Realizing the Promise of

NEXT-GENERATION MANUFACTURING

Innovative Materials and Manufacturing Technologies to Make Next-Generation Products

Oak Ridge National Laboratory

Next-Generation Manufacturing

Oak Ridge National Laboratory is working with additive manufacturing equipment manufacturers and end users to revolutionize the way products are designed and built. Our research and development in this crucial field are enabling a wealth of opportunities for product customization, improved performance, multifunctionality, and lower overall manufacturing costs. Not only does additive manufacturing remove the traditional limits on part geometry, but highly complex components can also be fabricated faster while consuming less material and using less energy. Additive manufacturing also eliminates the need for expensive part tooling and detailed drawing packages, causing a paradigm shift for the design-to-manufacture process.

Tools for Innovation

ORNL has a long history of working closely with industry and offers world-leading capabilities in materials development, characterization, and processing. It also has specialized facilities for modeling and simulation, creating an unmatched environment for breakthroughs in additive manufacturing.

ORNL's Manufacturing Demonstration Facility (MDF) includes comprehensive additive manufacturing capabilities. These technologies significantly impact numerous application areas, from aeronautic to robotic and automotive to biomedical. For aerospace components this design-to-manufacture process has already demonstrated the potential to reduce the buy-to-fly ratio from an industry average of 8:1 (that is, 8 pounds of material will produce 1 pound of aerospace-quality material) to nearly 1:1. The increased design flexibly has also enabled radical improvements in anthropomorphic designs for robotic manipulators—allowing internal routing of hydraulic and pneumatic lines for actuation—and reduced the design-cycle time from months to days. This revolutionary process also enables the customization of biomedical implants as well as surface modifications for increased biocompatibility. And new fluid-powered systems, from large multiton material-handling equipment to very small biomedical devices, are being developed in partnership with several companies to create next-generation additive manufacturing systems, consumables, and application concepts.

What is Additive Manufacturing?

Additive manufacturing creates components directly from a computer model, adding material only where needed, which means unlimited design flexibility, decreased energy consumption, and reduced time to market.

Polymer

Fused Deposition Modeling

Uses a heated nozzle to melt and deposit a thin filament of thermoplastic material into a two-dimensional pattern.

Equipment: Stratasys, 3D Systems, Afinia, Solidoodle

Multi-head Photopolymer

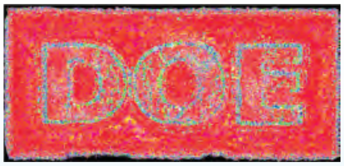
Inkjet print heads are used to jet liquid photopolymers onto a build platform. The material is immediately cured by UV lamps and solidified which allows to build layers on top of each other.

Equipment: Stratasys/Objet

Large-scale Polymer Deposition

Polymer pellets are heated to near molten temperatures and extruded layer-by-layer onto an out-of-the-oven build platform.

Equipment: BAAM-CI



Research Reveals Unique Capabilities of 3D Printing

ORNL researchers use an additive manufacturing method to control the structure and properties of metal components with precision unmatched by conventional manufacturing processes. Ultimately, this demonstration promotes the ability to build metal components with site specific control on crystallographic orientation of grains using the electron beam melting process.

Working with ORNL

The MDF gives industries access to unique research facilities and reduces their risk for adopting cutting-edge manufacturing technologies. ORNL has decades of experience working with industry through a variety of business agreements and recognizes the importance of protecting intellectual property.

Through the MDF the Advanced Manufacturing Program at ORNL offers a fertile environment for innovation, ensuring that new technologies and design methodologies are developed in the United States and high-tech enterprises have the infrastructure to flourish here. Such critical advances in manufacturing technologies will provide the basis for high-quality jobs for Americans and sustain US competitiveness in the 21st century.

Metal

Electron Beam Melting

Manufactures parts by melting metal powder in successive layers that are bound together utilizing a computer controlled electron beam.

Equipment: ARCAM

Laser Blown Powder Disposition

Uses inert gas to spray powder into a melt pool created by a high-power laser beam.

Equipment: DM3D, POM

Laser Sintering

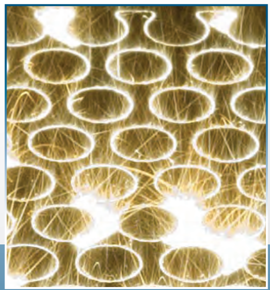
Uses a high power laser to fuse powdered material by scanning cross-sections on the surface of a powder bed.

Equipment: Renishaw

Binder Jetting

Utilizes a liquid binding agent that is selectively deposited to join powder particles through strategic layering.

Equipment: ExOne



Metal Laser Melting

Powder materials are locally fused by a high-energy fiber laser that is directed by a mirror-deflecting unit to create layer-by-layer components.

Equipment: Concept Laser

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For more information about additive manufacturing and related research, contact

Alan Liby
Director of the Advanced Manufacturing Program
Oak Ridge National Laboratory
PO Box 2008, MS 6186
Oak Ridge, TN 37831-6186
libyal@ornl.gov

www.ornl.gov/manufacturing

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ADVANCED MANUFACTURING OFFICE