Research Environment

Comprehensive Training in the Techniques Required for New Materials Exploration

Depending on their research themes, group members can acquire the following experimental and analytical skills:

- Synthesis and sample preparation of inorganic solids
- High-temperature and high-pressure synthesis and single-crystal growth under high pressure
- Single-crystal growth using flux methods
- Powder and single-crystal X-ray diffraction and crystal-structure analysis
- Measurements of magnetization, electrical resistance, heat capacity, and dielectric properties
- Measurements of ion-conduction properties
- Physical-property characterization at low temperatures and under high magnetic fields and high pressures
- Structural and physical-property analysis using neutron and synchrotron radiation
- Statistical-mechanical models and atomistic simulations
- Comparison and validation of experimental data and theoretical models

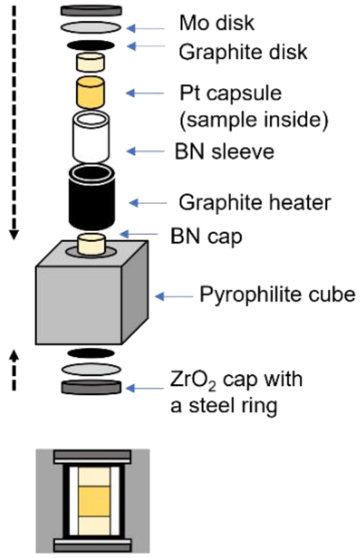
In addition to the research facilities at NIMS, we collaborate with neutron and synchrotron radiation facilities, universities, and theoretical research groups in Japan and overseas to address questions that cannot be resolved using a single instrument or research method.

Through presentations of research results, scientific writing, and collaborative research with universities and research institutions in Japan and overseas, group members can also gain international research experience.

Major Research Facilities and Experimental Environment

- **Multi-Anvil High-Temperature and High-Pressure Synthesis Apparatus**

Samples are compressed from multiple directions to synthesize new materials and grow single crystals under precisely controlled high-temperature and high-pressure conditions.

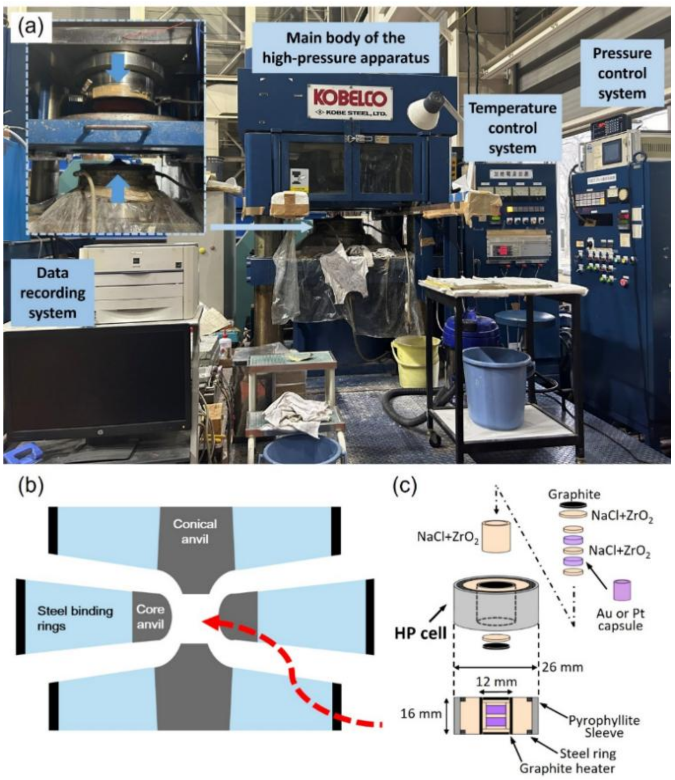


Cubic-anvil cell assembly

Cubic-anvil high-pressure apparatus

- **Belt-Type High-Temperature and High-Pressure Synthesis Apparatus**

High-temperature and high-pressure conditions are used to synthesize metastable phases and materials with new crystal structures that cannot be obtained at ambient pressure.



- **Single-Crystal and Powder X-Ray Diffractometers**

Single-crystal diffraction data are used to determine atomic arrangements, crystal symmetry, and interatomic distances precisely. Powder samples are analyzed to identify crystalline phases, lattice parameters, phase purity, and crystal structures.

- **Magnetic and Physical-Property Measurement Systems**

Magnetization, electrical resistance, heat capacity, the Hall effect, and other properties are measured at low temperatures and under high magnetic fields to investigate magnetic transitions, magnetic anisotropy, coercivity, and electronic transport properties.

- **Single-Crystal Growth and Controlled-Atmosphere Furnaces**

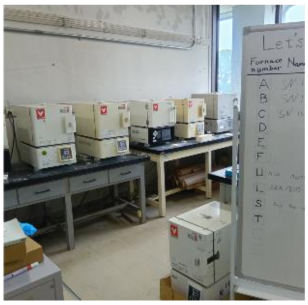
In addition to growing high-quality single crystals by flux and related methods, samples are fired and heat-treated under controlled atmospheres of oxygen, nitrogen, inert gases, and other gases.



- **Sample Synthesis and Preparation Facilities**

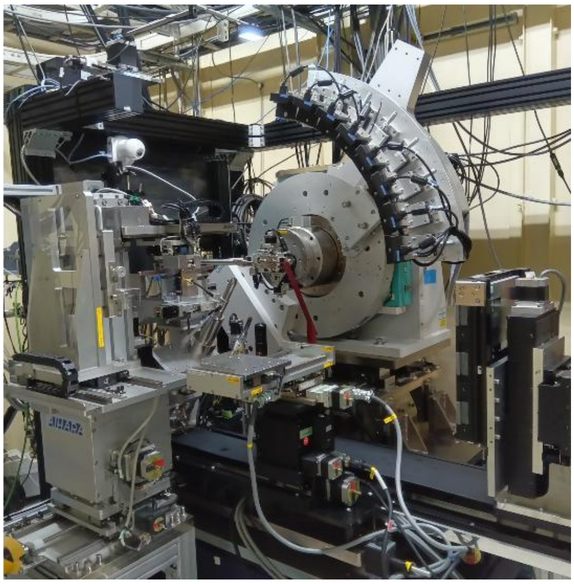
Samples are prepared for new materials synthesis through raw-material mixing, pellet formation, sealing, and heat treatment under controlled atmospheres. Materials that are unstable in air or moisture can also be handled under an inert-gas atmosphere.






- **Synchrotron X-Ray Diffraction at Shared Research Facilities**

High-brilliance synchrotron radiation is used to investigate minute samples, complex crystal structures, and temperature-induced changes in atomic arrangements with high precision.

- **Thermogravimetric and Differential Thermal Analysis Systems**

Mass changes and endothermic or exothermic responses during heating are measured to investigate decomposition, redox reactions, phase transitions, and reaction temperatures.


- **High-Temperature Electrical-Resistance, Nonlinear-Optical, and Thermoelectric Measurement Systems**

Electrical resistivity, second-harmonic generation, and the Seebeck coefficient are measured at high temperatures to investigate electronic conduction, phase transitions, broken inversion symmetry, polar structures, charge-carrier behavior, and thermoelectric properties.