# Guo Group

**Solid state and f-block chemistry**

## Studying Thermodynamics and structures of f-block condensed matters

### Ln/An material/minerals
- REE minerals/ceramics
- High entropy ceramics
- Silicate minerals
- An oxalates
- Pu-bearing solids

### Alternative nuclear fuels
- U-C, U-N, U-Si
- PuO$_{2+x}$
- CeO$_2$
- UO$_2$
- Cladding
- Molten salts

### Nuclear waste forms
- An silicates
- An phosphates
- U Pyrochlore
- Ceramics & Glass
- Repository research

### Lab capability I: in situ Structural studies (wide ranges of P-T)

#### Lab-based light source (XAS)

- Neutron PDF determines atomistic model of An silicate solid solution
- EOS and high P structures of silicate minerals (CeSiO$_4$) and U-Si intermetallic

Funded by DOE NEUP GSI, commissioned in 2021
- Reasonable XANES/XAFS and great XES for transitional metals, REE, and actinides (Th, U, Np, and Pu) for chemical states and local structures.

For structure from Å to micron
- Pair distribution function
- X-ray diffraction
- XANES and XAFS
- In situ capability (high T and P)
**Lab capability II:**

*Elastic Characterization (RT – 800 C)*

- High T Resonant Ultrasonic Spectroscopy
- Thermal stress distribution of a laser emitter Ce:YAG
- Poisson’s ratio
- Elastic behavior up to 800 C
- Bulk, Shear, Young’s Moduli and Poisson’s ratio

**Lab capability III:**

*High Temperature Thermodynamic Analysis (RT – 2400 C)*

- High T Differential Scanning Calorimetry – Thermogravimetric Analysis
- Application in aerospace thermal coating material stability study
- For thermal stability
  - Phase transition
  - Thermal stability
  - TGA up to 2400 C

- Drop solution Calvet calorimetry
- For thermodynamic stability
  - Heats of formation, $\Delta H_f$
  - Heats of mixing, $\Delta H_{mix}$
  - Heats of reaction (500 – 1000 C)

**Energetic landscape of waste form ABO$_4$ (zircon structure)**
Calorimetry Lab at WSU

**Basement** lab (B21), located in a **Nuclear Reactor** building

- Temperature fluctuation < 0.5 ºC
- Equipped with a rad glove-box for handling Pu (powder processing and pelletizing)
- Large quantity of $^{232}$Th, $^{238}$U;
- Moderate amounts of Np, Pu, (Am, Cm, Cf and other transuranium) (~ 100 Ci/yr)