

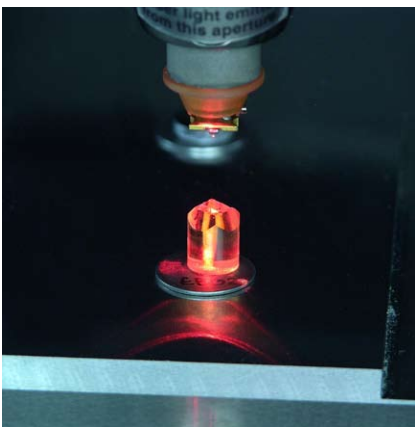


Nanotechnology, the Future of the Nation's Wood and Paper Industries, and the Forest Products Laboratory



Nanotechnology—the manipulation of materials measuring 100 nanometers or less in at least one dimension and having novel properties—is expected to drive global economic growth in this century. Many nations around the world are making major investments in nanotechnology research. The United States has committed \$1 billion annually to nanotechnology R&D. But very little attention or funding has focused on applying nanotechnology to one of our country's most versatile and abundant natural resources—its forests.

America's forests constitute an immensely valuable and renewable strategic asset. Trees are photochemical factories that naturally produce raw materials—including potentially useful nanoscale cellulose fibrils—from sunlight, water, and carbon taken from the atmosphere and soil. The United States has a vast infrastructure in place for growing, harvesting, transporting, and processing wood. Paper and wood products contribute more than \$240 billion to the Nation's GDP and provide more than



A toothpick-sized wood specimen, embedded securely in epoxy, awaits the business end of FPL's atomic force microscope, which can make ultra-sensitive measurements of wood cell topography and will be used to image the indents produced by the nanoindenter.

1.1 million jobs. The forest products industry is among the top 10 manufacturing industries in 42 of the 50 states. The future of this vital U.S. industry—and therefore, of the Nation's ability to care for and conserve its forests—will depend on the country's successful application of nanotechnology to forest products.

————— = 1 inch = 25.4 million nanometers

(A nanometer is a billionth of a meter, or 80,000 times thinner than a human hair.)

New Products, Materials, and Processes

Because nanoscale materials often exhibit novel properties, they offer the potential to develop entirely new or enhanced wood-based products and materials as well as new approaches and processes for producing such materials. For example, novel nanomaterials produced in other industry sectors could be used to improve the performance of current forest products; nanomaterials produced from wood could be used to produce materials with revolutionary strength, optical, electrical, and chemical properties; and nanomaterials produced in other industries could be combined with wood-derived nanomaterials to produce original materials having heretofore unimagined qualities and performance. The possibilities are numerous:

- Adhesives, coatings, and modified wood with enhanced resistance to fire, moisture, light, and decay
- Biocomposite “designer” materials with specifiable structural and functional properties
- Cost-effective substitutes for non-renewable metallic, plastic, or ceramic products
- Preservatives to replace wood treatments containing heavy metals
- “Intelligent” wood- and paper-based products that can measure forces, moisture, or temperature or detect decay or imminent failure
- Enhanced processes for converting biomass to fuels and energy

For more information, contact Ted Wegner, Assistant Director, USDA Forest Service, Forest Products Laboratory, (608) 231-9434, twegner@fs.fed.us www.fpl.fs.fed.us



-
- Highly efficient, low-heat electronic components for use in miniature devices such as computer circuits
 - Lightweight armor
 - Tissue scaffolds for replacement of human limbs and organs

Redefining Competitive Advantage

Nanotechnology will transform the international forest products industry from a resource-based industry to a knowledge-based industry—a transition favoring those countries that lead in nanotechnology R&D and product innovation. Recognizing the importance of the emerging technology, researchers and administrators at the USDA Forest Service Forest Products Laboratory (FPL) have taken steps to establish a foundation in forest products nanotechnology:

- The Forest Service has become part of the Federal National Nanotechnology Initiative and participates in coordinating and planning government-wide nanotechnology R&D.
- FPL interacts closely with the U.S. forest products industry on nanotechnology applications through the American Forest & Paper Association's Agenda 2020 Technology Alliance.

- FPL has acquired state-of-the-art instrumentation, including a nanoindenter coupled to an atomic force microscope, needed to study wood and other materials at the nanoscale level.
- FPL researchers are working to better understand the fundamental properties of wood cell walls and how those properties are affected by interactions with chemicals. This is both basic and applied research. Improved adhesives and sealants are anticipated. Other practical applications include better understanding of the aging process of caulking materials.

Nanotechnology R&D is critical to economical and sustainable production of new generations of forest-based materials that meet societal needs while improving forest health. Continued application of nanotechnology to forest products will involve scientific disciplines, tools, and instruments not traditionally associated with forest products research. The Forest Products Laboratory is uniquely positioned to carry out nanotechnology R&D and to work cooperatively with university researchers, other federal agencies, and materials industries to bring a range of resources to bear on nanotechnology and forest products.