



# Waste Immobilization Research & Development

## Thermal Processing Group

### Tank Waste Research: Glass Formulation, Feed Preparation, and Melter Processing

#### CAPABILITIES INCLUDE:

- Basic and Applied Research through Laboratory and Engineering Scale Testing
- Radiological and Non-Radiological Facilities

#### Basic Science:

- Phase instabilities (phase separation and crystallization)
- Radiation and oxidation effects on phase stability
- Mechanisms of metal cation dissolution in amorphous systems
- Nano-ordered phases in glass and ceramics
- Crystal settling in glass melters

#### Glass

- Formulation development for waste forms with targeted properties, e.g. waste loading, durability, liquidus, viscosity, and thermal expansion coefficient
- Batch-to-glass reaction chemistry research to understand the complex reactions that occur in converting melter feed to glass; to avoid process upsets such as foaming, cold-cap freezing, and reboil; and to optimize melter throughput



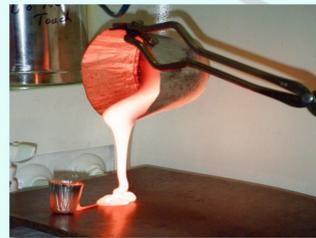
Glass Formulation at APEL Glass Development Lab



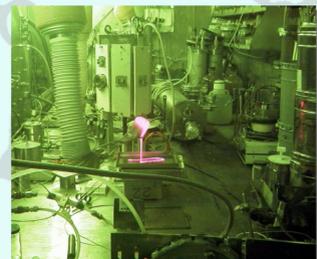
Glass property measurement: Durability



Glass property measurement: Viscosity



AN-107 LAW glass melting in Radiological Processing Laboratory (RPL) facility



AZ-102 HLW remote vitrification in Radiological Processing Laboratory (RPL) facility



AZ-102 HLW remote vitrification: in-cell camera

#### Melter Feed

- Development of waste slurry processing flowsheets
- Flowsheet characterization of offgas, physical & rheological properties, and chemical reactions
- Customization of waste feeds to provide optimal physical properties, waste loading, and melting properties.



AN-107 10M Na LAW slurry



AW-101 LAW calcined melter feed



HLW simulant melter feed



AN-107 LAW dried melter feed



AZ-102 HLW remote vitrification (in-cell camera): feed-to-glass conversion observation

#### Melter Processing

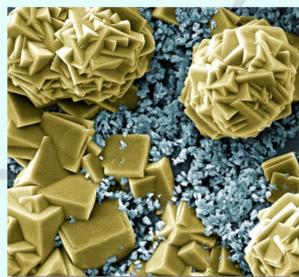
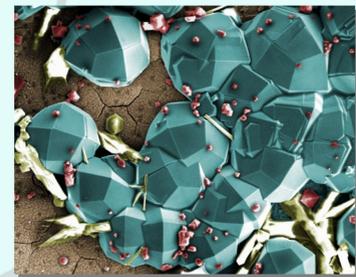
- Evaluate melter feed preparation flowsheets
- Evaluate processibility of melter feed formulations
- Offgas characterization of feed preparation and melting
- Equipment specification, development of process flowsheets, and scale-up
- Development of glass melt monitoring sensors for high-temperature, corrosive, and radioactive environments
- Technology development
  - Developed slurry-fed, joule-heated melter in the 1960's
  - Commercialized *In Situ* Vitrification and DC Plasma Arc technologies in the 1990's



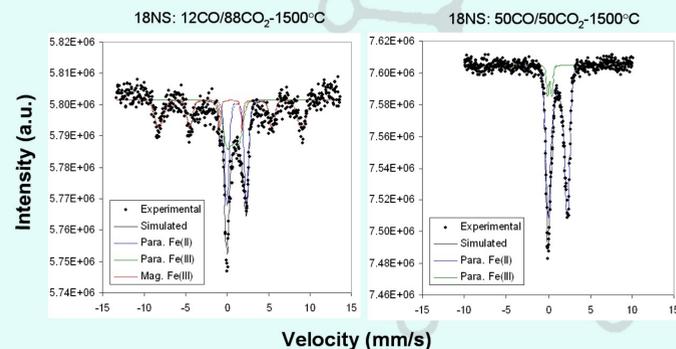
Research-scale melter - engineering scale continuous glass processing demonstration at the Applied Process Engineering Laboratory (APEL) facility.



HLW simulant glass



Crystallization under hydrothermal conditions VHT (vapor hydration durability test)



Oxidation states and local environments of iron in silicate glass – iron cluster formation revealed by using <sup>57</sup>Fe Mössbauer Spectroscopy

#### Collaborators:

- W.R. Wiley Environmental and Molecular Sciences Laboratory
- Savannah River Technology Center
- Australian Nuclear Science and Technology Organization (ANSTO)
- Lawrence Berkeley National Laboratory
- Idaho National Engineering & Environmental Laboratory
- Glass Service, LTD (Czech Republic)
- Massachusetts Institute of Technology
- University of Arizona
- University of Michigan

#### Key Clients:

- DOE Office of River Protection
- DOE Office of Fissile Materials Disposition (MD)
- West Valley Demonstration Project
- Tanks Focus Area
- Environmental Management Science Program
- INEEL HLW Program
- Savannah River Site Am/Cm Program