> "We're applying fundamental knowledge about plants, forestry, and agricultural systems to develop new renewable materials for 3D printing."
>
> Erin Webb,
> Agricultural Engineer

Engineering New Materials from Biomass

The vast agricultural and forestry resources of the United States supply a variety of materials that can be used to make bioderived products, from biofuels to cosmetics to the plastic in soda bottles. Oak Ridge National Laboratory's (ORNL's) bioderived materials research develops methods and technologies that enable greater and higher value use of biomass to sustainably produce a wider range of high-performance products.

Advancements in biomass technologies and applications build on years of research in conjunction with the US Department of Energy (DOE) BioEnergy Science Center and current Center for Bioenergy Innovation at ORNL. Bioderived research focuses on using a variety of strategically identified feedstocks and employing advanced processing methods to enable novel breakthroughs in fundamental science and product improvement.

Developing New Materials

A cross-disciplinary team of scientists is combining fundamental knowledge about plant biology with expertise in manufacturing to identify efficiencies and create new uses for biomass, matching plant characteristics and processing parameters to the end product. Researchers are studying nanocellulose, lignin, biofibers, and renewable composites for 3D printing.

Plant biology and genetics—Furthering an understanding of the relationship between genetics and plant characteristics based on studies of poplar trees, eucalyptus, and other feedstocks.

Conversion and engineering—Examining ways to deconstruct plants into usable components without destroying inherent plant characteristics and synergistically combining biological and chemical conversion to achieve higher yields and novel products.

Materials and manufacturing—Exploring material compositions and manufacturing methods to create opportunities to add value to production streams and create new structural and functional materials.

APPLICATIONS

- AUTOMOTIVE PARTS
- ENERGY STORAGE DEVICES
- MOLDS AND TOOLS
- PACKAGING AND INSULATION
- BIOMEDICAL DEVICES

Scientists are studying poplar trees and the genetics that lead to higher yields for use in biofuels and bioproducts.

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ENERGY

Applications, Demonstration, and Industry Innovation

ORNL is a US leader in unclassified materials research and development, with particular emphasis on the array of materials derived from biological feedstocks, specifically woody and herbaceous biomass. These bioderived materials are based on common forms of naturally occurring polymers, including nanocellulose, lignin, and hemicellulose. ORNL is working to advance fundamental and applied research throughout the production pipeline, from feedstocks to conversion to demonstration.

Biomass from plants can be harvested, stored, processed, and transported to produce fuels or bioderived materials for 3D printing. By integrating scientific discovery and technology innovations, ORNL is leading the way to developing new bioderived materials for a variety of applications, including large-scale additive manufacturing.

Recent Impacts

Printing with plants—Created a scalable processing technique that uses lignin, a current by-product of the biofuels production process, to produce a new material for 3D printing with excellent performance.

Supertough bioplastic—Developed a bioderived polymer that is 10 times tougher than polylactic acid without sacrificing strength or stiffness and with improved manufacturability.

Shape-memory conductors—Generated a renewable material programmed to remember its shape that offers a potential low-cost alternative to conventional conductors for sensors and robotics.

Partnerships and Collaborations

ORNL is partnering with the University of Maine in a unique collaboration to combine the Laboratory's bioscience, materials science, and additive manufacturing expertise and capabilities with the university's focus on forest-based biomaterials for new composites and biobased structures to advance and support Maine's forest products sector.

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ORNL used a bamboo composite to 3D print outdoor pavilions for a DesignMiami exhibition in Florida.