



# Fossil Energy

Oak Ridge National Laboratory has a rich history of scientific research supporting the nation's exploration, production, and use of abundant, domestic fossil energy. We focus on the 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

- Advanced manufacturing of new components to enable transformational fossil energy technologies
- 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
- Solutions to advance modular fossil fuel power generation, improving fleet efficiency
- Designing, developing, and characterizing materials for extreme environments
- Materials for Extreme Environments Consortium: Developing computational tools for the design and testing of new alloys for advanced power generation, including simulation of performance and service life



*ORNL scientists developed a carbon nanospoke catalyst that directly converts CO<sub>2</sub> and water into ethanol. The project won an R&D 100 award.*

## Carbon Capture, Use, and Storage

- Directly converting CO<sub>2</sub> to ethanol in a high-yield process using a nanotechnology-designed catalyst
- Using tracers to study the transport of CO<sub>2</sub> injected into the subsurface at the Cranfield site in Natchez, Mississippi—a unique, real-world test of CO<sub>2</sub> storage
- Developing models to predict the long-term security of CO<sub>2</sub> storage sites
- Demonstrating a new energy-efficient, direct-air-capture approach to CO<sub>2</sub> 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<sub>2</sub> solutions



**DEVELOPING**  
advanced imaging  
algorithms to see  
subsurfaces



**MODELING** concepts  
with supercomputing  
to speed research



**CONVERTING**  
coal into high-value  
products like  
carbon fiber



“Our nanoengineered electrocatalyst can directly convert CO<sub>2</sub> and water into ethanol to fuel vehicles and help balance the power grid.”

**Adam Rondinone, Senior Staff Scientist**

# Comprehensive Capabilities

**High-performance computing**—The nation'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

**Carbon Fiber Technology Facility**—DOE's only designated user facility for carbon fiber innovation, developing high-potential, low-cost precursors, including coal

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

**Battery Manufacturing Facility**—Analyzing every aspect of battery production, from raw materials and electrode preparation to finished product and performance testing

**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

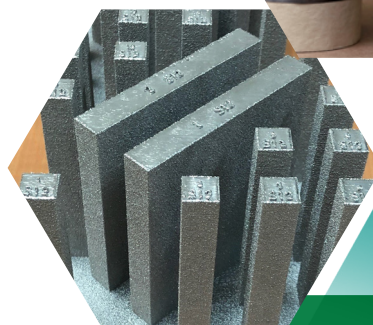
## Subsurface R&D

ORNL is developing solutions to better understand the subsurface environment, including

- 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 improved reservoir characterization;
- neutron scattering 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; and
- improved mineral recovery from geothermal brines and produced fluids, including membrane, solvent traction, ion exchange, and sorbent technologies.

## HPC4Materials

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



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