

## New composite advances lignin as a renewable 3-D printing material

December 19 2018, by Kim Askey

---



A new composite of lignin and nylon is easily extruded during 3D printing and exhibits good mechanical strength in finished products. Credit: Oak Ridge National Laboratory

Scientists at the Department of Energy's Oak Ridge National Laboratory have created a recipe for a renewable 3-D printing feedstock that could spur a profitable new use for an intractable biorefinery byproduct: lignin.

The discovery, detailed in *Science Advances*, expands ORNL's achievements in lowering the cost of bioproducts by creating novel uses for lignin—the material left over from the processing of biomass. Lignin gives plants rigidity and also makes biomass resistant to being broken down into useful products.

"Finding new uses for lignin can improve the economics of the entire biorefining process," said ORNL project lead Amit Naskar.

Researchers combined a melt-stable hardwood lignin with conventional plastic, a low-melting nylon, and [carbon fiber](#) to create a composite with just the right characteristics for extrusion and weld strength between layers during the printing process, as well as excellent mechanical properties.

The work is tricky. Lignin chars easily; unlike workhorse composites like acrylonitrile-butadiene-styrene (ABS) that are made of petroleum-based thermoplastics, lignin can only be heated to a certain temperature for softening and extrusion from a 3-D-printing nozzle. Prolonged exposure to heat dramatically increases its viscosity—it becomes too thick to be extruded easily.



Using as much as 50 percent lignin by weight, a new composite material created at ORNL is well suited for use in 3D printing. Credit: Oak Ridge National

## Laboratory

But when researchers combined lignin with nylon, they found a surprising result: the composite's room temperature stiffness increased while its melt viscosity decreased. The lignin-nylon material had tensile strength similar to nylon alone and lower viscosity, in fact, than conventional ABS or high impact polystyrene.

The [scientists](#) conducted neutron scattering at the High Flux Isotope Reactor and used advanced microscopy at the Center for Nanophase Materials Science—both DOE Office of Science User Facilities at ORNL—to explore the composite's molecular structure. They found that the combination of lignin and nylon "appeared to have almost a lubrication or plasticizing effect on the composite," noted Naskar.

"Structural characteristics of lignin are critical to enhance 3-D printability of the materials," said ORNL's Ngoc Nguyen who collaborated on the project.

Scientists were also able to mix in a higher percentage of lignin—40 to 50 percent by weight—a new achievement in the quest for a lignin-based printing material. ORNL scientists then added 4 to 16 percent carbon fiber into the mix. The new composite heats up more easily, flows faster for speedier printing, and results in a stronger product.



ORNL scientists have created a new composite material for additive manufacturing that makes use of lignin, a biofuels byproduct. Credit: Oak Ridge National Laboratory

"ORNL's world-class capabilities in [materials](#) characterization and synthesis are essential to the challenge of transforming byproducts like lignin into coproducts, generating potential new revenue streams for industry and creating novel renewable composites for advanced manufacturing," said Moe Khaleel, associate laboratory director for Energy and Environmental Sciences.

The [lignin](#)-nylon composite is patent-pending and work is ongoing to refine the material and find other ways to process it.

**More information:** Ngoc A. Nguyen et al. A path for lignin valorization via additive manufacturing of high-performance sustainable

composites with enhanced 3D printability, *Science Advances* (2018).  
[DOI: 10.1126/sciadv.aat4967](https://doi.org/10.1126/sciadv.aat4967)

Provided by Oak Ridge National Laboratory

Citation: New composite advances lignin as a renewable 3-D printing material (2018, December 19) retrieved 26 April 2024 from <https://phys.org/news/2018-12-composite-advances-lignin-renewable-d.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.