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College of Forestry, Wildlife and Environment

SUSTAINABLE BIO-BASED MATERIALS LAB

Update on Nanocellulose as a pesticide delivery system in seedling production

Southern Forest Nursery Management Cooperative

Celebrating 50 Years 1972-2022

FY 2023 Advisory Meeting

Maria Soledad Peresin
Associate Professor Forest Biomaterials
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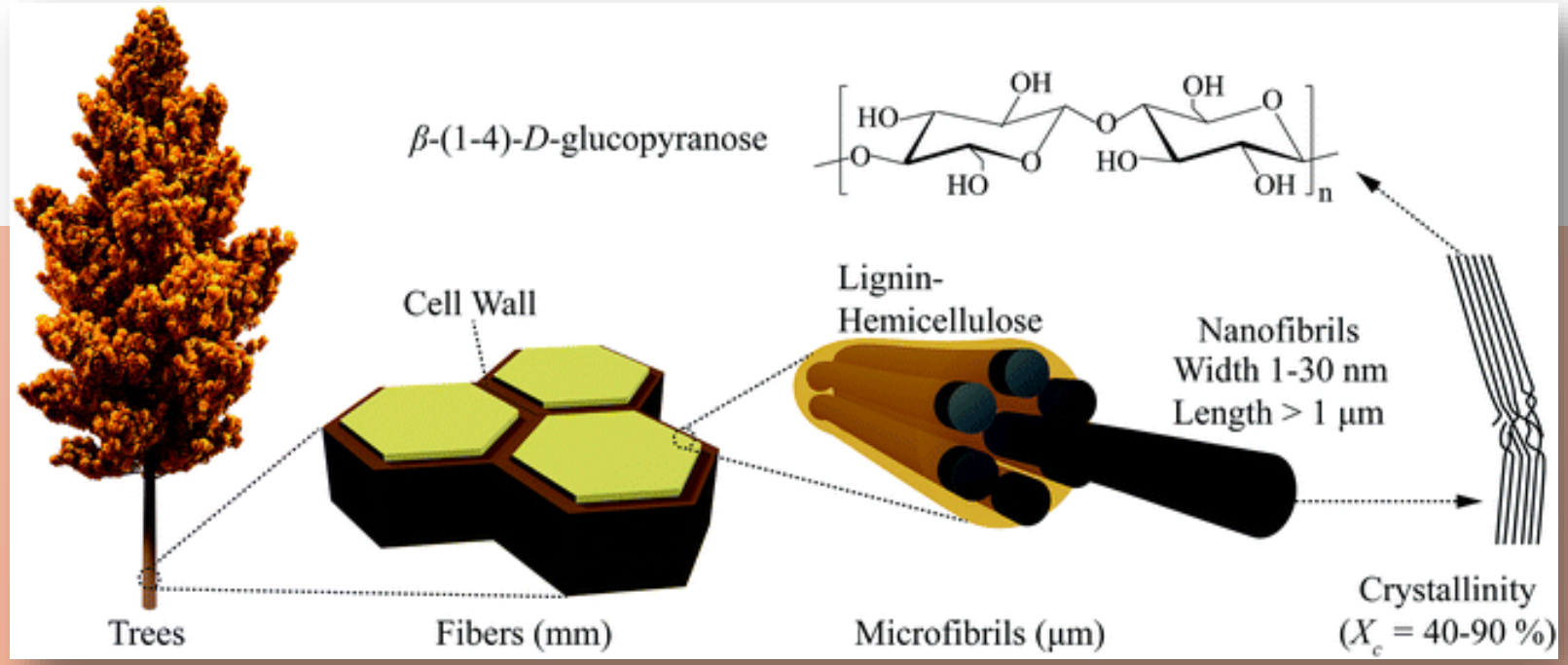
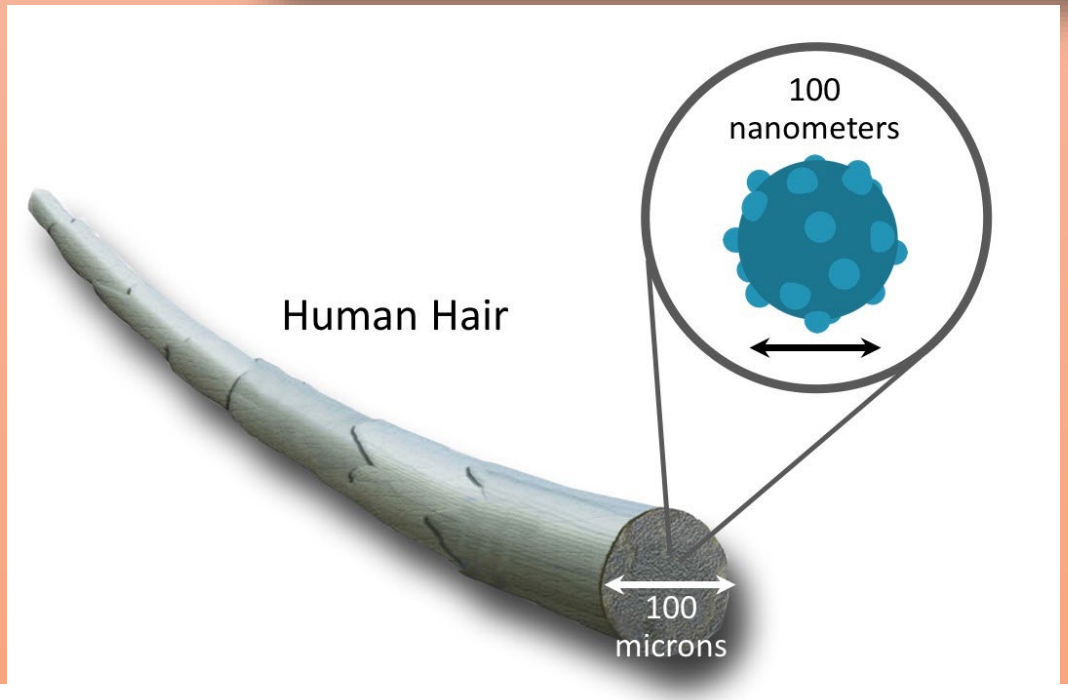
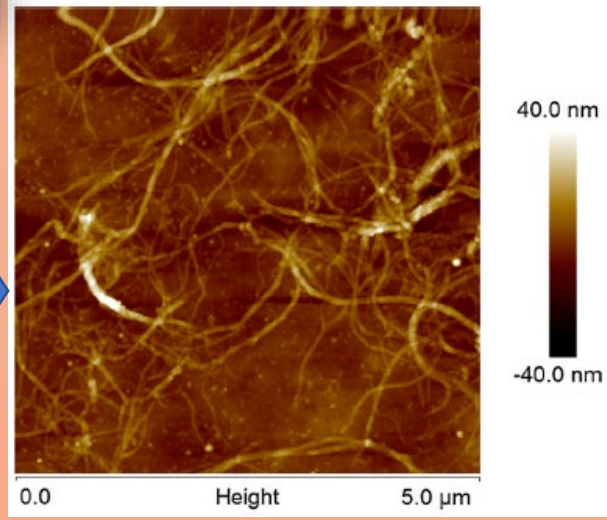




Benítez & Walther. *J. Mater. Chem. A*, **2017**, 5, 16003-16024



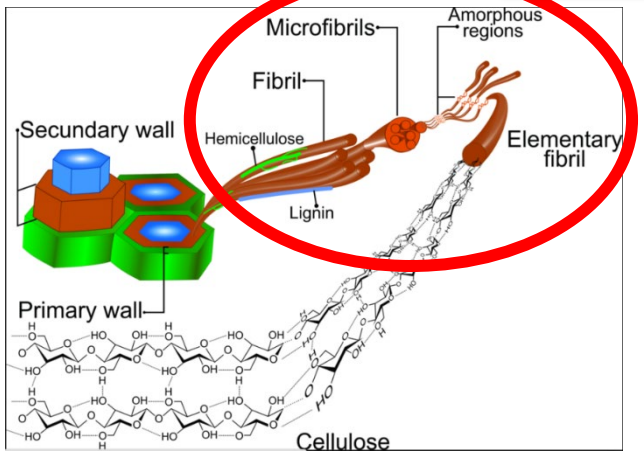
CELLULOSE FIBERS
200 microns

NANOCELLULOSE
100-200 nanometers

The Laboratory for Multiscale Regenerative Technologies at MIT, 2015

Nanocellulose production

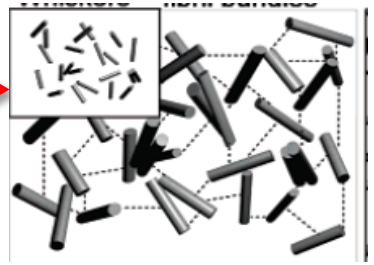
Fiber deconstruction

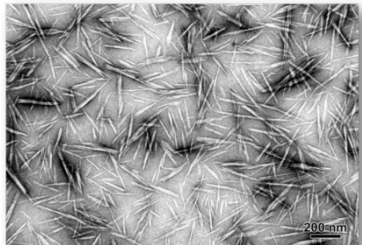


John Rojas, et al *DOI: 10.5772/61334*

Acid hydrolysis

Cellulose nanocrystals (CNC)

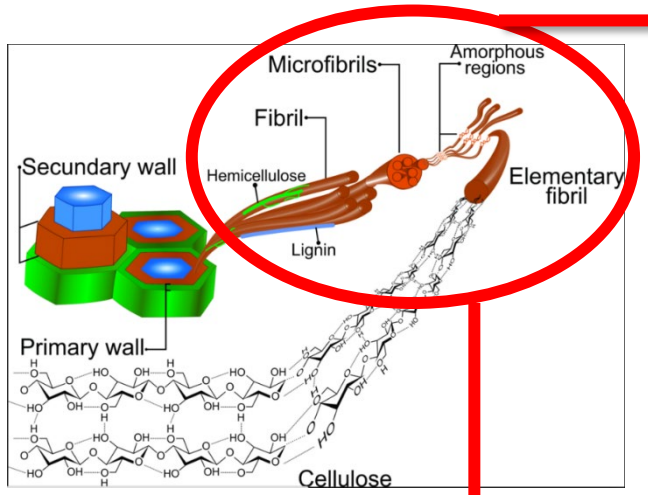




Peresin et al. *Biomacromolecules* (2010) 11, p. 674
Adapted from Pakko et al. *Biomacromolecules* (2007) 8 p.1934

Nanocellulose production

Fiber deconstruction



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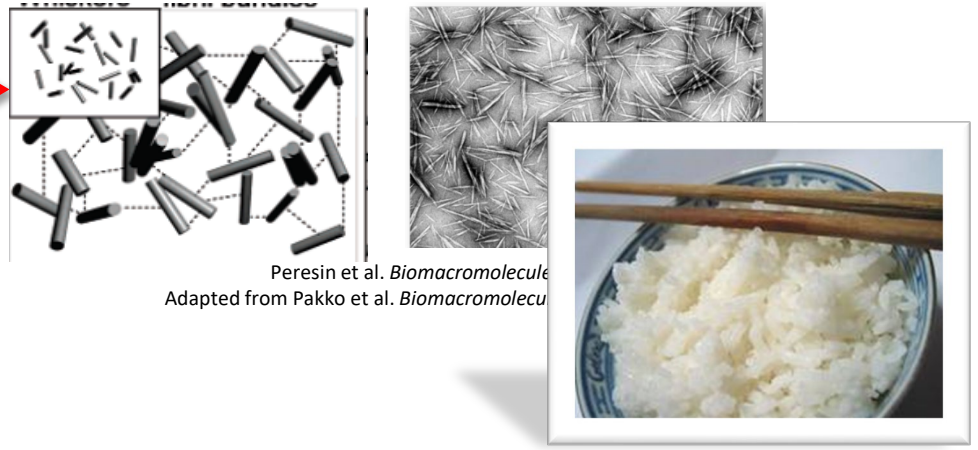
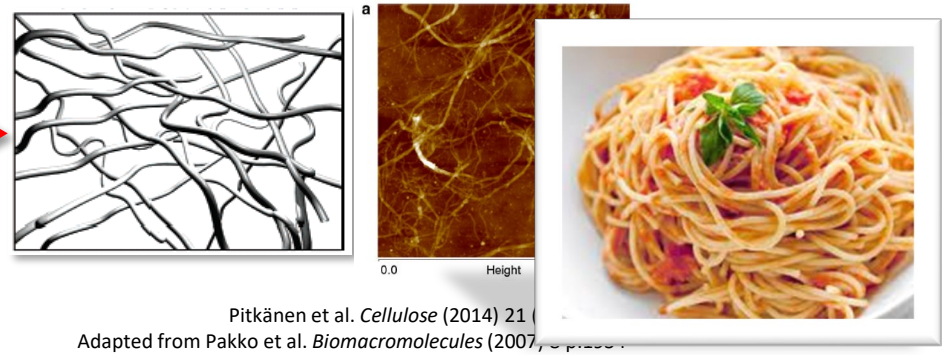


Peresin et al. *Biomacromolecule*
Adapted from Pakko et al. *Biomacromolecu*

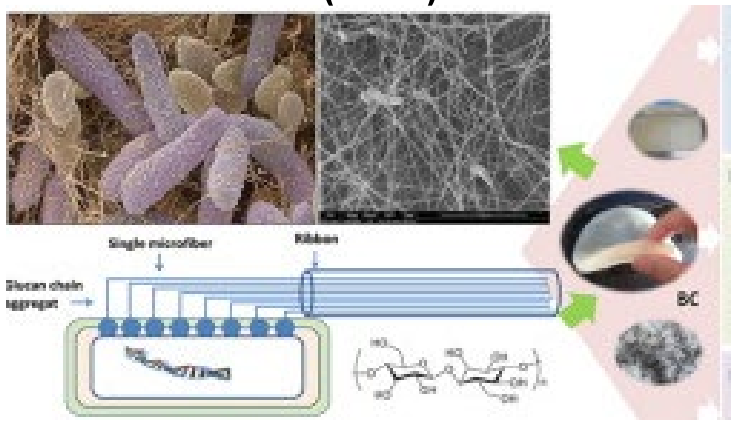
(Enzymatic/chemical pre-treatment) Mechanical treatments

Cellulose nano/microfibrils (CNF/MFC)



Pitkänen et al. *Cellulose* (2014) 21 (
Adapted from Pakko et al. *Biomacromolecules* (2007,

Bacterial Cellulose (BCN)



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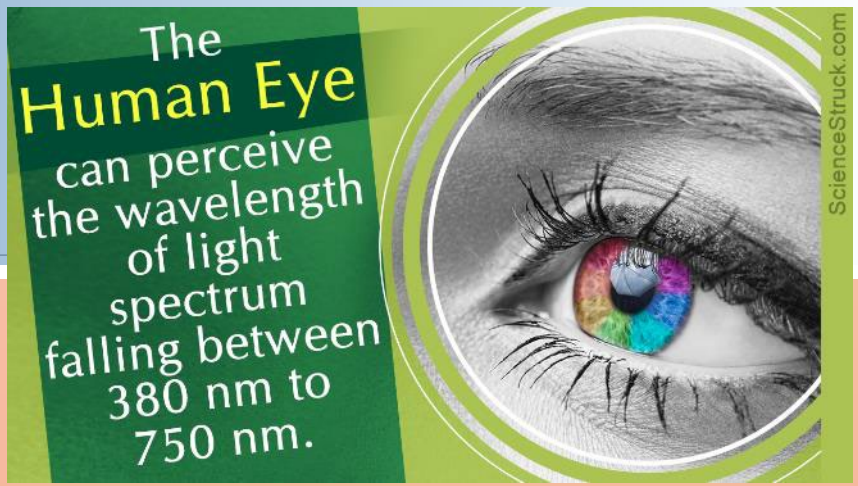
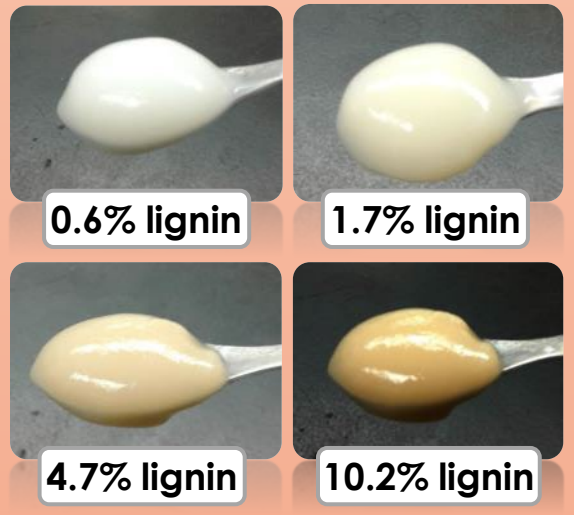
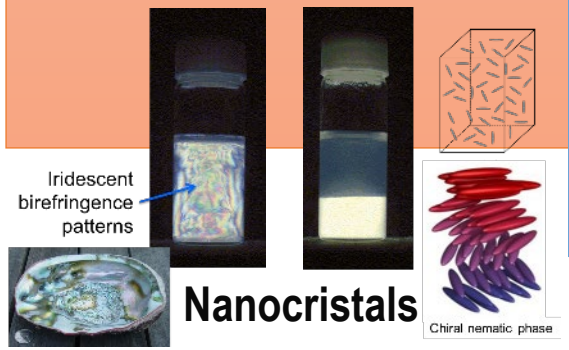
Nanocellulose properties



When suspended in water

- Strong network held by H-bonds
- Shear thinning behavior
- Self assembly: Liquid crystal properties (nanocrystals)

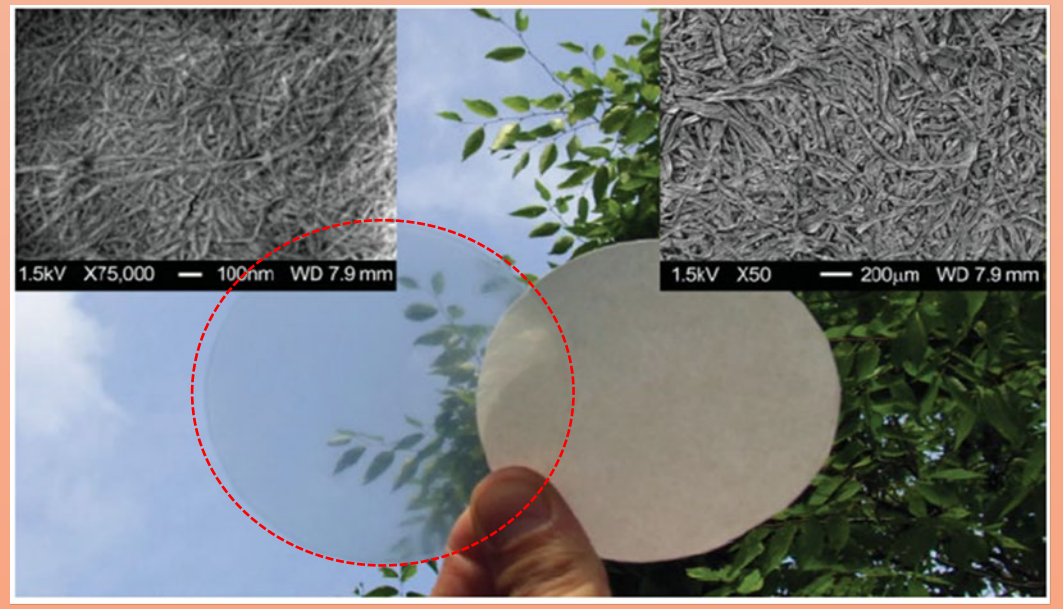




- Biocompatible
- Compostable
- Renewable
- High surface-area
- Many free hydroxyl groups for functionalization!

When it dries

- Great film formability
- Excellent mechanical strength and barrier properties



Nogi et al. *Adv. Mater.* **2009**, *21*, 1595.

NSF Center for Sustainable Technology

The NSF Center for Sustainable Nanotechnology

A multi-institutional partnership aimed at developing a molecular-level understanding of the fundamental chemical and physical processes that govern the transformations and interactions of nanoparticles in the environment.

The CSN is not a physical center but is instead a focal point for collaboration that links the complementary expertise of researchers at 12 different institutions to achieve what none of us could do individually. We co-advise graduate students and meet frequently in cyber-space. Funding for the CSN comes from the National Science Foundation.

Jason White
The Connecticut Agricultural Experiment Station

Howard Fairbrother
Johns Hopkins University

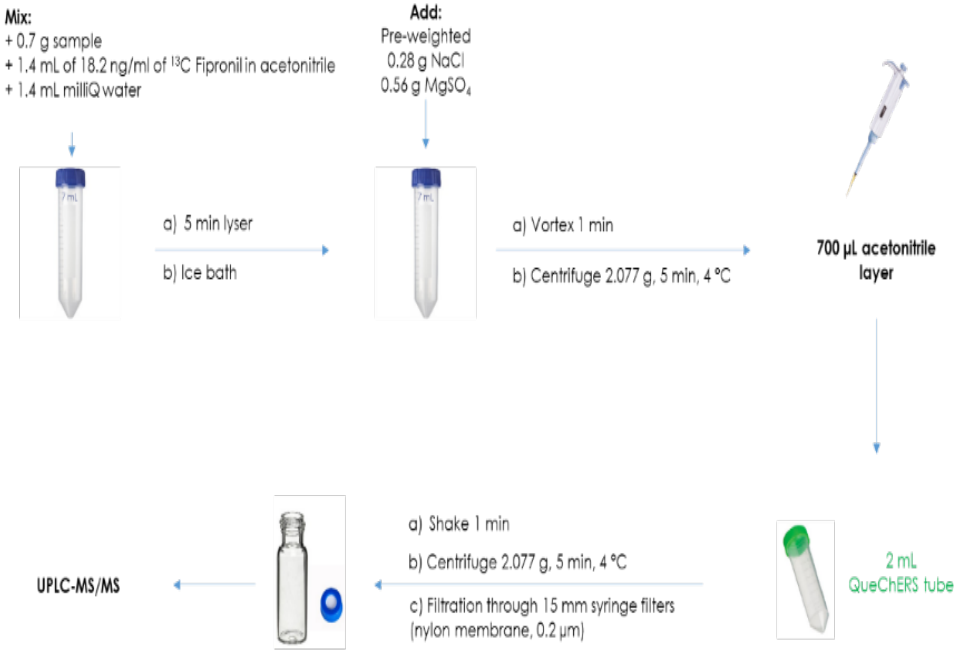
The NSF Center for Sustainable Nanotechnology

Enhanced pesticide performance using CNFs with different chemical composition as carrier systems

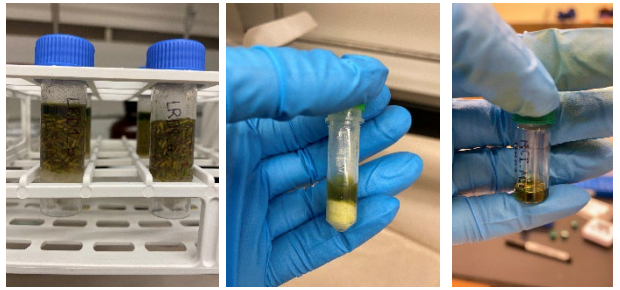
Injection

To utilize nanofibrillated cellulose with different chemical composition as a carrier for pesticide/insecticides

Extraction protocol



Sample preparation



U.S. Provisional Patent Application No.: 62/950,525. Peresin, M.S., et al. Nanocellulose-based Pesticide Encapsulation System for Forest Pest Control. 2019 – refiled 2021

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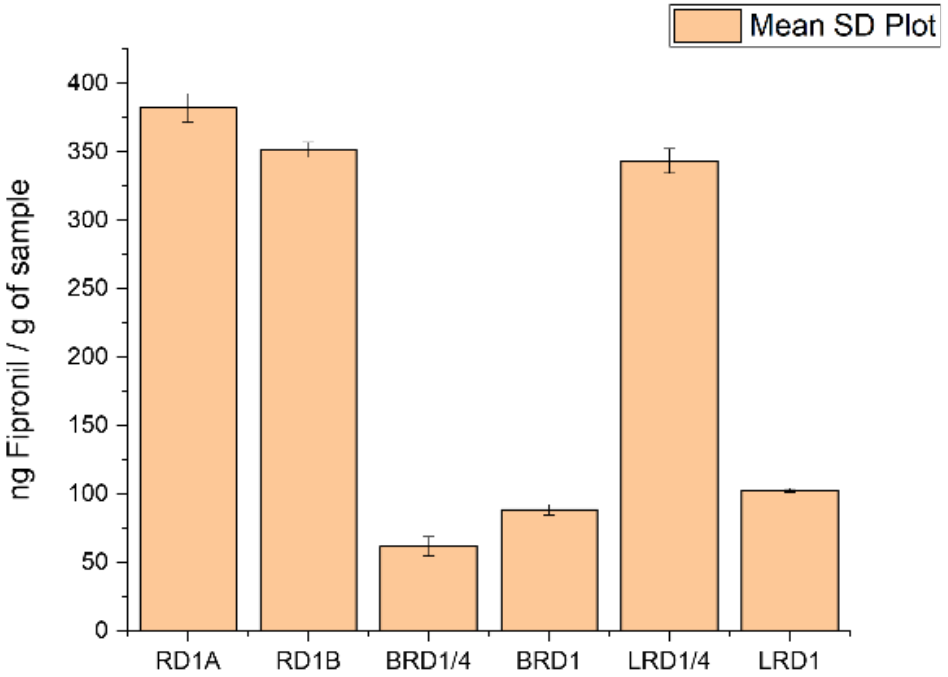
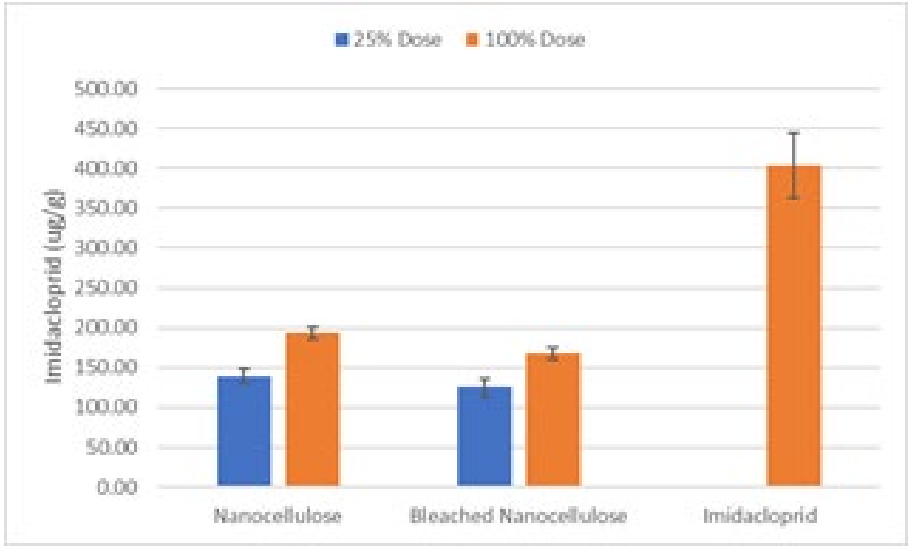
Enhanced pesticide performance using CNFs

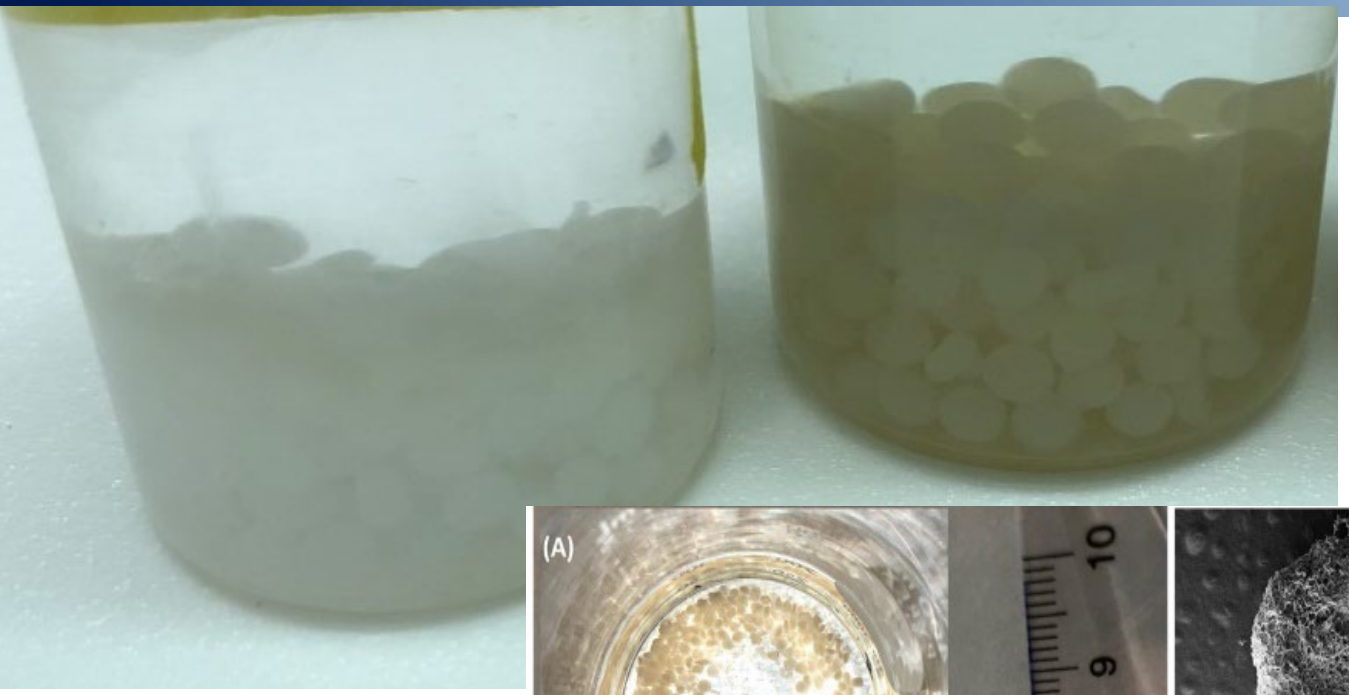
Soil-drench to root systems of Loblolly Pine. Bleached (B-CNF) and unbleached nanofibers (L-CNF)



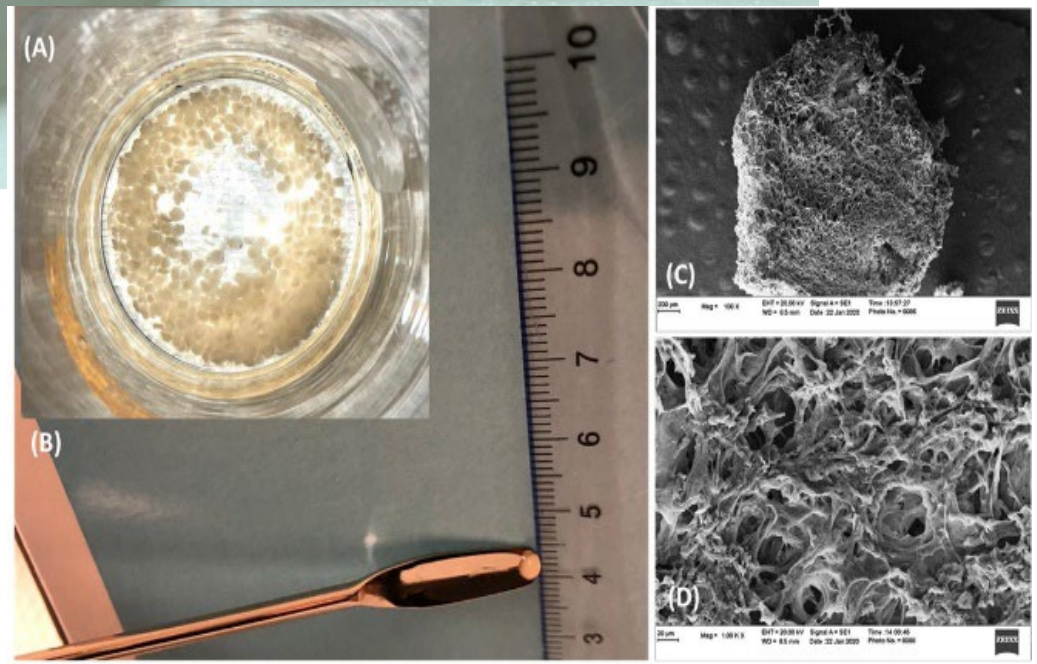


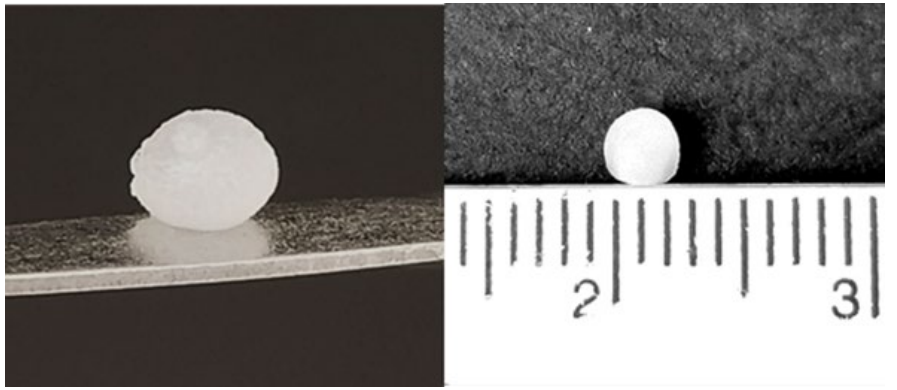
This preliminary data shows that our system could extend pesticide half life and efficacy in the tree. Therefore, our approach will decrease the amount and cost of the applied pesticide.

Homogeneous, porous CNF-beads carriers



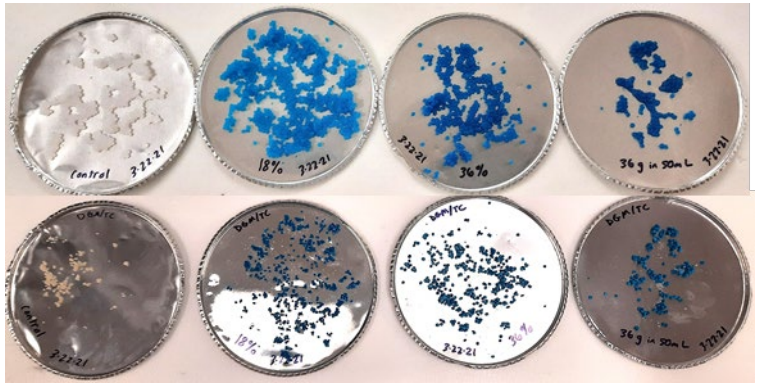
Develop bio-based materials to better the release of agri-chemicals for agriculture/horticulture

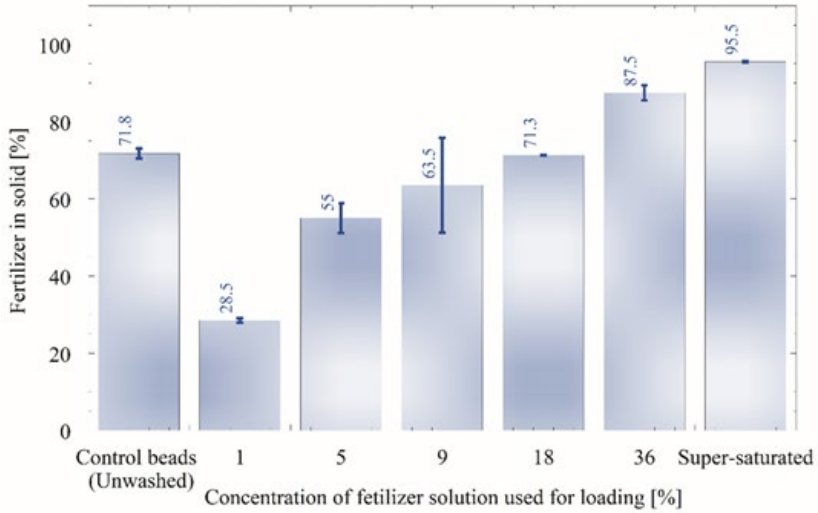




Slow-release of agrichemicals - Fertilizers

Develop bio-based materials to better the release of nutrients for agriculture/horticulture





The bio-based systems are able to hold the NPK fertilizer for up to 30 min, further modification could increase the release time

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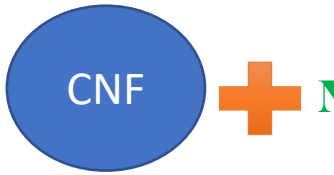
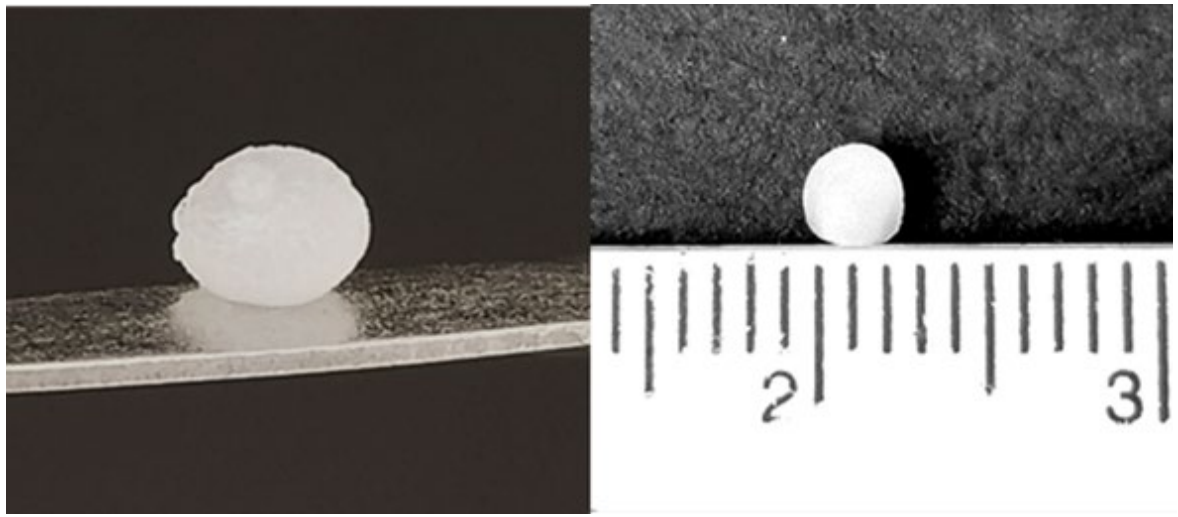
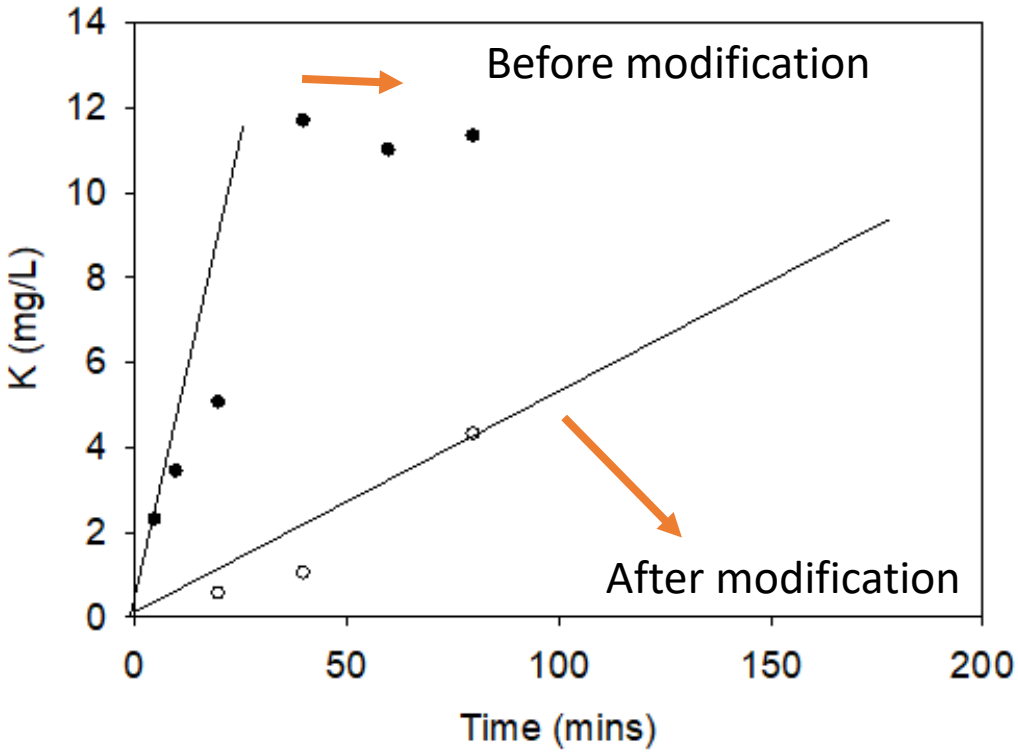
Slow-release of agrichemicals - Fertilizers







Current efforts

USDA Specialty Crops Research Initiative

Project title: Sustainable Nanoscale Biopolymer Carriers For Pesticides And Fertilizers In Pecan And Peach Crop Systems

Total $ amount requested: **USD 4,682,545**

Result: High priority (not funded) → collecting prelim data for resubmission Jan 2023

https://peresinlab.auburn.edu

Thanks for your attention!!

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Forest Products Development Center
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FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

USDA United States Department of Agriculture
National Institute of Food and Agriculture

NSF
WBC

NSF Faculty Early Career Development Program (CAREER) Award

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