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Forest Products Laboratory website:
www.fpl.fs.fed.us/

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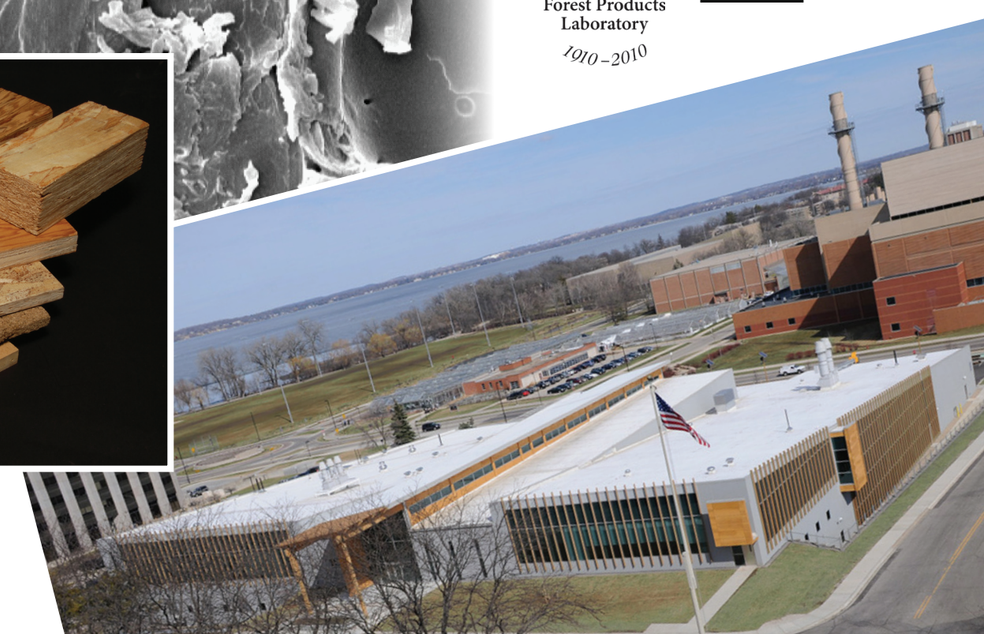
Engineered Composites Science

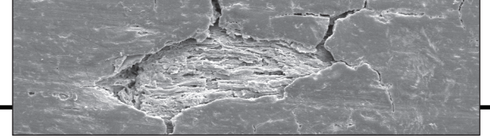
Forest Products Laboratory
Madison, Wisconsin

Mission: Understanding relationships between materials, process, and performance to engineer biocomposites that benefit users while promoting the sustainability of both virgin and recycled forest resources

100 Years of Service
Forest Products Laboratory
1910 – 2010

USDA





Promoting Sustainable Forestry

Through science and technology, the Forest Products Laboratory (FPL) works to conserve and extend our Nation's forest resources. We promote healthy forests and forest-based economies through the efficient, sustainable use of wood.

As an integral part of the FPL mission, the Engineered Composites Science Research Work Unit improves the long-term sustainability of our Nation's forests by creating valuable products from bio-based materials. Composites can promote the use of underutilized materials and improve the economics of costly forest restoration projects.

Research Scope

We use the term *composite* to describe any wood material combined with a non-wood material. We perform research on the following products:

- Conventional wood-based composites (e.g., plywood, oriented strand board-OSB particleboard, fiberboard-medium density fiberboard-MDF, hardboard)
- Wet-formed composites (e.g., 3-D engineered fiberboard)
- Wood-thermoplastic composites
- Nanocomposites

A Comprehensive Approach

Composites research at FPL aims to determine the relationship between raw materials, processing technologies, and performance levels to improve the value and performance of composite materials.

Highlighted research areas include:

- Developing value-added structural composite lumber and OSB panels from waste biomass such as slash, thinnings, and other sources of small diameter wood
- Developing medium density fiberboard from wood fiber, rice straw, and other agricultural residuals
- Developing methods for producing reactive extrusion composites from wood-derived materials and polymers
  - Understanding and manipulating microstructure for improved performance of polymer composites
  - Optimizing 3D Engineered Fiberboard technology through computer modeling, testing, process manipulation, fiber blends, and alternative materials evaluation
  - Optimizing microwave heating and pressing in a pressurized/vacuum environment
  - Developing destructive and non-destructive test methods to understand fundamental properties
  - Understanding the fundamental changes that occur during weathering
  - Improving composite durability through innovative methods including developing new additives, processing techniques, and post-processing treatments
  - Producing cellulose nanocomposites by breaking down wood fibers into their elementary nanofibrils and using those nanofibers as reinforcement for various composites

Capabilities

The engineered composites science team is a multidisciplinary team with emphasis in mechanical engineering, chemical engineering, materials science, and physics. Our expertise allows us to

- Understand fundamental relationships between wood, natural fiber, and alternative materials to optimize composite processing and performance.
- Improve the performance, durability, and value of existing composites while defining the next generation of hybrid composites made from natural fibers and alternative materials
- Develop tools to address resource sustainability, enhance recyclability, and minimize the environmental impacts of composite processing.

We work closely with other laboratories and research work units at FPL. We also partner with other government entities, industry, and academic institutions through collaborative research programs.

Equipment

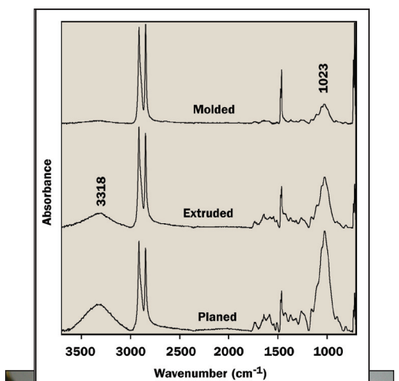
The equipment here highlights our major capabilities.

Size-reduction equipment

- Flakers
- Hammer mills
- Crusher rolls
- Pressurized and non-pressurized refiners

Fiber and flake processing

- Blenders (including rotary, paddle, and closed loop tube blender)
- Mixers
- Ovens
- Dryers
- Screeners



Web and mat forming

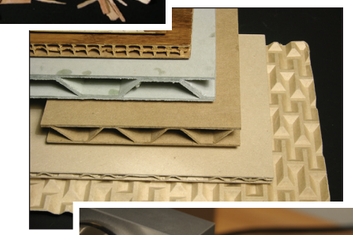
- Air-laid non-woven web former
- 36- by 36-in. and 24- by 24-in. medium-density fiberboard (MDF) mat formers
- Oriented strandboard (OSB) mat former and aligning head
- 26- by 104-in. and 24- by 24-in. wet process mat former

Presses

- Four hot presses (20 by 20 in., 36 by 36 in., 50 by 50 in., and 26 by 104 in.)
- All presses equipped with computerized process control and data acquisition

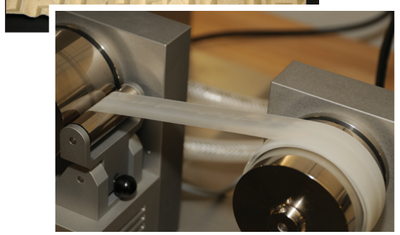
Wood fiber–plastics processing

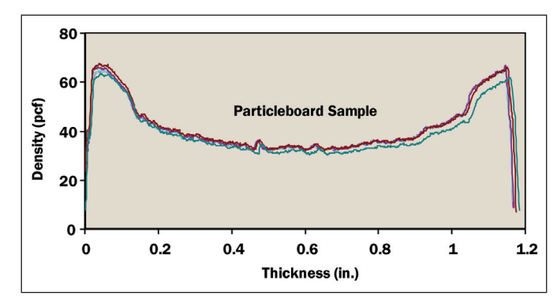
- Thermokinetic mixer
- Granulator
- 33-ton injection molder
- Compounding line
  - 32-mm twin-screw co-rotating extruder
  - Loss in weight feeder system
  - Strand and profile dies
  - Downstream equipment
- Profiling line
  - 3.5-in. single-screw extruder
  - Two profiling dies
  - Downstream equipment
- Torque rheometer
  - Extruder
  - Batch mixer
- Melt flow indexer



Nanocomposites processing

- High-shear microfluidizer
- Microcompounding and microprocessing system
  - Conical twin-screw compounder
  - Mini-injection molder
  - Film line
  - Fiber spinning line
  - Fiber conditioning



Testing and analysis equipment

- QMS vertical density profiler
- Fourier-transform near-infrared (FT-NIR) spectrometer
- Fourier-transform infrared (FTIR) microscope
- MTS universal testing machine
- Moisture analyzer
- Computer capture thickness and weight measurement
- 2-kW microwave (pressurized) press
- Cantilever beam non-destructive vibration tester
- Xenon-arc accelerated weathering device