitate process development

Engineering



- Equipment prototyping using 3D printing (e.g., rotating packed beds, centrifugal contactors)
- Prototype rotating packed beds under development for use in gas scrubbing, liquid extraction, and solid-phase extraction
- Multi-unit centrifugal contactors printed and tested for use in solvent extraction

Pilot-scale Testing



- Flowsheet validation
- Process Intensification with compact, fast, and efficient centrifugal contactors and rotating packed beds
- Integrated sensors for following chemistry between stages in real-time

Molten Salt Technology Development

Property Measurements



Viscometer system

- Broad suite of thermophysical and thermodynamic property measurements based on standard technologies and methods
- Equipment supports testing of materials containing transuranic elements and beryllium
- NQA-1 data quality level

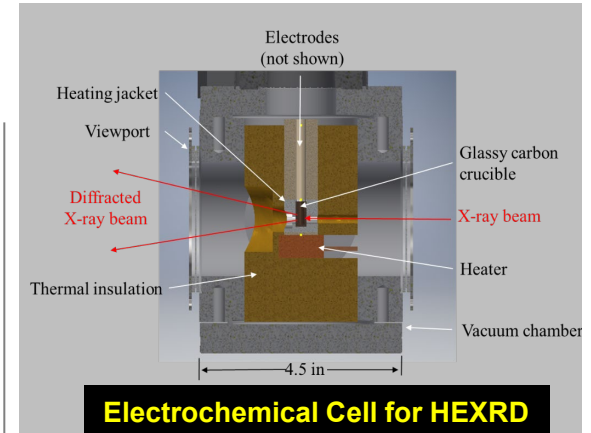
MSR Safety Analysis



Salt spill test stand

- Generate experimental data that support MSR safety analysis model development and validation
- Perform laboratory-scale separate effects tests of individual processes
- Perform engineering-scale integral effects tests of simulated fuel salt release accidents

Fundamental Studies



Electrochemical Cell for HEXRD

- Determine salt structure – property relationships to facilitate separations process development
- Electrochemical cell to manipulate molten salt redox chemistry *in situ*
- High energy X-ray diffraction at the Advanced Photon Source used to study the structure of molten salts

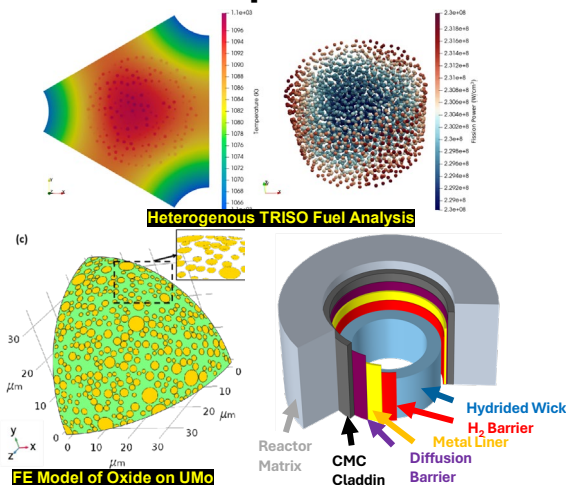
Fuel Development and Qualification

Design



- Fuel and material processing including actinide powder handling, heat treatment, atomization, coating
- Material synthesis and coating techniques such as
 - Atomic layer and physical vapor deposition (ALD/PVD) for FCCI, ATF, H₂/T permeation, molten salt corrosion
 - Powder metallurgy and composite material synthesis

Development



- Fuel behavior integrated simulation coupled with reactor design
 - Fuel performance evaluation, PIE analysis, qualification support
 - Fuel development for HPRR HEU to LEU conversion & for advanced fuel concepts
- Legacy SFR fuel data management and qualification
- Microreactors M&S and solid moderator encapsulation

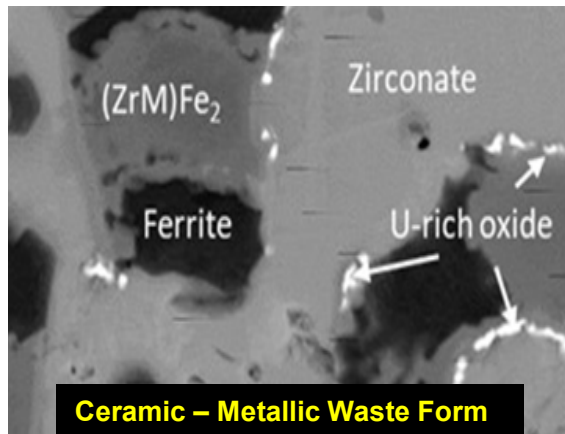
Qualification



- ATLAS Materials Irradiation Station (AMIS) - accelerated testing via ion irradiation of fuels and materials
- Nuclear fuel and structural materials characterization/testing capabilities
 - Microscopy techniques such as FIB, SEM, TEM for radioactive samples
 - X-ray techniques at APS and AML
 - Thermal-mechanical test: DSC/TGA, LFA, micro-mechanical/thermal conductivity

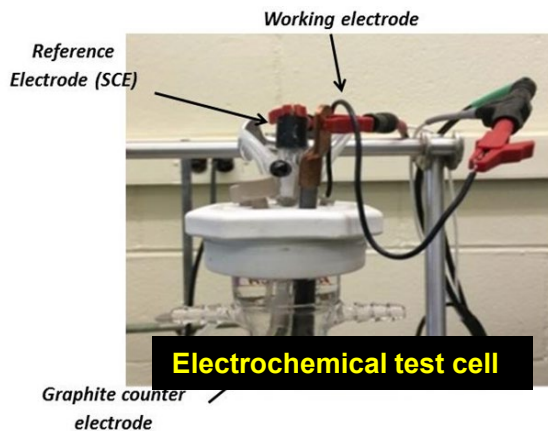
Materials Development

Waste Form Development



- Formulate waste forms durable over full range of environmental conditions for potential disposal options
- Utilize processing controls to achieve consistent waste form products
- Utilize multiphase material to maximize waste loading

Performance Testing



- Use material-specific testing to provide confidence in predicted long-term performance and radionuclide retention
- Utilize codified test methods (ASTM, ISO, ANSI/ANS, etc.) as appropriate
- Use performance assessment calculations that capture key dependencies on waste form characteristics and disposal conditions

Qualification

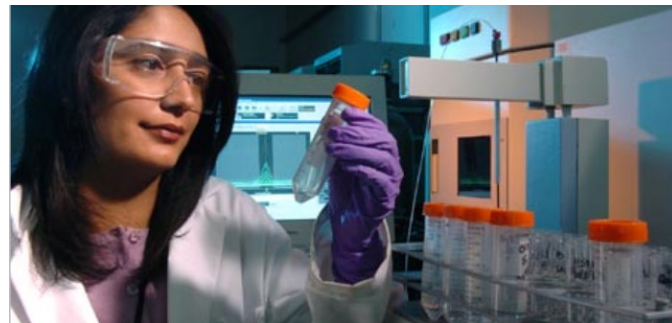


- Production and disposal regulations and requirements are established by national agencies
- Identify characteristics indicating acceptable performance (composition, microstructure, etc.)
- Demonstrate compliance with regulatory tests and requirements

Analytical Chemistry Laboratory

The Analytical Chemistry Laboratory carries out analytical research and collaborates to provide support to other research programs at Argonne and beyond.

- **Specialists in analyzing challenging samples**
 - Radioactive materials
 - Refractory and hard-to-dissolve materials
 - Toxic and air-sensitive materials
- **Novel, high-precision analysis techniques**
- **Long-term and short-term project support**
- **Audited internal QA/QC Program**
- **Experienced with national security-related work**



Technical Points of Contact

- Mark Williamson, williamson@anl.gov
- Candido Pereira, pereira@anl.gov
- Nick Condon, ncondon@anl.gov, Analytical Chemistry and Spectroscopy
- Bill Ebert, ebert@anl.gov, Pyroprocess and Materials Development
- Nathan Hoyt, nhoyt@anl.gov, Process Chemistry, Simulation & Safeguards
- Peter Tkac, tkac@anl.gov, Radiochemistry
- Latif Yacout, yacout@anl.gov, Fuel Development & Qualification



**ARGONNE'S WORK PROMOTES
U.S. PROSPERITY AND SECURITY**

Argonne 
NATIONAL LABORATORY



U.S. DEPARTMENT
of ENERGY