Molten Salt Thermophysical Examination Capability

State-of-the-art, shielded argon glovebox for irradiated and nonirradiated actinide materials

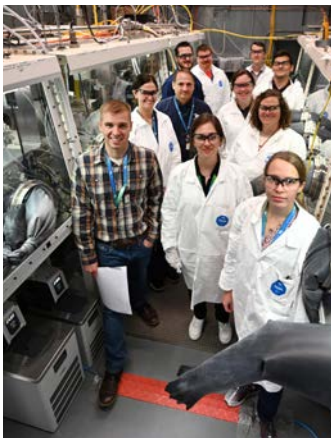
Advanced molten salt reactors use high-temperature chloride or fluoride salts as the fuel, coolant, or both. Research and infrastructure are needed to provide data on the properties of the salts and their interaction with the construction materials. This data will be used in the design, licensing, material tracking and predicting of safe reactor operations.

The Molten Salt Thermophysical Examination Capability (MSTEC) will be a state-of-the-art, shielded argon glovebox for irradiated and nonirradiated actinide materials. Funded by the National Reactor Innovation Center, MSTEC will offer a suite of thermophysical property characterization equipment, multifunctional furnaces and versatile workspaces for lab-scale experiments. Equipment within the MSTEC shielded glovebox has been designed for use with high-temperature fluids, such as molten salts, and modified to be operated remotely when necessary for handling samples.

The goal is to provide users with characterization equipment, infrastructure and technical staff necessary to provide reliable and reproducible data for designing, demonstrating, licensing and operating molten salt reactors.

MSTEC equipment can also be used for fuel cycle research and development, as well as material accountancy and mass tracking for nuclear safeguard-related research.

MSTEC is strategically located at Idaho National Laboratory, which contains unique facilities such as the Neutron Radiography Reactor and the Advanced Test Reactor for irradiating salts



and the Analytical Research Laboratories for isotopic and elemental analysis.

Materials that can be handled in MSTEC include, but are not limited to, irradiated and nonirradiated chlorides, fluorides, beryllium, actinides including plutonium and other minor actinides, and gases with hydrogen, chlorine and fluorine.

INL
Idaho National Laboratory

(Top to bottom) Rheometer, gas displacement pycnometer and thermomechanical analyzer

SCIENTIFIC EXPERTISE

MSTEC scientists, engineers and technicians are MSTEC's most valuable asset. Staff members are experts in their fields, ranging from mechanical and electrical engineering to distinguished instrument scientists who study molten salts and other nuclear applications. The MSTEC team will aid in experimental studies to troubleshoot complex problems and to offer simplified solutions.

TECHNICAL CAPABILITIES

A **rheometer** is a precision instrument used to measure viscosity and provide an understanding of fluid flow. The rheometer can accurately measure viscosity over a wide range of flow conditions, such as different shear stresses and temperatures, with relatively small sample volumes.

- Operating temperature up to 1,000°C
- Sample size of less than 10 mL
- Accuracy within ±5%
- Measuring geometries include parallel plate, cone and cup and double gap with custom designs available upon request

The **gas displacement pycnometer** is a device for nondestructively measuring the density of a solid. It does this by first determining the mass using a highly accurate balance and second by volume determination using argon or helium.

- Operating temperature up to 200°C
- Sample size of 1 cm^3
- Accuracy within ±2%

The **densitometer** is a custom instrument utilizing the Archimedes principle to measure density in the liquid phase. The instrument is designed to interface with the MSTEC universal furnace to allow for density measurements of high-temperature liquids, such as molten salts or liquid metals.

- Operating temperature up to 1,000°C
- Sample volume of 10 ml or less
- Accuracy within ±5%

The universal furnace can be used for a large range of applications including salt synthesis of novel fuel compositions, electrochemical measurements, probe development for real-time estimation of oxide and actinide species, and comparison of anode materials for electrochemical reduction and corrosion studies.

- Operating temperature up to 1,000°C
- Hot zone dimensions: 6.375" in diameter by 9.875" tall
- Featureless internal to accommodate different process operations
- Electrochemical and gas line feed throughs

The **simultaneous thermal analyzer (STA)** with mass spectrometer is a multifunctional instrument used to measure weight loss and energy change as a function of temperature. Applications include phase diagram development, enthalpy, vapor pressure, off-gas analysis, salt stability and temperature-dependent changes, i.e., invariant temperatures, polymorphic, and melting temperatures determination.

- Operating temperature up to 2,000°C
- Sample size greater than 10 milligrams
- Accuracy within ±5%

The **differential scanning calorimeter (DSC)** is an instrument for high-precision measurement of specific heat capacity and determining sample purity. In addition, the DSC can measure temperature-dependent transitions and the energy associated melting, crystallizations, or other crystallographic transitions.

- Operating temperature up to 1,650°C
- Sample size greater than 10 milligrams
- Accuracy within ±2% for energy and within ±5% for specific heat capacity

The **thermomechanical analyzer (TMA)** is a tool that measures dimensional changes in a solid or liquid material as a function of temperature and/or time under a defined stress. The TMA provides insight on the density change through a solid-liquid or liquid-solid transition. Other applications include thermal expansion of metals and irradiated materials.

- Operating temperature up to 1,000°C
- Sample volume of less than 0.25 mL
- Accuracy within ±2%

FOR MORE INFORMATION

Technical Contact
Toni Karlsson
208-533-8230
toni.karlsson@inl.gov

General Contact
Samuel Reiss
208-526-2930
samuel.reiss@inl.gov

www.inl.gov

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