



OAK RIDGE NATIONAL LABORATORY

# Advanced Manufacturing

Oak Ridge National Laboratory (ORNL) draws upon unmatched capabilities in materials, neutron studies, and computational science to develop innovative technologies to assist manufacturing companies of all sizes in the deployment of at-scale solutions that lower production costs and improve US economic competitiveness. Researchers focus on improving manufacturing operations through the development of novel energy technologies. In collaboration with co-located industry partners, researchers investigate next-generation materials, simulations, data analytics, and artificial intelligence to create and demonstrate new advanced manufacturing systems and processes.

## Research and Development with Impact

**Energy-efficient manufacturing and industrial improvements**—Using chemical engineering methods to discover and demonstrate effective and alternative feedstocks as sources of energy, to reduce or eliminate dependency on fossil fuels, and applying innovations to manufacturing processes in industry to reduce energy use and increase resiliency, affordability, and US economic competitiveness

**Composites and advanced fibers for manufacturing**—Converting natural feedstocks and developing novel conversion processes to create materials with desirable traits such as strength, ductility, or flexibility; testing processes at industry scale for the benefit of manufacturers and end users; developing circular economies, where materials are put back into use rather than discarded to help mitigate waste and pollution

**Precision manufacturing and machining**—Designing, implementing, and scaling up next-generation manufacturing systems through the integration of robotics, automation, controls, and machine tools including novel large-scale metal wire arc and laser systems with multiaxis controls and powder systems with the ability to manufacture crack-free, highly nonweldable alloys to demonstrate microstructure control

**Secure and digital manufacturing**—Developing a digital manufacturing platform and a cyber-secure manufacturing ecosystem by integrating manufacturing systems enabled by advanced data analytics, metrology, characterization, process control, and secure communication; research capabilities in communication, computing, storage, and user interface for advanced manufacturing process analysis, modeling, and control



### CONTROLLING

microstructure in metal parts



### CUTTING

advanced fiber costs



### ADDITIVE MANUFACTURING

large-scale objects such as cars, houses, and tooling molds



### CREATING

upcycling, recycling, and recovery of materials



### QUALIFYING

additively manufactured components

“Our goal is to bring long-term immediate and cost-effective energy solutions to the manufacturing industry. By working together, we can implement logical steps and activities to achieve the nation’s goals.”

**Sachin Nimbalkar, Group Leader, Manufacturing Energy Efficiency Research and Analysis**



# Recent Impacts

**Additive manufacturing**—Developed a data framework containing modeling and real-time data acquisition to recognize variations and defects in a broad range of powder bed additive manufacturing technologies; designed and fabricated an infrastructure-scale concrete deposition system for energy generation applications

**Improving industrial processes**—Initiated virtual in-plant trainings through the Better Plants program, working with 600 industrial participants and achieving more than 180 hours and \$6 million in energy cost savings

**Advanced composites**—Created the first 3D-printed thermal protection shield for use in a space mission, launched in August 2021 to the International Space Station

**Large-scale applications**—Demonstrated the largest-ever steel print—947 layers and measuring 7 feet tall, and 2 feet wide—using new multirobot-coordinated deposition and a welder that deposits an order of magnitude faster than conventional welders

**Industry partnerships**—Worked with industry to develop and deploy a commercial tool and software that work together to increase material removal rates by 232%, resulting in a total annual savings of more than \$3.2 million

## National Collaborations

ORNL is a founding member or partner in several national collaborations aimed at introducing energy solutions to the manufacturing industry including the Hub and Spoke Partnership with the University of Maine, Institute for Advanced Composites Manufacturing Innovation, Cyber Manufacturing Innovation Institute, Critical Materials Institute, Innovation Crossroads, and Better Plants Program.

## Unique Facilities

**US Department of Energy (DOE) Manufacturing Demonstration Facility (MDF)** creates and accelerates next-generation advanced manufacturing technologies, where materials, processes, and systems are holistically integrated to strengthen the US manufacturing base. Researchers at the MDF develop new tools and methods that are more cost-effective, efficient, and reliable for the nation's security, economy, and energy portfolio. Through a robust technology transfer program, the MDF provides industry partners affordable and convenient access to facilities, tools, and expertise to facilitate rapid deployment of new technologies and energy solutions.

**DOE Carbon Fiber Technology Facility (CFTF)** assists industry with overcoming the barriers associated with cost and technology scaling of low-cost fibers and associated composites, including product and market development. The CFTF identifies high-potential, low-cost raw materials such as textile, lignin, polymer, and hydrocarbon-based precursors and houses a highly flexible manufacturing line rated for 25 tons per year and a precursor melt-spinning line rated at 65 tons per year.

**At the DOE Battery Manufacturing Facility (BMF)**, every aspect of battery production is analyzed, from raw materials and electrode dispersion preparation to finished product and performance testing. Partners can leverage the BMF's capabilities and experts to integrate any component or material into a complete battery to analyze how well it works and how it can be improved.



**\$1B+**  
Follow-on  
private  
investment

**250+**  
Co-located staff,  
students, industry  
partners

**100+**  
Advanced  
manufacturing  
systems

**32**  
R&D 100  
Awards

### CONTACT:

William Peter  
Advanced Manufacturing  
Office Program Manager

peterwh@ornl.gov  
865-241-8113

One Bethel Valley Road,  
Oak Ridge, TN 37830



[www.ornl.gov/  
advanced  
manufacturing](http://www.ornl.gov/advanced-manufacturing)