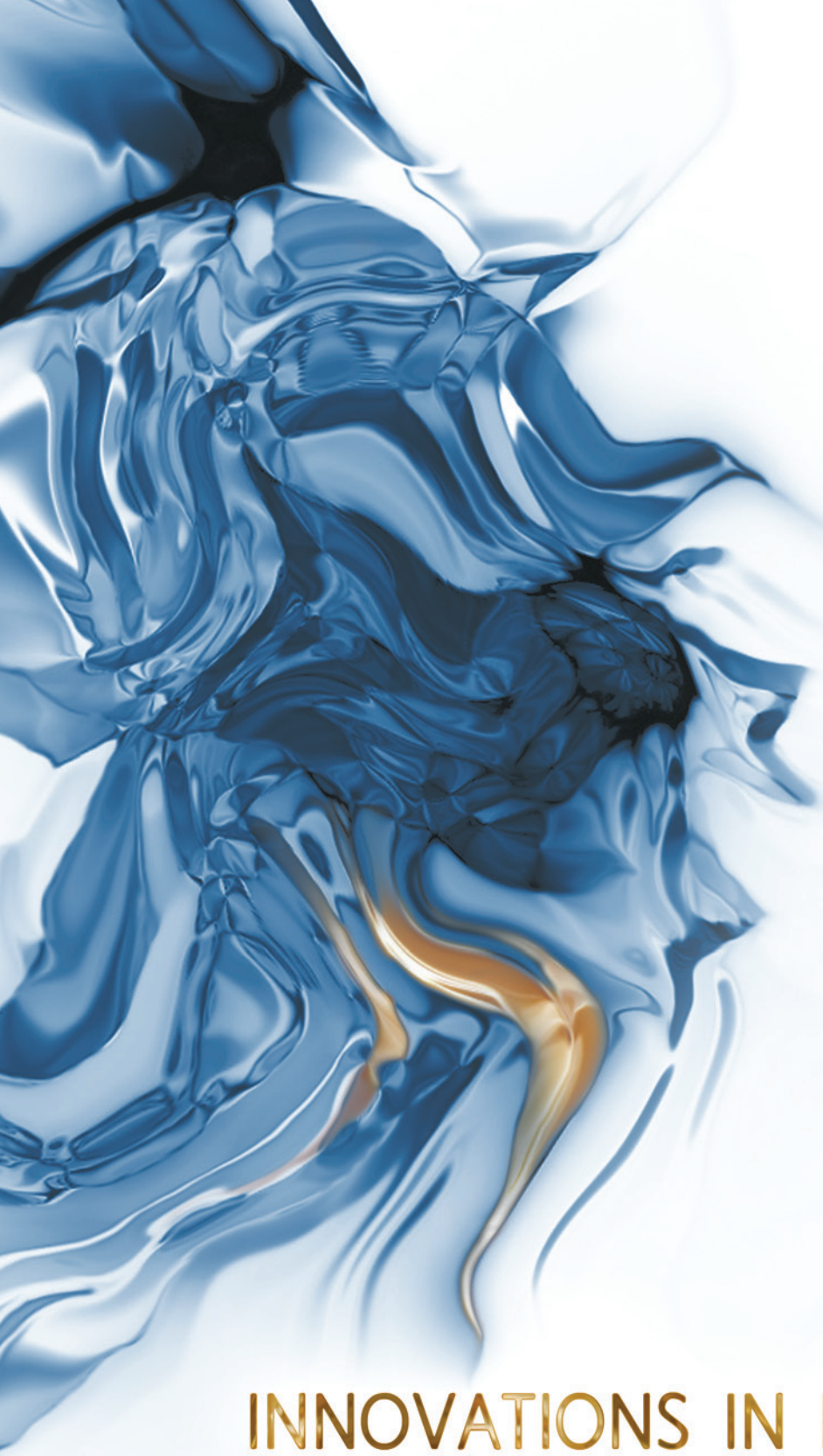
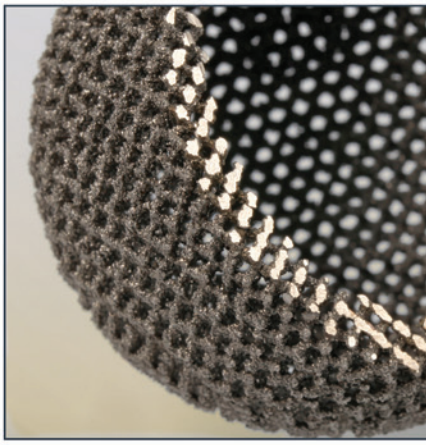




INNOVATIONS IN MANUFACTURING

Enabling the Future of Industry in the United States

OAK RIDGE
National Laboratory

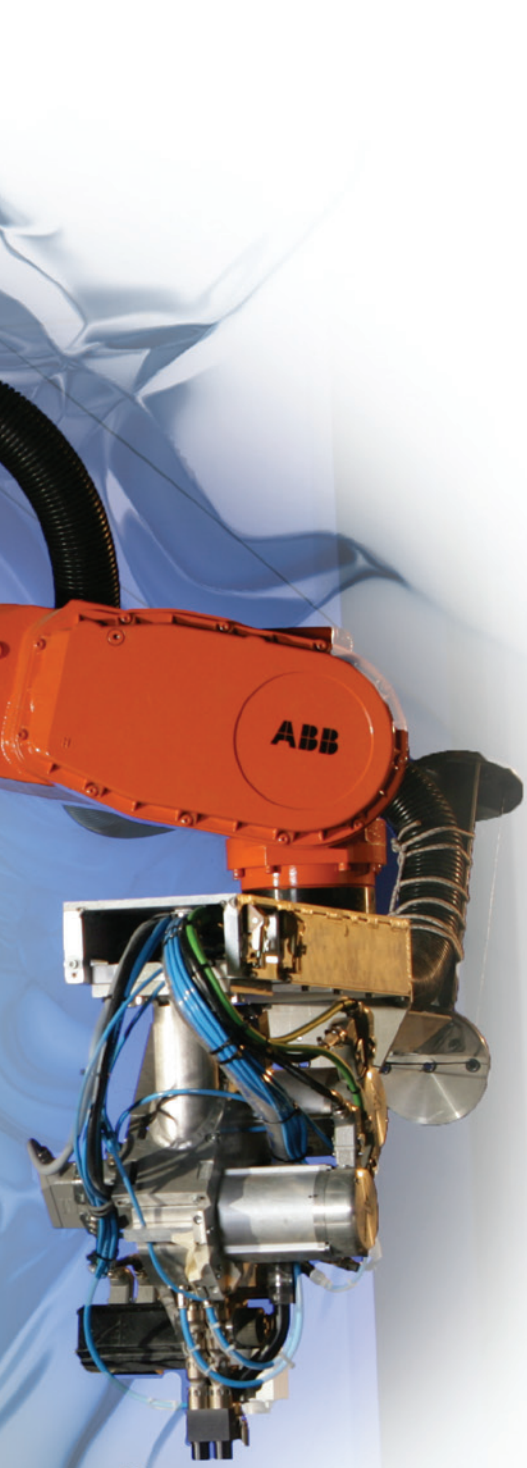
Enabling the Future of Industry in the United States

US MANUFACTURING FOR ADVANCES IN DEFENSE AND ENERGY

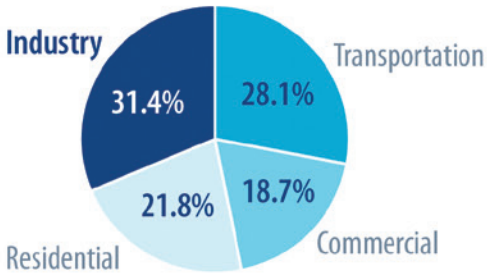
U.S. MADE

US Manufacturing for Advances in Defense and Energy

WHERE INNOVATION HAPPENS

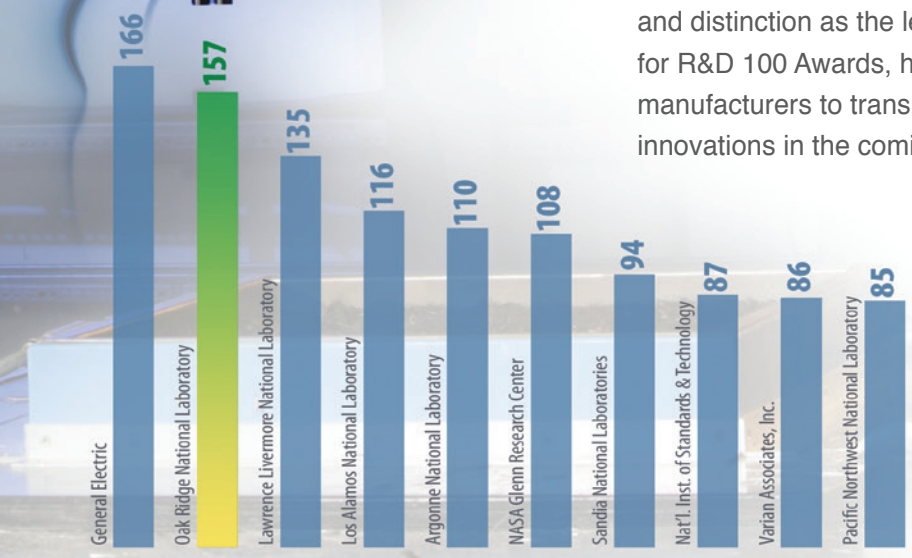


The US manufacturing industry is a cornerstone of the American economy and embodies the innovation and productivity that have allowed the United States to be the dominant leader in advanced manufacturing technologies since the early 20th century. A strong manufacturing base is vital for a balanced economy and critical to our nation's energy security and defense. Advances in manufacturing technology are imperative to avoid further erosion of our manufacturing base and maintain a competitive edge in the global market.



US industry consumed more than 31 quadrillion Btu in 2008—nearly a third of all energy used in the United States.

Innovation drives economic growth. New, cutting-edge technologies with real-world applications can both revitalize existing manufacturing industries and support the development of new products in emerging ones. The development and commercial deployment of advanced manufacturing technologies remain essential to America's long-term economic competitiveness. Manufacturing and materials research at Oak Ridge National Laboratory is focused on reducing the energy intensity of US industry, supporting development of new products, and strengthening our nation's vitality. ORNL, through its on going collaborative relationships with more than 1,000 companies and distinction as the leading Department of Energy Laboratory for R&D 100 Awards, has demonstrated the ability to work with US manufacturers to transition technologies that will drive manufacturing innovations in the coming decades.



Top Ten R&D 100 Award Winners

Historic Totals

Annual awards by *R&D Magazine* identifying the 100 most significant newly introduced R&D advances and technologies

ADVANCED MATERIALS

Lightweight Materials

Carbon Fiber

Advanced Structure Materials

Mesoporous Carbon

Nanomaterials

Titanium

Bioderived Materials

Aluminum

Refractories

Polymers

Coatings

Magnesium

Catalyst

Fuels

Discovering New Materials

New materials fuel the innovation engine that powers development of innovative products. Building upon a rich 60-year history in materials science, ORNL is discovering and developing advanced materials that will help reinvigorate existing manufacturing industries and result in creative new products. Stronger, more corrosion-resistant and lower cost steel alloys are being developed and commercialized to enable higher temperature and more energy-efficient operation in a variety of energy and industrial applications. New carbon materials are enabling cleanup of contaminated water produced while drilling to release vast new natural gas resources. ORNL is developing affordable new surface treatments and coating materials with wear and corrosion performance improvements that are four to eight times greater than heat-treated steels.

Storing Energy

Effective deployment of renewable energy sources such as wind and solar requires energy storage to overcome their intermittent nature. Advanced batteries will be critical to reducing the consumption of fossil fuels for transportation. ORNL's unparalleled expertise and capabilities in materials characterization and analysis are leading the development of a new generation of batteries that can store energy generated by solar panels, wind turbines, and electric cars.

Reducing Weight

Weight reduction is the key to energy efficiency in transportation and rapid deployment and maneuverability for our military forces. A reduction of 1,000 lb in vehicle weight will alone increase fuel economy more than 5 mpg. Combined with efforts to increase engine performance, such a reduction could allow cars of the future to achieve 100 mpg with no compromise of safety or performance. ORNL researchers are developing a new generation of carbon fiber composite materials and lightweight metal alloys to meet the weight reduction challenge.

A123Systems, Inc. | [illegible] | Alcoa Aluminum | Aleris International | Alpha Boilers, Inc. | Ame
Controls, Inc | Andritz Oy | Applied Materials Inc. | AquaChem, Inc. | ArcelorMittal USA | Avure Technologies | Babcock & Wilcox | Boeir
Products | Carpenter Technology Corporation | Caterpillar Inc. | CCS Materials Inc. | Ceramatec | Cleaver Brooks | CMS | Commercial Metals Company | CPL Sy
Inc. | E.ON Engineering | Eastman Chemical | Eaton Corporation | Edison Welding Institute | Emitting Lights LLC | Energy Industries of Ohio | Energy Systems
FPInnovations | Frito-Lay, Inc. | Gas Technology Institute | General Atomics | General Electric | Global Solar Energy | GrafTech International | GreenLeaf Corpo

INNOVATIVE PROCESSING TECHNOLOGIES

Reducing Costs

Two materials of great promise, titanium and carbon fiber, are restricted in application due to high material cost. New titanium powder and near-net shape consolidation processes hold the potential to reduce manufacturing energy intensity and cost up to 50%, as well as increase yields from 12% to near 90%. New low-cost precursor development and conversion technologies hold the key for reducing the cost of carbon fiber. ORNL is the recognized leader in these advanced processing technologies, which will enable broader deployment of these critical lightweight materials.

Increasing Performance

Use of magnetic fields to complement or eliminate conventional heat treatments can produce enhanced properties in a variety of materials including steel, titanium, magnesium, and other material systems. ORNL's ground breaking research in magnetic field processing is revealing a new domain of formerly unattainable material properties. ORNL's concerted investment in pulsed thermal processing, spanning most of a decade, is now paying large dividends as it enables manufacturing innovation in flexible electronics and next-generation solar photovoltaic devices.

Minimizing Lead Time

Additive manufacturing combines digital design, powder materials, and efficient energy sources to manufacture complex, near-net shape components. These technologies enable a paradigm shift in how we design and manufacture components of complex geometry. We are no longer constrained by limitations imposed by forming, casting, or machining processes. ORNL is employing its capabilities in ultrasonic, electron beam, and laser deposition to realize the full potential of this adaptive technology.

Carbon Materials

Process Intensification

Additive Manufacturing

Conventional Metals & Ceramics

Nanofermentation

Photonics

Welding & Joining

Magnetic Field Processing

Powder Consolidation

Continuous Reel-to-Reel

Driving Down the Cost of Lightweight Materials

50%

Energy Defense Energy

AUTOMATION & CONTROLS

Sensors

Wireless Communications

Computational Manufacturing

Robotics

Modeling and Simulation

Modeling, simulation, and automation reduces the manufacturing design, production cycle, and cost of manufacturing. ORNL's world-leading supercomputing facilities and broad modeling capabilities allow scientists and engineers to accelerate product design from concept to commercialization.

Sensing, Tracking, and Measurement

Advanced sensors and sensor networks will revolutionize manufacturing by providing industry the tools necessary to understand and optimize efficiency and lower operational costs. ORNL's research priorities in sensing are focused on biochemical, environmental, robotics, advanced logistics and process control systems, and intelligent sensor technologies for applications that advance science, improve energy efficiency, or enhance national security.

Communicating Wirelessly

Robust wireless communication networks offer rapid technology insertion and minimum cost of retrofit for reliable process control to improve energy savings, process efficiencies, and raw material utilization. From one-of-a-kind processes to intelligent robotics for manufacturing, the development and deployment of process automation and control are critical for productivity improvement in industry. ORNL leads the industry effort to establish wireless communication protocols and demonstrate the application of high-payoff wireless communication in industrial settings.

JOBS

1 direct manufacturing job equals
3 indirect jobs in related industries

iMI Vision / CCI Valve | Impact-REW Systems | International Paper | [illegible] Systems. | ITN Energy Systems | John
LMC, Inc. | Lockheed Martin Aeronautics | Mach I Inc. | Magnesium Elektron North America | Massachusetts Institute of Technology Institute | Maxwell Technol
Technologies | Metalsa-Roanoke, Inc. | Michigan Economic Development Corporation | [illegible] | Mossey Creek Solar | MS Technology Inc. |
| Navy Research Lab | nGimat Corporation | Novacentrix | One Planet Technologies LLC | [illegible] | Palmer Labs | Perpetua Power Source Tec
Polymers Center of Excellence | Porous Power Technologies, LLC | PPG Industries | Pratt & Whitney Rocketdyne | Queen City Forging | RFViz | Rolled Alloys

High Temperature Materials Laboratory
A user facility for materials characterization, synthesis, and testing

Spallation Neutron Source
The world's most powerful accelerator-based neutron source

Carbon Fiber Technology Center
North America's most comprehensive carbon fiber material and process development capabilities

Multiprogram Research Facility
Capable of executing national security science and technology projects

High-Performance Computing
World's most powerful open scientific computing facility

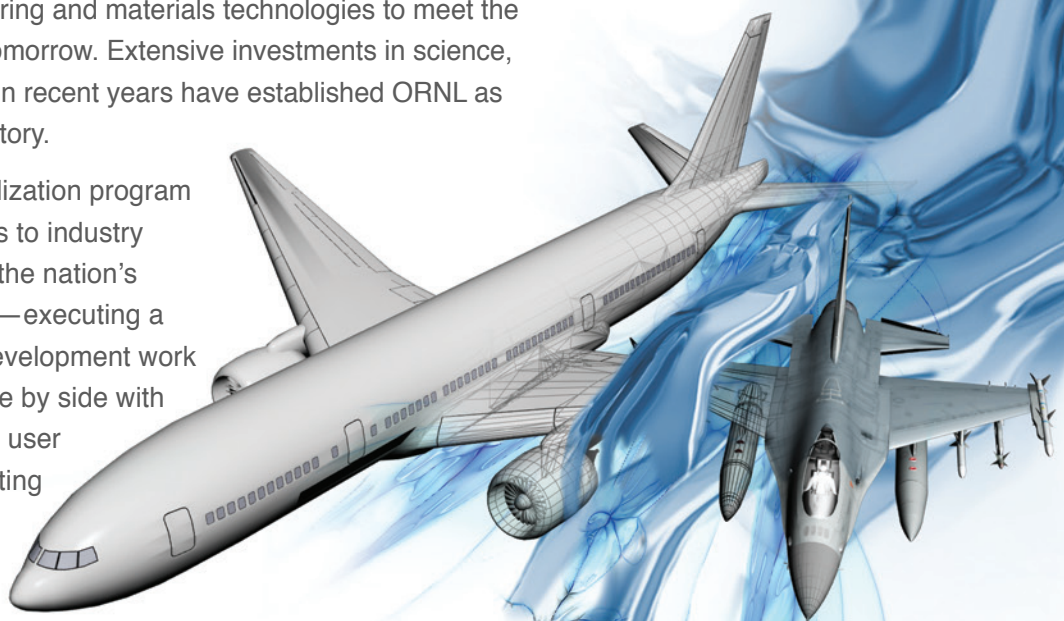
Energy Research
Nation's broadest portfolio of energy programs

Science and Technology Park
Making ORNL expertise and innovations available for economic growth

ADDRESSING THE CHALLENGES OF TOMORROW

Manufacturing is the engine that drives prosperity, spuring job creation and investment across the economy. Innovation is critical to the future of US industry for reducing barriers and enabling affordable, rapid, adaptable, energy-efficient manufacturing. ORNL is one of the world's most capable resources for transforming the next generation of scientific discovery into solutions for rebuilding and revitalizing America's manufacturing industries. From concept to commercialization, ORNL's world-leading facilities and expertise enable the accelerated development and deployment of innovative manufacturing and materials technologies to meet the commercial and defense needs of tomorrow. Extensive investments in science, computing, and process equipment in recent years have established ORNL as the nation's premier research laboratory.

Oak Ridge's aggressive commercialization program provides technology-based solutions to industry engaged in virtually every sector of the nation's economy. Regardless of the activity—executing a license, conducting research and development work sponsored by others, or working side by side with industry or university researchers at user facilities—we are committed to creating win-win opportunities to strengthen the competitiveness of our nation and its research enterprise.



Achieving an Innovative, Energy Independent and Sustainable Industrial Base

n Deere Power Systems | Johnson Controls
logies | MeadWestvaco | Media & Process Tech
| Multigig | Multisolutions Inc. | National Energy
hnologies | Petro Beam, Inc. | Planar Energy
| Ross Technology Corp. | SAFC HiTech Labs

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U.S. DEPARTMENT OF ENERGY

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