

The Diffraction User Center (DUC) is part of the High Temperature Materials Laboratory (HTML), which is a DOE User Facility dedicated to solving materials problems that limit the efficiency and reliability of systems for power generation and energy conversion, distribution, storage and use. The DUC provides world-class facilities and a staff of technical experts for determining the structure of materials, using x-ray, synchrotron, and neutron diffraction techniques.

### Multipurpose X-Ray Powder Diffraction



*This instrument provides either divergent- or parallel-beam optics coupled with high-temperature stages.*

- Philips X'Pert Pro vertical  $\theta/\theta$  goniometer
- Cu or Cr x-ray targets
- Anton Paar XRK 900 high-temperature (HT) furnace with rotating sample stage (RT to 900°C)
- Anton Paar HTK16 HT furnace Pt strip heater (RT to 1600°C)
- Multipurpose RT sample stage
- Proportional detector or position-sensitive detector
- X'Pert Plus Crystallography and Rietveld software

#### Applications

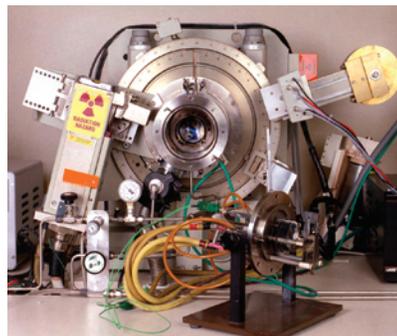
- HT phase transformations
- HT residual stress using parallel beam optics
- Thermal expansion using parallel beam or divergent optics
- Phase equilibria studies

### High-Temperature X-Ray Powder Diffractometer

- Scintag PAD X vertical  $\theta/\theta$  goniometer
- Cu, Mo, Cr, Co, Ag, and Fe x-ray targets
- Buehler HDK 2.3 furnace with Pt, W, Ta, or Mo strip heaters (RT to 1600°C, or 2200°C+ in vacuum)
- Controlled environment (O<sub>2</sub>, Ar, N<sub>2</sub>, H<sub>2</sub>, ambient, etc.), 1 atm, pO<sub>2</sub> sensing
- Peltier Si(Li) energy-dispersive detector
- Position-sensitive detector (rapid data acquisition)

#### Applications

- *In situ* process simulation
- Lattice thermal expansion coefficients
- Oxidation/reduction kinetics
- Phase equilibria studies
- Order/disorder transformations
- Rietveld analysis



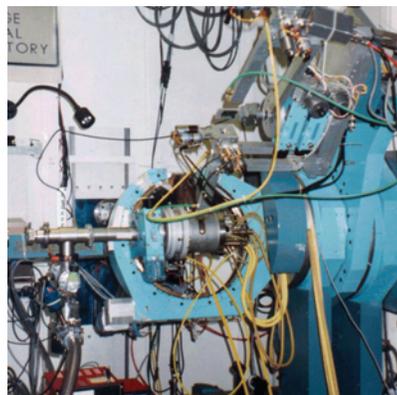
*This instrument combines divergent optics with a high-temperature stage and atmospheric control.*

### High-Temperature Synchrotron X-Ray Diffractometer at the National Synchrotron Light Source

- Six-circle Huber diffractometer with split chi-ring; crystal analyzers (Si, Ge, LiF, graphite); CAMAC multichannel analyzer; pinholes > 10 mm diam; scintillation and proportional counters
- Focusing incident beam silicon monochromator
- Tunable wavelengths from 0.5 to 2.5 Å
- Buehler HDK 2.3 furnace with Pt, W, Ta, or Mo strip heaters (RT to 1600°C, or 2200°C+ in vacuum)
- Controlled environment (O<sub>2</sub>, Ar, N<sub>2</sub>, H<sub>2</sub>, ambient, etc.), 1 atm
- Rotating capillary mount and optional furnace

#### Applications

- Oxidation/reduction kinetics
- Phase equilibria studies
- Order/disorder transformations
- Single-crystal diffraction
- Rietveld analysis



*This high-flux beamline instrument is designed to permit the measurement of precise lattice parameters.*

## Low-Temperature X-Ray Powder Diffraction

- Scintag XDS2000 vertical  $\theta/\theta$  goniometer
- Cu, Mo, Cr, Co, Ag, and Fe x-ray targets
- Displex closed-cycle He refrigerator (10 K to 300 K)
- Cold sample loading
- Diffraction side graphite monochromator and scintillation detector

### Applications

- *In situ* process simulation
- Lattice thermal expansion coefficients
- Oxidation/reduction kinetics
- Phase equilibria studies
- Order/disorder transformations



*This instrument combines divergent optics with a displex closed-cycle He refrigerator.*

## High-Temperature Neutron Powder Diffractometer at the High Flux Isotope Reactor

- High-resolution 32-detector array
- Sensitive to light elements (H, C, O, S, etc.)
- Bulk diffraction rather than near-surface
- Temperatures up to 1600°C in vacuum furnace
- Temperatures from 2 K in He cryostat

### Applications

- Phase equilibria studies
- Order/disorder transformations
- Rietveld analysis
- Microstress analysis in composites

## Room-Temperature X-Ray Powder Diffractometer

### Features

- PANalytical X'Pert Pro MPD vertical  $\theta/\theta$  goniometer
- Cu x-ray target
- Programmable slits
- X'Celerator RTMS detector with optional monochromator
- Single- or 15-position sample holder

### Applications

- Structure refinement
- Lattice parameter refinement
- Quantitative phase analysis
- Crystallite size and microstrain determination

## DUC Staff

### E. Andrew Payzant, User Center Leader

E-mail: [payzanta@ornl.gov](mailto:payzanta@ornl.gov)  
Phone: (865) 574-6538

### Jianming Bai

E-mail: [bai@bnl.gov](mailto:bai@bnl.gov)  
Phone: (631) 344-2583

### Claudia J. Rawn

E-mail: [rawncj@ornl.gov](mailto:rawncj@ornl.gov)  
Phone: (865) 574-3184

### Roberta A. Peascoe-Meisner

E-mail: [meisnera@ornl.gov](mailto:meisnera@ornl.gov)  
Phone: (865) 576-9480

### LaRonda Mack

Group Secretary  
E-mail: [mackl@ornl.gov](mailto:mackl@ornl.gov)  
Phone: (865) 576-0815  
Fax: (865) 574-3940

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