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Trees...In Space?

Russian cosmonaut Fyodor Yurchikhin checks out "trees" in a plant growth chamber aboard the space shuttle Atlantis during its October flight to the International Space Station. Forest Products Laboratory researchers were part of a team that sent the plant *Arabidopsis thaliana*—a member of the mustard family—in space to better understand the effect of gravity on lignin. Lignin is a substance that affects the strength of plant stalks and stems.



"Much is known about *Arabidopsis*," says FPL senior scientist Raj Atalla. "It has been genemapped, and it is extremely quick growing, so it is well suited for this experiment." Atalla adds that studying the effect of gravity on lignin could help scientists better understand the lignin synthesis process. This could have many benefits for the pharmaceutical and timber industries, among others.

The team is made up of researchers from the University of Colorado, NASA, Weyerhaeuser, and UPM—Kymmene of Finland. "FPL's unique contribution is studying structural changes in the wood tissue," says Atalla. Later next year the team plans on sending up loblolly pine for the second time. 

Cleaning up the papermaking process

Revolutionary chemistry mimics natural processes, makes economic sense, and produces no harmful effluents

By Gordie Blum

Thanks to tougher environmental regulations and numerous industry initiatives, making paper is a much cleaner process than it was 20 years ago. It is also more expensive. According to industry figures, on average a pulp and paper plant spends between 10% and 20% of its total annual budget on environmental protection. From 1993 to 1998, industry spending on environmental compliance ranged from \$588 to \$740 million.

Despite these efforts, papermaking still produces small amounts of byproducts that can impact the environment. But a new process may change that. In fact, this process could help virtually eliminate any environmental impact. "We feel we are on the verge of discovering the holy grail of papermaking," says Ira Weinstock, FPL research chemist. Weinstock is referring to a complex chemical process known as polyoxometalate

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FPL Technology Back on the Market


By Rebecca Hoene

In the early 1990s, researchers at the Forest Products Laboratory developed and patented a technology for making light weight, high-strength panels from recycled paper fibers. These panels, called Spaceboard, were used for everything from trade show displays to Hollywood props and sets, including those for several HBO programs and the movie “Batman Forever”. The technology was licensed to several companies, but none was able to succeed commercially.

Recently, Sonoco has revived the product and is now manufacturing and marketing it under the name SONOBoard 3D. The plant is currently using 100% recycled fibers to create the panels. SONOBoard is 3/8 inch thick with a hexagonal honeycomb-style pattern on

one side and a smooth surface on the other. Two panels can be glued together to make a 3/4-inch-thick panel with two smooth sides.

SONOBoard is strong and durable yet very lightweight. It is non-toxic and completely recyclable. The panels can be used to create a wide variety of products using standard processes such as drilling, sanding, fastening, gluing, and laminating. Sonoco is currently pursuing the use of SONOBoard for furniture, shelves, cores for doors, room dividers, and wall panels.

For more information, please contact Don Jenkins, General Manager of Sonoco Structural Fiber Division, at 843/339-6622 or by email at don.jenkins@sonoco.com. 

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Cleaning Up *(from page 1)*

(POM) bleaching. Although the chemistry is complex, the concept is fairly straightforward.

“POMs mimic the naturally occurring break-down of wood by fungi, but they do so in a much more rapid way,” says Weinstock. “Industry cannot afford to wait 10 years for fungus to degrade wood.”

Weinstock is part of a team led by FPL senior scientist Raj Atalla. The team, which includes Craig Hill at Emory University in Atlanta and others from the University of Wisconsin–Madison and the Helsinki University of Technology in Finland, is refining this process in hopes that the paper industry will soon implement it on a large scale.

Weinstock says the key to good papermaking is the ability to remove lignin—which gives wood its structural strength—while leaving the cellulose (the fiber) undamaged. “Lignin is the Styrofoam packing that holds the fiber in place,” he explains. “We have to peel it away to get at the fiber.”

So far chlorine has proven to be the best agent for degrading lignin while minimizing damage to the cellulose. However, some of the cellulose is damaged using chlorine. An even bigger problem with chlorine is that it is harmful to the environment. The papermaking industry has moved away from using elemental chlorine and now uses chlorine dioxide; but chlorine dioxide produces troublesome chlorinated hydrocarbon byproducts that require costly cleanup.

The natural way

In nature, fungi use enzymes to selectively convert cellulose to glucose—converting an organic material to energy—using only oxygen and water. FPL researchers knew that if they understood how enzymes selectively degrade wood, they would be onto something. A long-term research project like this was ideal for a Federal lab because industry and universities usually need a quicker return on their research.

“We feel we are on the verge of discovering the holy grail of papermaking.”

“Because FPL has had some interest in wood for the past 90 years or so, we had some understanding of those processes,” says Atalla wryly. “Kent Kirk [a former FPL researcher] discovered the metal ions in these enzymes where most of the activity takes place back in the mid-

1980s. From there, we’ve been working hard to refine the system.”

Atalla explains that the plant enzymes that degrade wood are made up of long protein chains. But for most processes, including the degrading of wood, the activity hub of the enzyme is a series of metal ion clusters that Atalla refers to as “transition metals.” Understanding how those metals work is the key to duplicating the process.

Says Weinstock, “What we have done is basically develop industrial practices that mirror those found in nature, but in a much more rapid and versatile way.”

Because POMs mirror natural processes, no harmful byproducts are produced.

“We simply turn the wood into what it originally was produced from—carbon

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ASK FPL

It's that time of year again when staying cozy in front of the fireplace is a top priority for many of us. The following questions address the smartest ways to use wood for warmth.

What is the best type of wood to burn in my fireplace?

Choosing the best wood for your fire depends on several factors. You should consider what species are readily available to you, any personal preference you have to aroma, and what type of fire you want to start.

Softwood species are easy to ignite and burn quickly with a hot flame. However, they also burn rapidly and require frequent replenishing to stay lit. Softwood fires are recommended if you're looking

to warm up with a short fire that will burn out quickly.

For a longer lasting fire, hardwood species are recommended. These woods burn less vigorously with a shorter flame and produce long lasting, steady glowing coals.

The ideal fire, then, would be made with a mixture of softwood logs for easy ignition, and hardwood logs for longevity. By adding wood from fruit trees, such as apple and cherry, or nut trees, such as hickory, beech, or pecan, your fire will also emit a pleasant aroma.

The chart below outlines the characteristics of several species and may help you decide which wood to use for your fire.

Species	Relative amount of heat per cord	Is it easy to burn?	Is it easy to split?	Does it give off heavy smoke?	Does it pop or throw sparks?	General rating
Ash, red oak, white oak, beech, birch, hickory, hard maple pecan, dogwood	High	Yes	Yes	No	No	Excellent
Soft maple cherry, walnut	Medium	Yes	Yes	No	No	Good
Elm, sycamore, gum	Medium	Medium	No	Medium	No	Fair
Aspen, basswood, cottonwood	Low	Yes	Yes	Medium	No	Fair, but good for kindling
Chestnut, yellow poplar	Low	Yes	Yes	Medium	Yes	Poor
Southern yellow pine, Douglas fir	High	Yes	Yes	Yes	No	Good, but smoky
Cypress, redwood	Medium	Medium	Yes	Medium	No	Fair
White cedar, western red cedar, eastern redcedar	Medium	Yes	Yes	Medium	Yes	Good, great for kindling
Eastern white pine, western white pine, sugar pine, ponderosa pine, true firs	Low	Medium	Yes	Medium	No	Fair, but good for kindling
Tamarack, larch	Medium	Yes	Yes	Medium	Yes	Fair
Spruce	Low	Yes	Yes	Medium	Yes	Poor



Is it safe to burn lumber scraps?

No, it is not always safe to burn scrap wood. Some lumber has been treated with preservatives to prolong its useful life, and these preservatives can be harmful to people and the environment. Treated wood should not be burned in open fires, stoves, or fireplaces, because toxic chemicals may be produced as part of the smoke and ashes. It can be difficult to tell if wood has been treated or not, so it is best not to burn any scrap wood in your home.

What is the best way to season firewood?

Seasoning (or drying) of wood for fuel is very important because dry wood is easier to burn, safer to use, and produces more heat than green wood. To properly season firewood, small pieces of wood and split wood should be stacked in piles on two bed pieces to keep the piles off the ground. For faster seasoning, sticks can be placed between layers of wood to increase air ventilation through the pile. In either case, the stacks should be placed somewhere that air can circulate readily through the pile, but where it is also sheltered from rain and dew. An open shed is an example of an ideal place to season wood. A cord of most hardwood species takes 9-12 months to season thoroughly, but the moisture content will be significantly reduced in about 3 months. Wood will season fastest in late spring, summer, and early fall, and more slowly when cut in late winter.

Questions?

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This information was acquired from the Forest Service publication "Firewood for your Fireplace", and the FPL publications "Wood For Fuel" and "The Wood Handbook" (available on our website at <http://www.fpl.fs.fed.us>).

Chimney fires are a dangerous winter hazard to watch out for. To reduce your risk of fire and learn more about proper chimney care, visit the Chimney Safety Institute of America's website at www.csia.org.



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Cleaning Up *(from page 3)*
dioxide and water,” says
Weinstock.


What is even more exciting is the fact that POMs are reusable and extremely efficient, using only about 0.2 cubic meters of water per ton of pulp, compared to the 20 to 40 cubic meters used in traditional bleach pulping. “This technology is a huge step towards creating a closed-cycle mill—one that will have zero water discharge and zero environmental impact,” says Atalla. He adds that a major benefit to industry is that POMs effectively pulp mixed species,

“This technology is a huge step towards creating a closed-cycle mill—one that will have zero water discharge and zero environmental impact.”

making it easier for industry to count on a steady supply of fiber.

The final step, according to both Atalla and Weinstock, is making the POM system economically attractive to industry. “The current system is environmentally cleaner than chlorine, and cost

wise is about the same,” says Atalla. “However, we have to make it even more economically attractive than existing technologies because of the huge costs associated with transferring to a new process.”

The two are confident that this can be done. “Despite some tough economic times for the papermaking industry, their support has been strong for this project. We’re very optimistic about our chances for success,” says Atalla. 

Gordie Blum is FPL’s Public Affairs Director.
