"We're using advanced manufacturing to explore new superalloys that will enhance fossil fuel plant performance."

Michael Kirka,
Materials Scientist

Innovations for Fossil Energy

Oak Ridge National Laboratory (ORNL) has a rich history of scientific research supporting the nation's exploration, production, and use of abundant, domestic fossil energy. We focus on research and development of materials and sensors for extreme environments; modeling and simulation of subsurfaces; and technologies for carbon capture, use, and storage.

Materials and Manufacturing

- New alloys and coatings to enable safer, longer lasting, and more efficient power plant operation.
- Detailed analysis of novel materials to assist with certification before first use in power plants.
- Advanced manufacturing of new components for fossil energy production and use.
- Solutions to advance modular fossil fuel power generation, with resulting fleet efficiency improvements.
- Designing, developing, and characterizing materials for extreme environments.

Carbon Capture, Use, and Storage

- Directly converting CO_2 to ethanol in a high-yield process using a nanotechnology-designed catalyst.
- Using tracers to study the transport of CO_2 injected into the subsurface at the Cranfield site in Natchez, Mississippi—a unique, real-world test of CO_2 storage.
- Developing models to predict the long-term security of CO_2 storage sites.
- Demonstrating a new energy-efficient, direct-air-capture approach to CO_2 that recycles sorbent materials.
- Additive manufacturing of devices for carbon capture.

INNOVATING materials and sensors for power plants

ENGINEERING sorbents, solvents, and membranes for CO_2 solutions

DEVISING advanced imaging algorithms to see subsurfaces

MODELING concepts with supercomputing to speed research

MAKING manufacturing improvements for new alloys

ORNL scientists are using neutrons to study complex interactions in the subsurface in order to improve drilling operations and carbon storage.

Subsurface R&D

- Employing custom algorithms to enhance images and model the subsurface.
- Advanced materials to improve construction and durability of wellbores.
- Materials and sensors that can withstand a harsh underground environment and allow for better reservoir characterization.
- Using neutron scattering and other techniques to better explore pore-fluid interaction as it relates to oil and gas recovery and carbon storage.
- Improved mineral recovery with novel solvent extraction, membrane, ion exchange and sorbent technologies.
- Neutron imaging and scattering techniques to understand multiscale hydrocarbon storage within reservoir rock, flow through porous and fractured geologic materials, and deformation of geologic materials.
- Mineral recovery from geothermal brines and produced fluids, including membrane, solvent extraction, ion exchange, and sorbent technologies.

Comprehensive Capabilities

High-performance computing—The world's fastest, most artificial intelligence–capable supercomputer, modeling power generation and the subsurface environment.

Neutron science—Two of the most powerful neutron science facilities in the world, providing a nondestructive, atom-level view of materials and processes.

Center for Nanophase Materials Sciences—Nanomaterials synthesis, nanofabrication, imaging, microscopy, and modeling for materials characterization.

Manufacturing Demonstration Facility—Development of new manufacturing technologies to reduce the cost of materials for carbon capture and storage, modular power generation, coal gasification, and coal-to-products innovations.

Extreme Environment Evaluation and Testing—ORNL houses a large fleet of unique high-temperature corrosion, fatigue, and creep test equipment.

Chemical and Molecular Science, Engineering—Applying fundamental research to separations, sequestration, and power generation processes.

Model-Based Iterative Reconstruction—Novel algorithms to enhance subsurface imaging and modeling for improved reservoir characterization, better drilling and well completion techniques, and advancements in carbon storage.

The Haynes 282 superalloy was fabricated into rods and plates for analysis of its suitability in advanced gas turbines.

DOE HPC4Materials Program

ORNL is leveraging its world-renowned expertise and capabilities in materials science and HPC to develop materials that can withstand extreme conditions such as extreme pressures; extreme temperatures; radiation; or chemical, environmental, or fatigue stress states as part of the US Department of Energy's new **High Performance Computing for Materials Program.** Goal: Better performing materials that can save fuel and maintenance costs and increase US economic competitiveness.

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