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NEWSLINE

Forest Products Laboratory

Making the Most of Cellulose

New Method Helps Determine Best Uses for Biomass

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Major industries, from biofuels and pharmaceuticals to wood, paper, and textiles, stand to benefit from a new method developed by Forest Products Laboratory (FPL) scientists.

FPL research chemist Umesh Agarwal and his team developed two new methods for determining the crystallinity of cellulose, the main component of the cell wall of most plants and an abundant, renewable resource suitable for a broad range of uses.

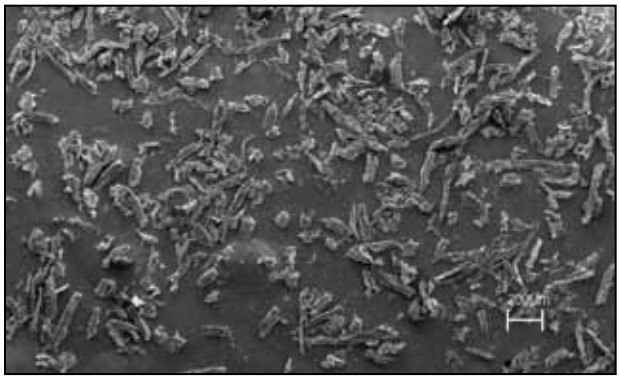
Crystallinity refers to the degree of three-dimensional structural order in a solid, which in part determines the physical, chemical, and mechanical properties of the material. The ability to measure cellulose crystallinity is key to using biobased materials efficiently, which is why a simple, reliable method for determining crystallinity is so valuable. And that is exactly what FPL researchers have come up with.

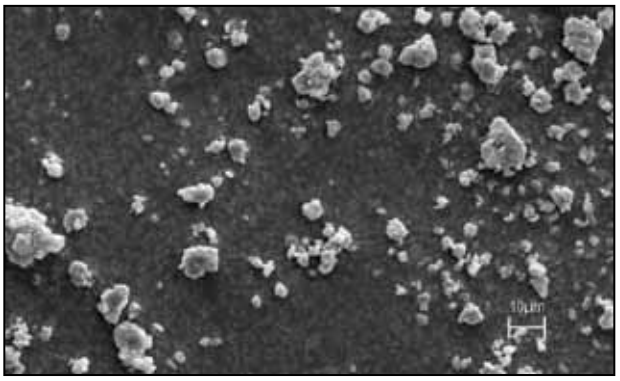
"We have developed two new methods of determining cellulose crystallinity based on FT-Raman spectroscopy, a univariate and a multivariate method," says Agarwal. "Both are very useful, but the univariate method is simple and accurate enough to be adopted by researchers and technicians worldwide."

These new methods improve upon the current standard, called Segal-WAXS, an X-ray method, developed in 1959 by Segal and used widely since then. Agarwal's results correlate well with Segal-WAXS, but ultimately the new method is more reliable.

"The problem with Segal-WAXS," explains Agarwal, "is that while it is good for analyzing cellulose with no crystallinity or with very high crystallinity, it is not very reliable for measurements that fall in between those two extremes."

FPL researchers are now applying these new methods to wood and agricultural fibers to examine new uses for biomass. Agarwal explains that both high and low crystallinity are useful, depending on the desired outcome.





Top: Scanning electron micrograph of lobolloly pine wood at 47% crystallinity.

Center: Loblolly pine wood at 0% cyrstallinity (20 times greater magnification).

Bottom: FT-Raman Instrument.

"If your goal is to develop a very strong product with low moisture absorption rates, you would be interested in highly crystalline cellulose," says Agarwal. "On the other hand, if you're looking to break down cellulose to create a product such as ethanol, finding a source material with low crystallinity would be in your best interest. The fact that we can now easily and accurately measure this vital property presents new opportunities for researchers in a wide variety of fields."

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Upcoming Events

11th International Conference on Wood & Biofiber Plastic Composites

May 16-18, 2011, Monona Terrace Community & Convention Center, Madison, Wisconsin, USA.

This conference and symposium seeks to bring together industry, government, and academia to share perspectives on what the future holds for wood and biofiber plastic composites. Topics for the conference include additives and formulating, advanced reinforcements, biopolymer matrices, enhanced performance, future applications, nanotechnology, and new processing/recycling. You can view conference information at http://www.forestprod.org/woodandbiofibercomposites/overview.html.

Wood You Believe...

- forests provide raw materials, maintain biodiversity, protect land and water resources, and play a role in climate change mitigation.
- forests cover a third of our planet's land.
- forests influence climate change mainly by affecting the amount of carbon dioxide in the atmosphere.
- when forests grow, carbon is removed from the atmosphere and absorbed in wood, leaves and soil.

From http://www.greenfacts.org/en/forests/index.htm

Carbon and U.S. Forests—An Intricate Balance

American forests play an important role in reducing carbon dioxide in the atmosphere. U.S. forest growth and harvested wood products sequester enough carbon to offset 12–19% of U.S. fossil fuel emissions annually. Understanding how changes in forest health affect the carbon cycle is essential to scientific efforts aimed at limiting the effects of global climate change.

A 2010 report published by the Ecological Society of America (ESA), "A Synthesis of the Science on Forests and Carbon for U.S. Forests," provides a detailed assessment of these issues. The report, published in the ESA journal Issues in Ecology, is written in an accessible and mostly jargon-free style aimed at exposing non-scientists to the findings of experts.

Forest Products Laboratory economist Ken Skog was one of six Forest Service employees working with other environmental scholars in developing the report. Michael G. Ryan of the Rocky Mountain Research Station in Fort Collins, Colorado, was the article's lead author. The report can be obtained free of charge online at http://www.fpl.fs.fed.us/documnts/pdf2010/fpl_2010_ryan001.pdf.

Although future impacts of climate change are uncertain, this report provides clear evidence that all strategies will have risks, uncertainties, and tradeoffs.

The article offers several insights:

- Avoiding deforestation retains forest carbon and has many co-benefits and few risks.
- Afforestation increases forest carbon and has many co-benefits. Afforesting ecosystems that do not naturally support forests can decrease stream flow and biodiversity.
- Decreasing harvests can increase species and structural diversity, with the risk of products being harvested elsewhere and carbon loss in disturbance.
- Increasing the growth rate of existing forests through intensive silviculture can increase both forest carbon storage and wood production but may reduce stream flow and biodiversity.
- Use of biomass energy from forests can reduce carbon emissions but will require expansion of forest management and will likely reduce carbon stored in forests.
- Using wood products for construction in place of concrete or steel releases less fossil fuel in manufacturing. Expansion of this use mostly lies in the non-residential building sector, and expansion may reduce forest carbon stores.
- Urban forestry has a small role in sequestering carbon but may improve energy efficiency of structures.
- Fuel treatments trade current carbon storage for the potential of avoiding larger carbon losses in wildfire. The carbon savings are highly uncertain.

FPL Cooperative Research and Development Opportunities for Innovation

Since 1910, the Forest Products Laboratory (FPL) has been committed to extending the Nation's forest resources through a strategy of wise use. To encourage innovation in forest products research, the FPL has long entered into cooperative agreements with private businesses, academia and other government institutions. It is clear that collaboration is key to developing new technologies and successfully turning research results into quality products.

Under expanded authority from the Federal government, collaborating with the FPL has never been more advantageous. Private start-ups or established entities needing expanded production resources can rent FPL space and equipment to pilot-test new products or process innovations without excessive overhead costs. Materials produced through such cooperative agreements can now be sold by the partner in limited quantities for market-testing purposes. In the past, research prototypes had to be destroyed.

FPL scientists are always looking to explore emerging research needs and apply new research tools. Collaborative partners have access to FPL scientists and technical staff. In some cases, joint venture agreements for collaborative research are also appropriate. Cooperative efforts also have the potential to strengthen local economies by creating new business and employment opportunities upon implementation in the home region of partnering businesses.

The FPL's new Centennial Research Facility (CRF), an 87,000-square-foot multi-use laboratory, will be the primary research facility for new cooperative partnerships. The CRF is home to three unique work units. The

Composites research focuses on developing highly engineered building products from low-value materials.

Centennial Research Facility.

Engineering Mechanics & Remote Sensing Laboratory conducts physical and mechanical testing and evaluation on a wide range of materials and building systems—from houses to transportation structures—to determine their mechanical and material properties. The **Durability & Wood Protection** unit works to extend the available timber supply through improved building design, advances in low-toxicity wood preservatives, and improvements in fire safety. The **Engineered Composite Sciences** unit seeks to understand relationships between materials, process, and performance in engineering biocomposites that benefit users while promoting the sustainability of both virgin and recycled forest resources.

The amendment to Federal law allowing for more extensive cooperative agreements was proposed by Senator Russ Feingold (D-WI). This amendment will help government facilities such as the FPL serve as an effective innovation incubator. Upon passage of this amendment, Senator Feingold stated that his intentions have been "all about making the Federal government a better partner for businesses and others in the private sector." FPL also often partners with other government agencies and academic institutions.

These new and exciting opportunities will help develop innovative solutions to sustainable energy and natural resource challenges through collaborative use of Federal science resources. In the spirit of a new century of service to the Nation, FPL welcomes all inquiries from viable partners. The primary contact is Susan LeVan-Green of the State & Private Forestry Technology Marketing Unit at FPL.

FPL Highlighted at Boy Scout Jamboree

Both the Forest Products Laboratory and the Boy Scouts of America celebrated 100 years of service in 2010. Representatives from FPL attended the annual Boy Scouts of America National Jamboree and staffed a booth at the head of the Forest Service "Decision Trail" to teach visitors about the vital role of research in the Forest Service. More than 25,000 people came through FPL's exhibit, and more than 300 Boy Scouts earned their Pulp and Paper merit badge guided by FPL staff. The Forest Service has participated in the Jamboree since 1967.

More than 43,000 Scouts descended on Fort A.P. Hill, Virginia, for the 100th anniversary of the Boy Scouts of America Jamboree. (FS Today, http://www.fs.fed.us/fstoday/100820/national-news/scouts.html)

FPL Centennial Video Available Online

"A Century of Innovation," a 12-minute video summarizing the history of research at the Forest Products Laboratory, is now available for viewing online. The video features historic footage from FPL's early days, highlights many FPL innovations that have had a lasting impact on society, and introduces our newest research facility. Visit our website to look back over a century of accomplishments and learn what's on the horizon as FPL begins a new era of forest products research. http://www.fpl.fs.fed.us/centennial/video.php

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In This Issue

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100 Years of Service

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1910–2010