

A LITTLE REVOLUTION: NANOTECHNOLOGY IN THE FOREST PRODUCTS INDUSTRY

By James T. Spartz,
University of Wisconsin Graduate Student

The future of the forest products industry dreams big. But it thinks small. Very small. Nanotechnology, the study of materials and structures 1 to 100 nanometers in size, presents unique physical, electrical, and magnetic properties. Simply put, this technology is the future. Nanotechnology sets the stage for 21st century developments of an age-old building material—wood—and the many lignocellulosic-based products society has come to depend on. Indeed, what's old is new again.

By becoming both a user of nanotechnology and a producer of novel nanomaterials, the forest products industry has enormous opportunity to reinvent and reinvigorate itself, says Ted Wegner, assistant director of the Forest Products Laboratory in Madison, Wisconsin. Anti-microbial and water-resistant coatings on lumber; thinner, stronger paper products; wood-based materials stronger than steel; embedded nanosensors in composite materials to measure forces, loads, moisture, and temperature; and photovoltaic capabilities for residential units are but a few of the potential industry applications.

To put the nanoscale in perspective, think of the Indianapolis Motor Speedway at about four kilometers per lap. Now picture a common brown ant, about four millimeters in length. The 1,000,000 times difference between the racetrack and the ant is roughly the same as between the ant and a single nanoparticle that is about four nanometers in diameter.

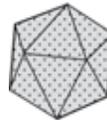
“Nanotechnology has been going on for a long time, we just didn't call it that” says Robert J. Moon, Forest Products Laboratory researcher located at Purdue University in West Lafayette, Indiana. The technology to see and work with these ultra small particles, to manipulate and study their physical, chemical, or biological properties, has been a recent development, says Moon.

Nanotech developments in forest products could also smooth over fluctuations in market highs and lows. The forest products commodity market, says Moon, can be more of a saw tooth than a sine wave: Steady rises in production and demand can be followed by sharp declines. Those market drop-offs, says Moon, “just decimate everybody.”

The U.S. forest and paper industry is the world's largest manufacturer of forest products. It is also an industry



The Indianapolis Motor Speedway is about four kilometers per lap.



The million times difference between the racetrack and the ant is roughly the same as between the ant and a single nanoparticle (about four nanometers in diameter).



A common brown ant is about four millimeters in length.

facing a number of stark business challenges, says Wegner. Global competitors, he says, often use new, highly efficient technologies and can have energy, labor, or resource advantages. “The American forest products industry alone has lost more than 250,000 manufacturing jobs since 2006. It's closed more than 220 plants since 1997,” says Wegner. These stark facts are amplified by the reality that mill closings devastate the mostly rural communities where pulp and paper mills are a primary employer. These lost jobs, and many tertiary positions, Wegner adds, are “high paying, skilled manufacturing jobs.”

Revitalization via nanotech developments in the forest products industry, and in rural communities that rely on primary and tertiary jobs, would require large capital investments to upgrade existing infrastructure located near both forest and water resources. Specialty production lines within larger facilities or separate boutique-type mills would be most realistic. These mills would have to specialize, says Moon, to produce what the competition could not, and would “have to be open-minded or have the ability to accept these new [nano-related] products.” For example, a lot of work is happening to develop functional displays out of certain types of paper products, says Moon. This means that if the newspaper

(continued on pg. 3)

NEWSLINE TEAM

Gordie Blum
Jim Anderson
Tivoli Gough
Bill Ireland
Sue Paulson
James Spartz
Rebecca Wallace

Check out our website at
<http://www.fpl.fs.fed.us>

Published quarterly by USDA Forest Service Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726-2398. Articles may be reprinted provided credit is given to the Forest Products Laboratory and NewsLine. To receive this newsletter electronically or to be removed from our mailing list, write Communications Director Gordon Blum at the address above or at gblum@fs.fed.us or call Forest Products Laboratory at 608-231-9200.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audio tape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call 202-720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.

Mention of commercial services, products, and firms is for information purposes only and should not be construed as U.S. Department of Agriculture Forest Service endorsement over other products, services, or firms that may be suitable.

UPCOMING EVENTS

INTERNATIONAL CONFERENCE ON WOOD ADHESIVES

September 29-30, 2009

Harvey's Resort, South Lake Tahoe, Nevada: The ninth in a series of conferences sponsored every 4-5 years by the USDA Forest Service, Forest Products Laboratory and Forest Products Society designed to provide a comprehensive update of the science and technology of wood adhesives and bonded wood products. The conference will be held in conjunction with ASTM International D 14.30 Wood Adhesives Subcommittee on October 1, 2009. Information transfer during the 3-day conference will take place via plenary, technical and poster presentations, and tabletop exhibits on the following subject areas: formaldehyde and environmental issues, resin chemistry modeling, biobased adhesives, analytical methods, engineered wood structures, and other topics. For more information visit <http://www.forestprod.org/confadhesives09.html>.



TAPPI 2009 CORRUGATED CONFERENCE

September 1-3, 2009

Hyatt Regency, Chicago, Illinois: Highlights this year include a repeat of the very cost effective Box Plant Deal, small group workshops to permit advanced training with emphasis on topics of interest and the Supplier Gala, a great opportunity to interact with customers and suppliers. For more information visit www.tappi.org/s_tappi/doc_events.asp?CID=11775&DID=562234.

WOOD YOU BELIEVE...

- Every year, six additional trees are planted for every one that is harvested.
- Our forest and our trees are renewable natural resources. Wood products come from a resource that grows, matures and is continually replanted for generations to come.
- We still have 70% of the forests that were here in the 1600's.
- There are 82% more hardwoods today than 40 years ago.

Facts from <http://www.bwphdws.com/woodfacts/default.htm>



A Little Revolution (continued from pg. 1)

industry doesn't completely dry up and blow away, someday there may be video capabilities embedded in the pages of your Sunday paper or weekly newsmagazine. But, Moon cautions, those types of advances are "a long way off."

What isn't so far off is the hope that nanotech start-ups can find a home not just in large centers of industry but also in rural communities. Kevin Klungtvedt is working to make this a reality in Rushford, Minnesota, a Root River valley farming community nestled in the Richard J. Dorer Memorial Hardwood State Forest. Klungtvedt leads RINTEK, a small nonprofit company providing laboratory, business incubation, and educational resources to support new and existing companies in the development of nano-related ideas, technologies, and product advancements.

Keeping nanotech start-ups small and rural makes sense to Klungtvedt. "The Woodrow Wilson Institute," he says, "has stated that 90 percent of all nanotech is done with companies of less than 100 people. That's small business!" And that's a smart way to go, suggests Klungtvedt, who has been working with scientists and business professionals at the University of Minnesota-Twin Cities to develop rural nanotech initiatives in southeast Minnesota.

"Small businesses in this economic climate need a place to call home that's inexpensive and a good place to bring a family," says Klungtvedt. He looks back to an era before globalization and points out that most small towns had several factories for many different locally produced products. "We're looking to go full circle on this," he says. Working along the same lines as the National Nanotechnology Initiative (NNI), Klungtvedt stresses, "our number one goal right now is to educate the population."

Along those lines, a new Fundamentals of Nanoscience course is being offered not far from Klungtvedt's home turf, about 20 miles north at the Minnesota State College-Southeast Technical branch in Winona. What's more, a Nanotechnology Rural Education Initiative grant, made possible through the National Science Foundation, has made stipends available for new students in the course.

Funding for education and training during these key early stages of advancement is crucial to getting a jump on the scientific competition. At the federal level, says Moon, "we're trying to build a program that's anywhere from \$85 to \$120 million in annual funding for research and development." Some of this federal funding, he suggests, would go to help U.S. start-up companies develop strategic nanotech innovations.

Europe and Asia are currently investing over \$1.5 billion annually in nano-based research, which makes demand for astute American leadership even more pressing. Optically transparent paper as foldable as standard paper has been produced in Japan; electro-active paper, a "smart material,"

from Korea has been proposed as a biomimetic actuator for microwave power transmission; and porous cellulose nanopaper of remarkably high toughness has been created by a team of scientists in Sweden. Given these advances, it seems the future of the paper industry has arrived in a big (or is it small?) way.

The Agenda 2020 Technology Alliance, a special project of the American Forest & Paper Association (AF&PA), has embraced developments in nanotechnology. This industry-led partnership with government and academia created the first nanotechnology roadmap for the U.S. forest products industry in 2005. It has since prioritized six areas where nanotechnology is of greatest interest: improving the strength-to-weight performance of forest products, developing commercially important wood-derived nanomaterials, understanding and controlling water-lignocellulose interaction in order to modify wood and wood-based material properties, modifying nanoscale surfaces and developing inorganic-organic nanocomposites, exploiting the photonics and electronic/piezo-electric properties of wood, and using nanomaterials and modifications to dramatically increase wood processing energy efficiencies. Safety and risk assessments are also primary concerns. The need to understand and mitigate risks to health, safety, and the environment that result from the introduction of engineered nanoscale materials, nanostructured materials, and nanotechnology-based devices was also affirmed as an integral part of all industry research efforts.

A revitalized forest products industry, stresses Wegner, would help enhance forest health and keep forested lands as forests by slowing current trends of forest fragmentation, parcelization, clearing, and conversion to non-forest uses. Innovations in nanotechnology will help spur an industry renaissance by replacing non-sustainable and fossil-fuel-based materials, such as plastics and metals, with wood and wood composite products and through economic growth and new opportunities for skilled workers. An array of forest ecosystem benefits, including wildlife habitat, clean water, clean air, carbon sequestration, and recreation, can be realized in part, says Wegner, because of advances in the use of nanotechnology.

Scientists, academics, and heads of industry have been working together to weave a diverse web of government and private initiatives in the area of nanotechnology research. The National Nanotechnology Initiative, by investing in fundamental research to further understand nanoscale phenomena and facilitate technology transfer, envisions a future in which the ability to control and understand matter at the nanoscale will lead to a revolution in technology and industry. Visit www.nanotechforest.org or www.nano.gov for more details.

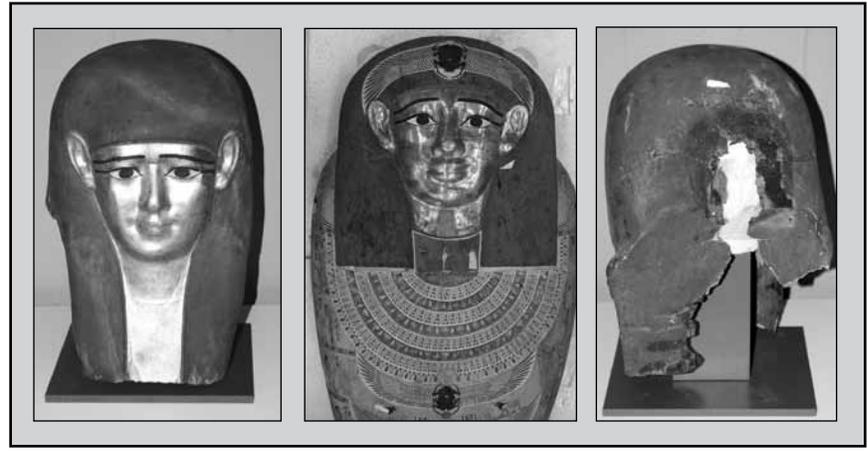
ANCIENT ART INSPECTED BY FPL SCIENTISTS

By Rebecca Wallace,
Public Affairs Specialist

FPL researchers recently put their wood condition assessment skills to use on an unusual subject: the coffin of Meretites, an Egyptian noblewoman. Acquired by the Nelson–Atkins Museum of Art in Kansas City, Missouri, the coffin is part of a 2,500-year-old assemblage of funerary objects that also includes a gilded mask, statuettes of Isis and Nephthys, and 306 figurines known as shabti.

FPL researchers were called upon for their expertise in determining the condition of wood without damaging it. Scientists were able to transmit sound waves through the wooden coffin and determine if decay was present by measuring the speed of the waves. The testing revealed that the upper section of the coffin was in excellent condition and that there was an area on the lower section that warrants further investigation based on evidence of deterioration.

The group of objects is not yet on display to the public but will be exhibited as a part of the specially designed galleries within the Nelson–Atkins ancient art collection, a renovation project expected to be completed in 2010.



FPL RESEARCHER ELECTED PRESIDENT OF AMERICAN WOOD PROTECTION ASSOCIATION

By Rebecca Wallace,
Public Affairs Specialist



On April 20, Bessie Woodward, a microbiologist at the Forest Products Laboratory, was elected president of the American Wood Protection Association (AWPA). Woodward is the first female president in the history of the century-old organization and will serve a one-year term. Woodward has been involved in wood preservation research since 1980. Her research focuses on the development of new methodologies aimed at shortening the time to evaluate long-term performance of wood preservatives. AWPA is a non-profit world-wide recognized organization that is responsible for propagating voluntary wood preservation standards. AWPA standards help ensure that treated wood products perform satisfactorily for their intended use.

ASK FPL

Questions?

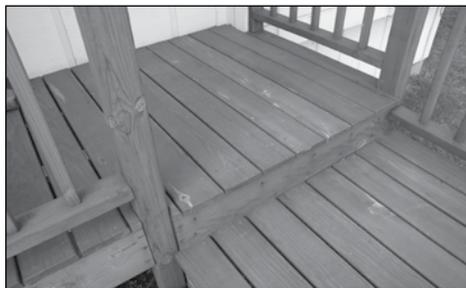
Contact us at
Forest Products Laboratory,
One Gifford Pinchot Drive,
Madison, WI 53726-2398
<http://www.fpl.fs.fed.us> or write
mailroom_forest_products_
laboratory@fs.fed.us
608-231-9200
TDD: 608-231-9544
FAX: 608-231-9592

WE GET THOUSANDS OF INQUIRIES EACH YEAR. WE PRINT WHAT WE FEEL ARE SOME OF THE BEST QUESTIONS HERE IS ONE WE RECENTLY RECEIVED.

I AM PLANNING TO FINISH MY DECK WITH AN OIL-BASED SEMITRANSSPARENT STAIN. DO YOU HAVE ANY TIPS FOR GETTING THE BEST RESULTS?

Semitransparent stains are a popular finishing choice because they penetrate the wood without forming a film, allowing much of the wood grain to show through the finish.

Penetrating stains perform best on roughsawn, weathered, or coarse-textured wood. Unlike paints, stains can be applied to weathered surfaces after only a cleaning with bleach and a small amount of detergent, followed by rinsing and waiting for it to dry before applying the finish. If you are finishing smooth wood, powerwash, sand, or wet the surface to relieve stresses and open the surface pores. If the surface is dirty or has mildew, clean it with bleach and detergent before applying the finish.



Stains may be applied by brush, spray, or roller. To prevent lap marks, finish the board or panel in one working session. Working in the shade will give the best results because longer drying time means greater penetration of the stain.

For best results, roughsawn or weathered lumber should be treated with two coats of penetrating stain; the second coat should be applied before the first is dry. (If the first coat has completely dried, it may seal the wood surface so that the second coat scarcely pen-

etrates.) To prevent formation of a film, an hour after applying the second coat, use a cloth, sponge, or dry brush lightly wetted with stain to wipe off any excess stain that did not penetrate the wood.

A word of caution: Sponges or cloths that are wet with oil-based stain are particularly susceptible to spontaneous combustion. To prevent fires, seal such materials in a water-filled air-tight metal container immediately after use.



Forest Products
Laboratory

1910-2010

NEWSLINE

Published quarterly by
USDA Forest Service
Forest Products Laboratory
One Gifford Pinchot Drive
Madison, WI 53726-2398
Chris Risbrudt
Director

FIRST CLASS PRSRT
U.S. POSTAGE PAID
MADISON, WI
PERMIT NO. 168

RETURN SERVICE
REQUESTED

VISIT FPL'S NEW
AND IMPROVED WEBSITE
<http://www.fpl.fs.fed.us/>

FPL recently completed a long-overdue overhaul of our website. When you have some time, please check it out at www.fpl.fs.fed.us

You'll notice that we have a new system in place to catalog information, and we have greatly upgraded our search capabilities. We hope that you find the site much easier to use and navigate.

To continuously improve our website, we want to hear from you. Please email our new webmaster, Rajinder Lal (rlal@fs.fed.us), to let him know what you think. Also, please help us spread the word by sharing this news with your friends and contacts.

Summer 2009 IN THIS ISSUE

- A LITTLE REVOLUTION:
NANOTECHNOLOGY
IN THE FOREST PRODUCTS
INDUSTRY
- FPL RESEARCHER ELECTED
PRESIDENT OF AMERICAN WOOD
PROTECTION ASSOCIATION
- ASK FPL
- WOOD YOU BELIEVE
- UPCOMING EVENTS
- ANCIENT ART INSPECTED BY FPL
SCIENTISTS