SMART 2025: Emerging Engineered Wood for Buildings

Center for Materials Innovation
Yale University
August 17-19, 2025

Yale

Welcome & Overview

Sustainability represents a critical global challenge that demands disruptive innovations in materials science to propel advancements in key sectors such as water, energy, food, and plastics. The Sustainable Materials Advanced Research Summit (SMART) was established as a premier international forum to facilitate knowledge exchange and promote academic excellence in sustainable materials research. SMART emphasizes breakthroughs in both natural and engineered materials, including cellulose, lignin, wood, chitin, and more.

This year's summit is also Yale's inaugural Engineered Wood Conference, highlighting the urgent need to address the building and construction sector's significant environmental impact, which accounts for approximately 37% of global CO_2 emissions.

Transitioning to renewable materials like wood offers a promising pathway for climate change mitigation. Wood's advantages include its ability to sequester and store biogenic CO_2, lower energy consumption during production compared to steel and concrete, and enhanced building energy efficiency due to its low thermal conductivity. Despite these benefits, challenges such as strength and durability limitations persist.

Recent advancements in nanoscale engineering have significantly improved the performance and sustainability of engineered wood products. These innovations, alongside progress in renewable energy, automation, green chemistry, and artificial intelligence (AI), offer transformative opportunities to optimize wood material design and manufacturing, support sustainable forest management, and advance the decarbonization of the built environment.

We have invited leading experts from academia and industry to share their insights on emerging engineered wood technologies and their critical role in decarbonization efforts. The summit will cover a broad range of topics including climate and CO_2 mitigation strategies, advances in engineered wood materials and manufacturing processes, the unique mechanical and fire-resistant properties of wood, applications such as cross-laminated timber in construction and structural wood in transportation, the integration of AI in material design and production, and comprehensive perspectives on life cycle analysis and sustainable forestry management.

We warmly invite you to join us at Yale
for this dynamic and impactful summit!

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SMART 2025

Emerging Engineered Wood for Buildings

August 17-19, 2025 Yale University,
New Haven, Connecticut, USA

Conference Topics

- Climate and CO_2 Engineered Wood
- Materials and Processes
- AI in Materials and Product Development
- Advanced Properties of Engineered Wood
- Life Cycle Assessment, Forestry Management

Organizers

- Liangbing Hu,Yale University
- Alan Organschi, Yale University
- Shuna Ni, University of Maryland
- Orlando Rojas, University of British Columbia
- Yuan Yao, Yale University

Conference Support

- Gen Li, University of Maryland
- Yimin Mao, Florida State University

Conference Manager

- Xinqian Allison Qiu, Yale University

Sunday, August 17

2:45 PM **Yale Campus Tour (Recommended, Optional)**
Yale Visitor Center (149 Elm Street, New Haven)

6:00 PM **Welcome Reception & Registration**
Greenberg Conference Center (391 Prospect Street, New Haven)

Monday August 18

8:00 AM Coffee & Networking

9:00 AM Opening Remarks
Liangbing Hu, Yale University

Session 1 - Climate and CO_2

9:15 AM *Carbon, The Flow of Life*
Paul Hawken

Session 2 - Engineered Wood Materials and Processes (Part I)
Chair: Soydan Ozcan

9:40 AM *Wood Binding Wood: Opportunities for Cellulose Nanomaterials in Composites Technology*
Mehdi Tajvidi, University of Maine

10:00 AM *Durability Testing of Wood Materials: Laboratory and Field Approaches Across Diverse Climates*
Xinfeng Xie, Michigan Technological University

10:20 AM *Sustainable Delignification of Dimensional Wood for Producing of Advanced Wood Structural Materials*
Junyong Zhu, USDA Forest Products Laboratory

10:40 AM *Self-flow Lumber Treatment Technology*
Sheldon Shi, University of North Texas

11:00 AM *Nano-Engineered Wood*
Liangbing Hu, Yale University

11:20 AM Group Photo

12:00 PM Lunch

Session 2 - Engineered Wood Materials and Processes (Part II)
Chair: Mehdi Tajvidi

1:00 PM *Innovative Cellular Manufacturing Through Large-Scale Additive Manufacturing with Bio-Based Composites for Specialized Production*
Soydan Ozcan, Oak Ridge National Laboratory

1:20 PM *Extending the Service Life of Engineered Wood Products*
Jun Zhang, Koppers Performance Chemicals

1:40 PM	*Genome-edited Trees for High-Performance Engineered Wood* **Gen Li**, University of Maryland
2:00 PM	*Living Wood* **Tian Li**, Purdue University
2:20 PM	*Conducting Lab Stranding Research Support for New Product Development in the Engineered Wood Market* **Lorne Fardy**, Kadant Carmanah Design
2:40 PM	*Advancing Wood Technologies Through the Lens of Colloid Science* **Orlando Rojas**, University of British Columbia
3:00 PM	Break
	Session 3 - AI in Engineered Wood R&D **Chair: Lorne Fardy**
3:20 PM	*Collective Intelligence and Mediated Agency: Architecture, AI, and Autonomous Algorithms* **Philip Bernstein**, Yale University
3:40 PM	*Hybrid Mass Timber Structures with Superwood Components* **Yunfeng Zhang**, University of Maryland
4:00 PM	*From Centralized to Federated Physics-Informed Deep Learning: Accuracy, Scalability, and Reliability* **Lu Lu**, Yale University
4:20 PM	*Advancing Fire Safety in Tall Mass-Timber Buildings: Unlocking the Potential of Mass-Timber Products for Climate-Friendly Construction* **Shuna Ni**, University of Maryland
4:40 PM	Closing Remarks
6:00 PM	Dinner Chef Jiang (67 Whitney Ave, New Haven)

Tuesday, August 19

8:00 AM	Coffee & Networking
9:00 AM	Yale Engineering Dean's Welcome **Jeffrey F. Brock**, Yale University
	Session 4 - Advanced Properties of Engineered Wood **Chair: Alan Organschi**
9:15 AM	*Engineered Wood with Multiple Functions for Load-bearing Applications* **Lars Berglund, KTH Royal Institute of Technology**
9:35 AM	*The Interaction Between Water and Cellulose-Rich Materials* **Lars Wågberg**, KTH Royal Institute of Technology
9:55 AM	*Unconventional Fatigue Failure of Densified Wood* **Teng Li**, University of Maryland
10:15 AM	*Engineered Wood for Automotive Applications: Opportunities and Challenges* **Alan Luo**, Ohio State University
10:35 AM	*The Molecular Origin of Moisture Sensitivity of Wood* **Yoshiharu Nishiyama**, CERMAV-CNRS
10:55 AM	Break
	Session 5 - Use of Engineered Wood (Part I) **Chair: Lars Wågberg**
11:10 AM	*SuperWood for a Sustainable Built Environment* **Jiaqi Dai**, InventWood
11:30 AM	*Current Research on the Hygrothermal and Energy Performance of Cross-Laminated Timber and Wood Fiber Insulation Building* **Ling Li**, University of Maine
11:50 AM	*Engineering Mass Timber: Buildings and Bridges (Zoom)* **Douglas Rammer**
12:10 AM	*Engineering Mass Timber for Sustainability: A Case Study of the Ascent (Zoom)* **Marco Lo Ricco**
12:30PM	Lunch
	Session 5 - Use of Engineered Wood (Part II) **Chair: Yuan Yao**
1:30 PM	*Closing the Loop: Transforming Forest By-products into Complex Geometries for Living Building Systems* **Anna Dyson,** Yale University

1:50 PM	*Reading the Signals from the Forest* **Alan Organschi**, Yale University
2:10 PM	*The Next Big Thing? -Reflections from the NHERI TallWood Project* **Shiling Pei**, Colorado School of Mines
2:30 PM	*Building Resilience with Timber: Sustainable Material Strategies for Modern Construction* **Weichiang Pang**, Clemson University
2:50 PM	*AI-powered Smart Fiber Optic Sensors for Structural Monitoring* **Yi Bao**, Stevens Institute of Technology
3:10 PM	*Predictive Design of Sustainable Biobased Packaging via Machine Intelligence for Improved Postharvest Preservation* **Po-Yen Chen**, University of Maryland
3:30 PM	Break
	Session 6 - Life Cycle Analysis and Forestry Management **Chair: Orlando Rojas**
3:45 PM	*Wood as a Modern-Day Resource for Energy and Material: Conflicts and Synergies with other Forest Values* **Mark Ashton**, Yale University
4:05 PM	*Life Cycle Systems Modeling for Sustainable Wood Utilization from Local to Global* **Yuan Yao,** Yale University
4:30 PM	**Closing Remarks & Next Summit Announcement** **Liangbing Hu**, Yale University **Orlando Rojas**, University of British Columbia

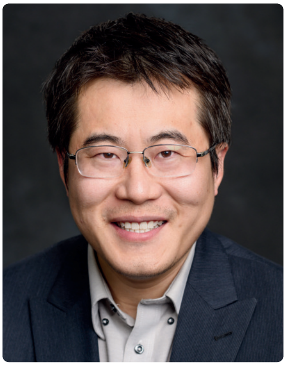
Mark Ashton

Yale University

Wood as a Modern-day Resource for Energy and Material: Conflicts and Synergies with Other Forest Values

Bio: Mark S. Ashton, Morris K. Jesup Professor of Silviculture and Forest Ecology and Director of Yale Forests, Senior Associate Dean of The Forest School at the Yale School of Environment. Professor Ashton conducts research on the biological and physical processes governing the regeneration of natural forests and on the creation of their agroforestry analogs. In particular, he seeks a better understanding of regeneration establishment among assemblages of closely related trees. His long-term research concentrates on tropical and temperate forests of the Asian and American realms. The results of his research have been applied to the development and testing of silvicultural techniques for restoration of degraded lands and for the management of natural forests for a variety of timber and nontimber products and services. He is the author or editor of over twelve books, including the nations textbook on silviculture and applied forest ecology, and over 200 publications in applied forest ecology.
WEBSITE: http://environment.yale.edu/silviculture/home/

Abstract: Wood from forests has been utilized by people for thousands of years. Originally it was the sole source of heat for warmth and cooking, the most important construction material for shelter, and the dominant medium for making a variety of tools. It fueled the industrial revolution in many regions, but with the discovery of fossil fuels for energy, the manufacture of steel and cement for construction, and the creation of plastics for tools and implements it has largely fallen out of favor. Today much of the world's forests have been transformed. Cleared for agriculture, then cutover, and now recovering in much of the temperate world. People now find forests valuable as a source of clean drinking water supply, for recreational opportunities, and for biodiversity conservation. In the world today with the reinvention of wood as a material and source of energy where will people secure a sufficient amount of wood given the multiple values that society now demands from its forests? I will discuss these issues and suggest solutions.



Yi Bao

Stevens Institute of Technology

AI-powered Smart Fiber Optic Sensors for Structural Monitoring

Bio: Yi Bao is an Associate Professor of Civil Engineering and the Founding Director of the Smart Infrastructure Laboratory at Stevens Institute of Technology. Before he joined Stevens in August 2018, he was a postdoc at the University of Michigan – Ann Arbor and Guest Researcher at the National Institute of Standards and Technology, Gaithersburg. Dr. Bao is an expert in the fields of structural monitoring and smart sensors. To date, he has authored/coauthored more than 200 journal papers, with over 9300 times (h-index 58). Since 2022, he has been ranked a top 2% highly cited scholar in Stanford University's list. His research in prior five years was ranked No. 1 in fiber optic sensors and top 10 in structural engineering according to ScholarGPS. He is an Associate Editor for the journal of Engineering Structures, ASCE's Journal of Bridge Engineering, Frontiers in Physics, and Innovative Infrastructure Solutions.

Abstract: Distributed fiber optic sensors are gaining increasing attention in structural monitoring due to their unique abilities to measure spatially distributed strain and temperature and detect anomalies. These sensors generate vast amounts of data, providing valuable insights into structural conditions. However, efficiently processing and analyzing this data remains a challenge, as conventional manual methods are time-consuming and labor-intensive, leading to delays in interpretation and decision-making. Recent advancements in machine learning offer transformative solutions for real-time data processing and analysis. This presentation explores machine learning-powered detection, localization, quantification, and visualization of cracks and corrosion in concrete and wood structures. By leveraging machine learning algorithms, distributed fiber optic sensor data is processed and integrated into digital twins, facilitating predictive evaluations and optimizing operation and maintenance strategies. The presentation will discuss current challenges and emerging opportunities in intelligent structural monitoring.

Lars Berglund

KTH Royal Institute of Technology

Engineered Wood with Multiple Functions for Load-bearing Applications

Bio: Lars Berglund is a professor in wood and wood composites at KTH Royal Institute of Technology in Stockholm, Sweden. His main research interest is in nanostructured cellulosic materials, wood and biocomposites. He has been a visiting researcher at UMASS Amherst, Stanford, Cornell and Kyoto University. He is a member of the Royal Swedish Academy of Engineering Sciences and the founding director of Wallenberg Wood Science Center.

List of publications is available at:
https://orcid.org/0000-0001-5818-2378

Abstract: Wood is from renewable resources with very low carbon footprint, recyclable of low cost and with established infra-structure for harvesting and processing. The need for sustainable technical solutions to engineering problem can expand the applications for wood, by engineering its microstructure and tailor properties. In addition, it is possible to add new functions, such as optical transmittance and improved durability. Recent progress in engineered wood includes additions of many new functions and improved mechanical performance. Starting with desirable microscopic structures with connections to nanostructure, mechanical performance, durability and optical transmittance of engineered wood will be analyzed. Challenges in terms of processing, cost and materials design obstacles will be discussed and exemplified with experimental and modeling results. The potential of deep learning methods will be illustrated by analyzing and addressing challenges with generation of large data-sets for structure-property relationships.

Phil Bernstein

Yale University

Collective Intelligence and Mediated Agency: Architecture, AI, and Autonomous Algorithms

Bio: Phil Bernstein is Deputy Dean and Professor in the Practice at the Yale School of Architecture, where he has taught courses in professional practice, project delivery, and technology since 1988. He was formerly a Vice President at Autodesk, where he was responsible for setting the company's AEC vision and strategy for technology and sustaining the firm's relationships with strategic industry leaders and associations. Prior to joining Autodesk, Phil practiced architecture as a principal at Cesar Pelli & Associates where he managed many of the firm's most complex commissions including projects for Reagan National Airport, the Mayo Clinic, and Goldman Sachs. He writes extensively on issues of architectural practice and technology, and his books include Architecture | Design | Data – Practice Competency in the Era of Computation (Birkhauser, 2018) and Machine Design: Architectural Futures in the Era of Artificial Intelligence (RIBA, 2022). Phil has been honored twice by DesignIntelligence as one of the "30 Most Admired Educators in Architecture" and was named as an Outstanding Industry Contributor by the Connecticut Construction Institute. He received a Bachelor of Arts magna cum laude with Distinction in Architecture from Yale University and a Master of Architecture also from Yale. He is licensed to practice in California.

Abstract: As AI races ahead in support of various disciplines and tasks, specific challenges remain before it will reach fruition—or even reasonable utility—in the building industry, particularly at the nexus of design and construction manifest in architectural practice. The confluence of decisions necessary to create a finished building, ranging widely from aesthetic, life safety, constructability, even projected cost, create a challenging landscape for useful AI. The architect is responsible for bringing all these considerations to fruition while protecting the public's health, safety and welfare, obligations which may defy automation. This talk will examine those challenges, speculate on potential futures, and offer suggestions for where the most fruitful lines of investigation—academic, professional, and commercial—may lie.

Po-Yen Chen

University of Maryland

Predictive Design of Sustainable Biobased Packaging via Machine Intelligence for Improved Postharvest Preservation

Bio: Dr. Po-Yen Chen is an Assistant Professor in the Department of Chemical and Biomolecular Engineering at the University of Maryland, College Park, with affiliations to the Maryland Robotics Center (MRC) and the Artificial Intelligence Interdisciplinary Institute at Maryland (AIM). He received his B.S. in Chemical Engineering from National Taiwan University and Ph.D. from MIT, and was a Hibbit Early Career Fellow at Brown University. Before joining UMD, he served as an Assistant Professor at the National University of Singapore. Dr. Chen's research integrates machine learning-enabled predictive and generative modeling with robotics-automated experimentation and simulation to accelerate the discovery of high-performance, sustainable materials. His ML-driven approach overcomes longstanding challenges in multi-component formulation and multi-property optimization, replacing trial-and-error methods with efficient, data-driven design. His robotics- and AI-integrated workflow tackles urgent global challenges such as plastic pollution and resource depletion by enabling the rapid development of functional materials with programmable properties. These materials show promise in soft electronics, conductive aerogels, smart soft robotics, and next-generation sustainable technologies.

Abstract: The widespread use of petrochemical-based plastics in food packaging raises environmental concerns and lacks antimicrobial properties, limiting protection against microbial contamination. While biobased nanocomposites offer a sustainable alternative, optimizing their formulations remains challenging due to a vast materials library, inefficient trial-and-error experimentation, and complex multi-property requirements. In this talk, a data-driven workflow integrating robotic automation, machine learning predictions, density functional theory (DFT) simulations, and life cycle assessment (LCA) is developed to accelerate the discovery of sustainable biobased packaging materials. An automated pipetting robot formulates 2,420 biobased nanocomposites, and their film quality data train an artificial neural network classifier, defining a design space. Within this space, 16 active learning loops fabricate and characterize 343 biobased nanocomposites, generating a high-quality dataset. Leveraging this dataset and DFT simulations, a prediction model explores ~1 billion formulations, identifying those with superior mechanical resilience and tunable transparency. Among them, a $Cu2+$-incorporated, chitosan-rich film further demonstrates moisture absorption, oxygen impermeability, and antimicrobial performance, outperforming conventional plastics. Additionally, a data-sharing platform is created, featuring forward prediction and inverse design capabilities to promote community adoption. This integrative approach accelerates the development of high-performance biobased packaging and paves the way for a sustainable antimicrobial alternative to conventional plastics.

Jiaqi Dai

InventWood

SuperWood for a Sustainable Built Environment

Bio: Jiaqi Dai is the CTO and co-founder of InventWood, a pioneering materials innovation startup that has developed SuperWood – a highly densified wood product that is beautiful, durable, and stronger than steel. InventWood is launching a groundbreaking commercial manufacturing facility in Frederick, MD. Jiaqi has over 10 years of experience leading materials R&D, technology transfer, and IP strategies. Recognized as one of the World's Top 2% of Scientists, he has co-led research projects totaling >$25M in the climate tech sector, including a recent SCALE-UP project funded by the Department of Energy's ARPA-E office to commercialize the Superwood technology.

Abstract: The construction industry seeks sustainable materials that offer high strength and durability while minimizing environmental impact. Advanced wood-based materials, such as the SuperWood technology platform developed by InventWood, present a compelling solution. It greatly enhances mechanical performance and contributes to meaningful reductions in carbon emissions, making them ideal candidates for next generation building materials. This presentation will dive into the innovative processes and construction applications of the SuperWood technology platform, with a particular focus on its potential to transform a wide range of forest products into high-value, low-carbon alternatives to conventional building materials. SuperWood is not only a strong material by itself, but also a high-performance component that can significantly enhance the strength and resilience of engineered wood products. We will compare its advantages over carbon intensive materials like concrete and steel, emphasizing its renewable nature, lower carbon footprint, and overall sustainability. Additionally, we will address the current challenges to widespread adoption of SuperWood, and ongoing research and development efforts aimed at optimization. Inventwood is a material innovation company that focuses on disruptive wood and cellulose technologies for sustainability. These technologies create sustainable materials that can compete with traditional carbon intensive building materials, such as concrete and steel, in terms of strength and durability, while also offering environmental benefits like lower carbon footprint.

Anna Dyson

Yale University

Closing the Loop: Transforming Forest By-products into Complex Geometries for Living Building Systems

Bio: Anna Dyson is the Hines Professor at the Yale Schools of Architecture (YSoA) and the Environment (YSE), and founding Director of the Yale Center for Ecosystems in Architecture (Yale CEA). Her work integrates design with science and engineering to develop next-generation systems for sustainable energy, water, and material use in buildings. At Yale, Dyson established a PhD program in Architectural Sciences, honored by ACADIA and the U.S. Green Building Council. Her research has been supported by the NSF, DOE, EPA, UNEP, NYC-DDC, NYSERDA, and private foundations including the Gates Foundation. She holds numerous international patents for clean technology innovations and has exhibited work at MoMA, the World Future Energy Summit, and the Center for Architecture. Notable projects include the Active Modular Phytoremediation System (AMPS), the Ecological Living Module (UN News' #1 World Changing Idea), and the Public Safety Answering Center II, featured in The Wall Street Journal's Best Architecture of 2017.

Abstract: The UN Global Report *Building Materials and the Climate: Constructing a New Future* presents two key, potentially synergistic recommendations: 1. Shift building material lifecycles away from reliance on non-renewable minerals toward regenerative biogenic material systems wherever possible. 2. Increase the integration of living biomass into urban built environments. In this talk, we explore the potential to expand the use of forest and agricultural by-products in building-integrated living systems for urban air and water treatment. These systems incorporate design components with complex geometries associated with plumbing and environmental controls, not typically associated with biogenic materials.

Lorne Fardy

Kadant Carmanah Design

Conducting Lab Stranding Research Support for New Product Development in the Engineered Wood Market

Bio: Lorne Fardy, MSc., P.Eng., VP of Product Development at Kadant Carmanah Design, brings over 28 years of experience in the engineered wood products industry, including mill manufacture, engineering design in wood frame construction, and the research and development of new products. Currently, he leads the Research & Development team at Kadant Carmanah Design, leveraging his knowledge of the oriented strand board (OSB) manufacturing process to improve the design and operation of the company's industry-leading SmartRING and SmartDISC Stranders.

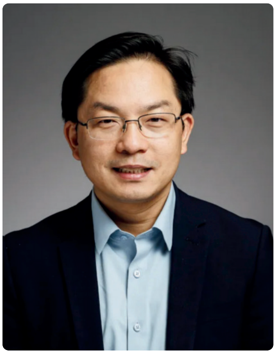
Abstract: The demand for engineered wood products (EWPs) and other sustainable building materials for residential and light-frame commercial construction is rising globally. Recognized for structural properties, manufacturing efficiencies, and sustainable footprint, strand-based EWPs such as OSB and laminated strand lumber (LSL) have expanded significantly in production and market consumption within the last 30 years, with further growth projected. The leading manufacturer of industrial stranding equipment, Kadant Carmanah Design, maintains and operates a strand-based testing laboratory that conducts research and development services using lab-scale equipment to simulate strands produced in a mill environment. Lorne Fardy leverages his 28-year career in the EWP sector—from process management at the mill level to quality assurance at the distribution level—to bridge the gap between research and commercialization by aligning strand-based research strategies with business objectives and market competitiveness. In his presentation, he will share how this lab is used by research facilities to test stranding capabilities across sustainable materials for the EWP sector, including bamboo, grass, and reclaimed wood. His research has expanded the company's equipment product line to now include camera and real-time data collection systems, using machine learning technology to attain artificial intelligence capabilities.

Paul Hawken

Carbon, The Flow of Life

Bio: Paul Hawken starts ecological businesses, writes about nature and commerce, and consults with heads of state and CEOs on climatic, economic, and ecological regeneration. He has appeared on numerous media, including The Today Show, Talk of the Nation, Bill Maher, CBS This Morning, Charlie Rose, and others, and his work has been profiled or featured in hundreds of articles, including the Wall Street Journal, New York Times, Newsweek, Washington Post, Forbes, and Business Week. He has written nine books, including six national and NYT bestsellers: *Growing a Business, The Next Economy, The Ecology of Commerce, Blessed Unrest, Drawdown*, and *Regeneration*. He is published in 30 languages, and his books are available in over 50 countries. His latest book, *Carbon, The Book of Life*, was published by Viking/Penguin on March 18, 2025. Paul has served on the board of many environmental organizations, including Point Foundation (publisher of the Whole Earth Catalogs), Center for Plant Conservation, Conservation International, Trust for Public Land, Friends of the Earth, and National Audubon Society. He has received six honorary doctorates. He is the founder of Project Drawdown and Project Regeneration (regeneration.org), which is the world's largest, most complete listing and network of solutions to the climate crisis. He lives in Mill Valley, California, at the edge of wilderness in the Cascade Creek watershed with his wife Jasmine and coyotes, foxes, bobcats, ravens, red-tail hawks, pileated woodpeckers, and flocks of nuthatches.

Abstract: Carbon is the overwhelming focus of the climate movement. The objectification of carbon and the movement to "decarbonize" can isolate the causes and the cures for global warming. In the pursuit of solutions, carbon became a metric of progress. Such reductionism overlooks the fact that the biosphere and atmosphere are complex adaptive systems that are inseparable. Terms like sustainability mask the crises we face, a convenient buzzword without meaning. This conference is about meaning, breakthroughs, and the reimagination of the extraordinary properties of the long chains of glucose made by plants. A casual observer may see engineered wood as arcane and specialized. I believe it is world-changing.



Liangbing Hu

Yale University

Nano-Engineered Wood

Bio: Dr. Liangbing Hu is the Carol and Douglas Melamed Professor of Electrical and Computer Engineering and Materials Science at Yale University, where he also serves as the founding director of the Center for Materials Innovation. He joined Yale's faculty in July 2024 after serving as a Distinguished University Professor at the University of Maryland, College Park. His research group specializes in materials innovation, device integration, and advanced manufacturing, with current projects in electrified ultrahigh-temperature synthesis, next-generation energy storage beyond lithium-ion, and novel wood nanotechnologies. Dr. Hu has authored over 450 peer-reviewed publications, including more than 10 articles in *Science* and *Nature*. His work has been recognized with several prestigious awards, including the Anselme Payen Award from the ACS Division of Cellulose and Renewable Materials, four R&D 100 Awards, the Nature Spinoff Prize, and the TAPPI Nano Middle Career Award. He is a Fellow of the Materials Research Society (MRS) and the American Chemical Society (ACS) and currently serves as an Associate Editor for ACS Nano. Dr. Hu received his B.S. in Physics from the University of Science and Technology of China in 2002, and earned his Ph.D. from the University of California, Los Angeles (UCLA) in 2007.

Abstract: I will provide an overview of our published work on nanoscale-engineered wood, focusing on the assembly and functionalization strategies of wood nanocellulose for building applications. Specifically, I will highlight our studies on lightweight structural materials (super wood as a steel replacement, *Nature*, 2018), 3D foldable wood for lightweight honeycomb structures (*Science*, 2021), radiative cooling wood (*Science*, 2019), as well as transparent wood, flexible/spongy wood, and thermal insulation wood.

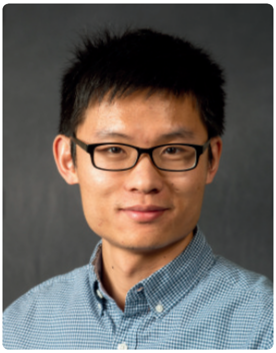
Ling Li

University of Maine

Current Research on the Hygrothermal and Energy Performance of Cross-laminated Timber and Wood Fiber Insulation Building

Bio: Dr. Ling Li is an associate professor of sustainable bioenergy systems at the School of Forest Resources of the University of Maine. Her research interests and expertise lie in wood physics, with a focus on the hygrothermal behavior of bio-based materials, including mass timber, wood fiber insulation, and other building products, at both the assembly level and the whole-building level.

Abstract: Decarbonization efforts as a result of the anthropogenic driven climate crisis are driving increased interest in bio-based building materials, including cross-laminated timber (CLT) and wood fiber insulation (WFI). These wood-based building materials can be used to increase energy efficiency and offer solutions that limit risk of interstitial condensation. WFI is a vapor-open, high specific heat, low embodied carbon insulation derived from fibrillated softwood chips. The hygroscopic nature of wood allows for seasonal moisture migration through the wall assembly, preventing liquid water accumulation within the envelope. The objective of this research was to monitor and evaluate the hygrothermal performance of a hybrid wood-based building envelope comprised of CLT and WFI. A one-story school building located in Belfast, ME (US Climate Zone 6A), was instrumented with temperature, relative humidity, and moisture content sensors during the manufacturing of the prefabricated wall and roof panels. Sensor clusters were installed at different locations within the wall and roof in both north- and south-facing orientations. In addition, an energy monitoring system was installed during the construction of the building to record the energy consumption of the school building; however, the results were not included in this study. Data was collected over a two-year period and was used to assess the temperature and relative humidity profile of the system, as well as validate a one-dimensional hygrothermal model. The model was then used to perform a long-term durability assessment. Results demonstrate that condensation and moisture accumulation have not occurred, while measured and simulated values agree. A long-term mold risk assessment found there to be no mold risk at any of the monitoring positions or interior surfaces.



Gen Li

University of Maryland

Genome-edited Trees for High-Performance Engineered Wood

Bio: Dr. Gen Li is an Assistant Research Professor in the Department of Plant Science & Landscape Architecture at the University of Maryland. His research focuses on advancing CRISPR-based genome editing technologies in plants, with an emphasis on poplar as a sustainable feedstock for engineered wood materials. Dr. Li's work integrates plant synthetic biology, tree bioengineering, and tissue regeneration to improve wood properties such as durability, strength, and fire resistance.

Abstract: Replacing conventional structural materials with high-performance engineered wood offers significant potential for reducing CO_2 emissions and enhancing carbon sequestration. Traditional methods for fabricating engineered wood involve energy-intensive chemical treatments to reduce lignin content, resulting in denser products with improved mechanical properties but posing sustainability challenges. This study introduces a genome editing approach to reduce lignin in poplar, enabling the chemical-free processing of advanced wood materials. Utilizing the cytosine base editor nCas9-A3A/Y130F, the 4CL1 gene, one of the key genes involved in lignin biosynthesis in poplar, was mutated, achieving a 12.8% reduction in lignin content. The genome edited wood facilitated waste-free densified wood production through water immersion and hot pressing, exhibiting a tensile strength of 313.6 ± 6.4 MPa, comparable to aluminum alloy 6061 and densified wood from chemical treatment process, demonstrating the effectiveness and application potential of genetic modification in reducing lignin content. Recently, we developed a transgene-free genome editing system that demonstrates the potential of genetic modification to produce sustainable, high-performance engineered wood. This study highlights the potential of genetic modification to create sustainable, high-performance engineered wood, contributing to reduced CO_2 emissions and environmental conservation, all while operating outside the scope of government regulatory oversight on genetic modified organisms.

Tian Li

Purdue University

Living Wood

Bio: Dr. Tian Li is the Schaefer Faculty Scholar and an Associate Professor of Mechanical Engineering at Purdue University. She received her B.S. in Electronic Science and Technology from Huazhong University of Science and Technology and her Ph.D. in Electrical and Computer Engineering from the University of Maryland, where her work on III-V optoelectronic devices earned the Distinguished Dissertation Award and the Outstanding Graduate Assistant Award. Following her Ph.D., Dr. Li was a postdoctoral researcher in Prof. Liangbing Hu's group at the University of Maryland, where she and her collaborators discovered unique optical, thermal, mechanical, and transport properties in nanocellulose and wood, and demonstrated high-temperature thermoelectrics in reduced graphene oxide up to 3000 K. In 2020, she joined Purdue and founded the ReNEWED Lab (Redesigning Natural materials for Energy, Water, Environment, and Devices). Dr. Li has received numerous accolades, including the ACS CELL Division KINGFA Young Investigator Award, ASME Haythornthwaite Foundation Research Award, and MRS Postdoctoral Award. Her honors include the Packard Fellowship, Kavli Fellowship by the National Academy of Sciences, Violet B. Haas Fellowship, Moore Inventor Fellowship Finalist, Forbes 30 Under 30, R&D 100 Award Finalist, and the Sony Research Innovation Award.

Abstract: Living trees sequester carbon by pulling CO_2 from the atmosphere and storing it as woody biomass. However, once processed as building materials, natural wood loses its carbon capturing capacity and becomes vulnerable to microbial decomposition and weathering. In this talk, I will present a biologically integrated strategy that reimagines microbial action—not as degradation—but as a tool for structural enhancement and sustained carbon uptake. By sequentially infiltrating filamentous fungi and carbon-fixing bacteria into the wood's native scaffold, we create a composite with over 90% lumen filling, markedly improved strength, reduced permeability, and in situ carbon sequestration from atmospheric CO_2. The process operates under ambient, aqueous conditions, uses only minimal nutrients, and is compatible with diverse local species—offering a scalable, low-energy pathway to carbon-negative structural materials for climate-responsive infrastructure

Teng Li

University of Maryland

Unconventional Fatigue Failure of Densified Wood

Bio: Teng Li is currently the Keystone Professor in the Clark School of Engineering at the University of Maryland, College Park, US, where he directs the Laboratory for Advanced Sustainable Materials and Technology. He received his Ph.D. degree in Engineering Science from Harvard University in 2006. His research interests focus on mechanics of sustainable materials, machine learning enabled materials discovery, low dimensional materials, energy materials, soft materials and biomaterials, flexible electronics, and nanoelectronics.

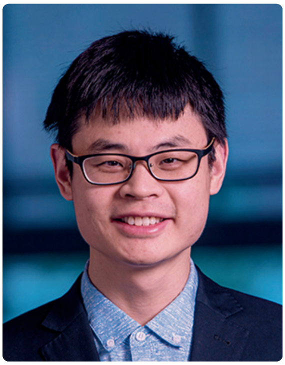
Abstract: Fatigue is a critical failure mechanism in various materials, often leading to catastrophic consequences. Designing materials with non-catastrophic fatigue failure is desirable yet challenging. This work presents the remarkable fatigue behavior of densified wood, exhibiting both a higher fatigue strength and non-catastrophic failure compared to natural wood. The improved bonding between wood fibers, primarily through hydrogen bonds, enables robust structural integrity even after fatigue failure. This mechanistic understanding offers insights for achieving non-catastrophic fatigue failure in diverse materials, presenting a fundamental principle for material design with broad implications.

Marco Lo Ricco

Engineering Mass Timber for Sustainability: A Case Study of the Ascent

Bio: Marco Lo Ricco is a structural engineer, professionally licensed as a P.E. in Wisconsin and S.E.in Illinois, with over 20 years of professional consulting and 6 years of research experience with a government agency. Marco focuses research and development of timber structures on the themes of structural resiliency and sustainability. Marco has developed a passively rocking cross-laminated timber (CLT) walls for seismic mitigation, reinforced CLT panels for protective design applications, and conducted building lifecycle assessments to measure various aspects of structural performance. The objective to Marco's research is to create high-performance timber structures that make communities more resilient to hazards and construction more environmentally sustainable.

Abstract: At the time of its grand opening, the Ascent was declared the world's tallest hybrid mass timber and concrete apartment building. The top 18 stories of the building serves as a residential tower and is constructed of mass timber framing. A comparison of the Ascent with an entirely concrete building design, as a benchmark, was conducted using whole building lifecycle assessment methodology. The results reveal the sustainable benefits of mass timber construction and areas where technological innovation may enhance performance of mass timber structures even further.



Lu Lu

Yale University

From Centralized to Federated Physics-Informed Deep Learning: Accuracy, Scalability, and Reliability

Bio: Lu Lu is an Assistant Professor in the Department of Statistics and Data Science at Yale University. Prior to joining Yale, he was an Assistant Professor in the Department of Chemical and Biomolecular Engineering at University of Pennsylvania from 2021 to 2023, and an Applied Mathematics Instructor in the Department of Mathematics at Massachusetts Institute of Technology from 2020 to 2021. He obtained his Ph.D. degree in Applied Mathematics at Brown University in 2020, master's degrees in Engineering, Applied Mathematics, and Computer Science at Brown University, and bachelor's degrees in Mechanical Engineering, Economics, and Computer Science at Tsinghua University in 2013. His current research interest lies in scientific machine learning and artificial intelligence for science, including theory, algorithms, software, and its applications to engineering, physical, and biological problems. His broad research interests focus on multiscale modeling and high performance computing for physical and biological systems. He has received the 2022 U.S. Department of Energy Early Career Award, and 2020 Joukowsky Family Foundation Outstanding Dissertation Award of Brown University. He is also an editor of Applied Mathematics and Mechanics and Journal of Machine Learning.

Abstract: Deep learning has achieved remarkable success in diverse applications; however, its use in scientific applications has emerged only recently. In this talk, I will first review physics-informed neural networks (PINNs) and available extensions for solving forward and inverse problems of partial differential equations (PDEs). I will then introduce an emerging paradigm in scientific machine learning, deep neural operators, pioneered by us for learning nonlinear operators of complex dynamic systems via neural networks. I will present the deep operator network (DeepONet) to learn various operators that represent deterministic and stochastic differential equations. I will demonstrate the effectiveness of DeepONet and its extensions to diverse multiphysics and multiscale problems, such as bubble growth dynamics, high-speed boundary layers, electroconvection, hypersonics, geological carbon sequestration, full waveform inversion, and astrophysics. Deep learning models are usually limited to interpolation scenarios, and I will quantify the extrapolation complexity and develop a complete workflow to address the challenge of extrapolation for deep neural operators. Moreover, I will present the first operator learning method that only requires one PDE solution, i.e., one-shot learning, by introducing a new concept of local solution operator based on the principle of locality of PDEs.

Alan Luo

Ohio State University

Engineered Wood for Automotive Applications: Opportunities and Challenges

Bio: Alan Luo is Donald D. Glower Chair in Engineering, Professor of Materials Science and Engineering, and Professor of Integrated Systems Engineering (Manufacturing) at The Ohio State University (OSU) in Columbus, OH. He leads the Lightweight Materials and Manufacturing Research Laboratory and is Director of the Advanced Casting Research Center (ACRC) at OSU. He also serves as a technical leader at The REMADE (Reducing EMbodied-Energy And Decreasing Emissions) Institute. Professor Luo is an elected member of the National Academy of Engineering (NAE), a fellow of The Minerals, Metals & Materials Society (TMS), Society for Automotive Engineers (SAE), and American Society of Metals (ASM). He has 27 patents and more than 400 technical publications on lightweight materials, advanced manufacturing, and integrated computational materials engineering. Prior to joining OSU in 2013, Dr. Luo was a GM Technical Fellow at General Motors Global Research and Development Center (Warren, MI) with 20 years of industrial experience.

Abstract: Natural wood was widely used in early automotive manufacturing, dating back to 1906 when the Ford Model N contained approximately 60% wood materials. However, modern automotive materials have been dominated by metals, i.e., steels, aluminum, and magnesium, largely due to their low cost, high strength, toughness, as well as excellent manufacturability and weldability. Engineered wood materials, such as densified "superwood" and 3D-molded wood, promise as a lightweight and renewable alternative for metallic materials in automotive applications. This presentation will discuss potential use of engineered wood material in the automotive industry, which is transitioning from internal combustion engine (ICE) technology to electric and fuel cell vehicles for energy efficiency and sustainability. The talk will also present some of the technical challenges associated with the potential wood applications, such as forming and joining technologies. Specifically, various joining technologies, including adhesive bonding, self-piercing riveting (SPR), and riv-bonding (a combination of SPR and adhesive bonding), have been developed for joining wood products to aluminum alloys.

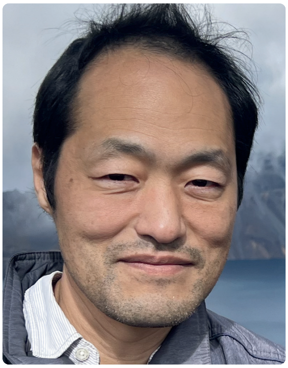
Shuna Ni

University of Maryland

Advancing Fire Safety in Tall Mass-Timber Buildings: Unlocking the Potential of Mass-Timber Products for Climate-Friendly Construction

Bio: Dr. Shuna Ni is an Assistant Professor of Fire Protection Engineering at the University of Maryland, joined in 2022. Ni's research focuses on structural fire engineering, fire forensics, fire resilience of wildland-urban interface communities, impact of fire on civil infrastructure and fire safety of tall mass-timber buildings. Ni has authored over 40 peer-reviewed publications, conference presentations, and proceedings. Her research has been funded by the National Science Foundation, National Institute of Justice, Fire Protection Research Foundation, University Transportation Centers, BLM-National Interagency Fire Center, Grand Challenges Grants Program at the University of Maryland, and industrial partners such as FM.

Abstract: The emergence of new mass-timber technologies with potential economic and sustainability benefits has led to the proposal and/or construction of tall mass-timber buildings worldwide. Unlike compartments constructed of noncombustible materials, the fuel provided by the exposed engineering timber in a mass-timber compartment contributes to fire development; thus, more stringent requirements on fire safety are needed for tall mass-timber buildings. However, there is a lack of methods to estimate design fires in compartments with exposed timber, posing a significant challenge for the performance-based design of tall mass-timber buildings under fire hazards. We compiled available experimental data on mass-timber compartment fires, proposed a simple analytical method to evaluate the contribution of exposed timber to a compartment fire, and discussed its effect on gas-temperature increase and required firefighting resources. In addition, we have proposed a reference methodology based on Present Net Value evaluation for the cost–benefit analysis of fire measures in mass-timber buildings, integrating construction cost databases, fire statistics, and numerical modeling techniques. Ongoing efforts include studying wind effects on fire dynamics in CLT and other mass-timber compartments to develop reliable simulation techniques for both windy and windless conditions, as well as linking wood pyrolysis directly to the mechanical degradation of wood at high temperatures. The ultimate goal of our research is to advance fire safety in tall mass-timber buildings to unlock the potential of mass-timber products for climate-friendly construction.



Yoshiharu Nishiyama

CERMAV-CNRS

The Molecular Origin of Moisture Sensitivity of Wood

Bio: Born in 1972 in Berlin, West Germany, Dr. Yoshiharu Nishiyama is a leading researcher in fiber diffraction and the structural analysis of biopolymers. He earned his undergraduate degree in Forest Products from the University of Tokyo in 1995 and completed his Ph.D. in 2000. Following four years as an assistant professor, he joined CERMAV-CNRS (Centre de Recherches sur les Macromolécules Végétales – CNRS) in 2005, where he currently conducts research as a senior scientist. Dr. Nishiyama's contributions to the field have been recognized with numerous honors, including the Japan Wood Research Society Prize (2008), the Hayashi Jisuke Award (2012), the Marcus Wallenberg Prize (2015), the Anselme Payen Award (2022), and the Japan Cellulose Society Award (2024).

Abstract: Wood is a hygroscopic material, leading to significant dimensional variation that poses a challenge in its utilisation as a construction material. In this presentation, I will discuss the molecular origin of the swelling/shrinking behavior and consider the rationale of the sustainable wood utilisation in structural materials.

Alan Organschi

Yale University

Reading the Signals from the Forest

Bio: Alan Organschi is a principal and partner at GOA, an architectural practice in New Haven, Connecticut recognized internationally for its integration of design, construction, and environmental research in work that spans in scale from global environmental analysis to demonstration projects in micro-housing. He is also Professor in the Practice at the Yale School of Architecture where he has taught architectural design and building science for two decades and where he now directs the Yale Building Lab. In April 2021, Mr. Organschi was appointed Director of the Innovation Labs at the Bauhaus Earth, a global interdisciplinary initiative in regenerative building research and experimentation based in Berlin, Germany. He has written and lectured extensively on the carbon storage benefits of biogenic material substitution and circular economic strategies in urban building. He is co-author of Carbon: A Field Manual For Building Designers and the scientific paper "Buildings as a Global Carbon Sink" published in *Nature Sustainability* in January 2020, and a contributing author to the Urban Systems Chapter of the IPCC's Sixth Assessment Report. He currently serves as an Industry Peer Advisor on the Climate Security Roundtable for the Bureau of Overseas Building Operations at the US Department of State. Among the many regional, national, and international awards for the buildings in their practice, Mr. Organschi and partner, GOA principal Elizabeth Gray, were honored in 2012 for their work with an Architecture Award by the American Academy of Arts and Letters.

Abstract: The eco-systemic sources (soils, forests, wetlands, etc.) from which—or through which—we draw virgin raw material for building (and which we encroach upon with our continual expansion of human settlement) are receding and weakening, increasingly unable to supply the ecosystem services (clean air and water, habitat, foodstuffs) that are critical to our and our fellow species' survival. Despite massive physical investment and environmental impact, we have been largely unsuccessful in meeting the basic need for safe and secure shelter and convivial living conditions for broad swaths of humanity. As we approach this critical planetary threshold, what scientists describe as a "climate tipping point," how can we, as architects (and with our colleagues in the building sector) mitigate or even reverse the ecological and atmospheric impacts of our work? How can we properly read, comprehend, and instrumentalize the signals of both stress and regenerative potential from the planet's natural systems that have languished neglected and ignored in our current extractive economic calculation as unconsidered externalities?

Soydan Ozcan

Oak Ridge National Laboratory

Innovative Cellular Manufacturing Through Large-Scale Additive Manufacturing with Bio-Based Composites for Specialized Production

Bio: Dr. Soydan Ozcan is a Distinguished Scientist and Group Leader of the Sustainable Manufacturing Technologies Group at Oak Ridge National Laboratory (ORNL), where he leads multidisciplinary teams advancing sustainable and smart manufacturing. His expertise spans bio-based materials, circular economy, resilient supply chains, critical minerals, and advanced digital manufacturing. He directs the national SM²ART program (Specialized Materials and Manufacturing Alliance for Resilient Technologies), a Hub-and-Spoke R&D initiative with the University of Maine focused on developing high-value biomaterials and scalable, low-waste processes for composite and additive manufacturing. Dr. Ozcan collaborates with over 30 industry partners to translate lab research into commercial products and scalable processes across aerospace, modular housing, and infrastructure sectors. He has published over 100 peer-reviewed papers, holds 25 patents, and authored 11 book chapters. A frequent speaker and mentor to green tech ventures, he has led numerous industrial demonstrations and earned 17 innovation awards, including the Battelle Distinguished Inventor Award, TAPPI Nano Technical Award, and two R&D 100 Awards.

Abstract: Large-Scale Additive Manufacturing (LSAM) is a high-speed, energy-efficient process capable of producing complex, large-scale components up to 200 times faster than traditional polymer AM. Its compatibility with sustainable, bio-based feedstocks makes it a key driver of green manufacturing across industries such as construction, wind energy, automotive, and marine. Projects like BioHome3D showcase LSAM's potential, using bio-based fillers and binders to create carbon-storing composites for broader structural applications. A key advancement is the integration of cellulose—a renewable, abundant biopolymer—into LSAM feedstocks. Innovations in fiber formation and drying technologies have enabled scalable, cost-effective production of cellulose-based composites, reducing energy demands and supporting affordable, high-volume manufacturing. Additionally, LSAM facilitates recycling and re-manufacturing of end-of-life composite parts, enabling closed-loop material lifecycles. This dual capability—bio-based production and material recovery—positions LSAM as a powerful tool for advancing sustainable, circular manufacturing practices.

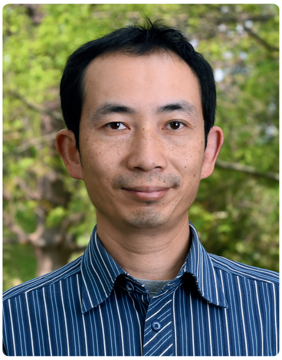
Weichiang Pang

Clemson University

Building Resilience with Timber: Sustainable Material Strategies for Modern Construction

Bio: Dr. Weichiang Pang is a Professor of Civil Engineering at Clemson University whose research focuses on the structural performance and risk assessment of wood and mass timber buildings subjected to earthquakes, hurricanes, and other natural hazards. He has extensive experience in numerical modeling and large-scale experimental testing, with over 150 peer-reviewed journal and conference publications. He serves as Chair of the ASCE Technical Committee on Wood Structures and as an advisor to the South Carolina Department of Insurance. His work aims to improve the safety, resilience, and sustainability of timber construction through advanced design methods and hazard mitigation strategies.

Abstract: Timber offers a sustainable path forward in building design, but true resilience requires thoughtful integration of all materials. This talk explores how to leverage wood's renewable advantages while combining it intelligently with concrete and steel. Using real-world examples, we'll discuss strategies for designing sustainable, resilient structures that make the most of each material's strengths, highlighting innovations in timber engineering and best practices for balanced, climate-conscious construction.



Shiling Pei

Colorado School of Mines

The Next Big Thing? -Reflections from the NHERI TallWood Project

Bio: Dr. Shiling Pei received his Ph.D. in Civil Engineering from Colorado State University in December 2007 and joined the faculty of Civil and Environmental Engineering at Colorado School of Mines in Fall 2013. His research focused on traditional and innovative timber systems, multi-hazard mitigation through performance based engineering, numerical modeling of structural dynamic behavior, and large-scale dynamic testing. Dr Pei recently led an NSF funded six-university collaborative research project to introduce resilient tall mass timber buildings to the U.S. His team completed the test of a 10-story full-scale wood building at NHERI@UCSD shake table, representing the world's tallest full-scale building ever tested on a shake table.

Abstract: During the summer of 2023, the NHERI TallWood project team and their collaborators completed a monumental effort spanning close to a decade (2014-2023) with solid engineering proof of the viability of tall mass timber buildings for regions with high seismicity. The full-scale 10-story TallWood test building was not only the world's tallest building structure tested on a shake table, but also the most resilient, withstanding over 80 earthquake tests without damage or need to repair. This presentation will provide an overview of the NHERI TallWood testing project findings. More interestingly, the speaker went on a 9-month trip in 2024 after completing the TallWood project across the regions of the world (New Zealand, Japan, and Italy) with high seismic hazard and strong interest in mass timber. After reflection on the mass timber R&D work in the U.S. and the experience of traveling and interacting with colleagues around the world, a proposal for "the next big thing" for mass timber research for the U.S. will be presented from the presenter's perspective.

Douglas Rammer

Engineering Mass Timber: Buildings and Bridges

Bio: Mr. Rammer is a Research Engineer focused on developing better Wood Based Products and Buildings. Since 1993, he has conducted research on improving engineering design criteria columns, glued laminated beams, and connections. Since 2008, he has participated in four National Science Foundation funded projects to investigate the seismic behavior of traditional wood and Cross Laminated Timber (CLT) structures. Mr. Rammer recently led and funded a small group of academic and industry representatives in a 10-year effort to determine the seismic design parameters for CLT shear wall building using the FEMA P-695 method. This work involved the development of component size experiments, numerical seismic modeling, and creation of design criteria. Doug serves on committees tasked with the development of design criteria for wood based structures; which over his career include American Wood Council design committees, ASCE-SEI Technical Executive Committee, American Society of Civil Engineering Design (ASCE) of Wood Engineered Construction Standards, ASCE Timber Bridge Committee, and the Building Seismic Safety Council, ANSI A190.1-2022 Product Standard for Structural Glued Laminated Timber, and ANSI/APA PRG 320: Standard for Performance-Rated Cross-Laminated Timber.

Abstract: There have been significant inroads in the United States mass timber construction market space, since the adoption of PRG 320 – Standard for Performance Rated Cross Laminated Timber (CLT) in 2013. Over the last decade, several research studies on fire and seismic performance have solidified Mass Timber Buildings into the pages of the International Building Code.

This presentation will give a brief overview of the some significant mass timber engineering design accomplishments in the US building code since 2013 and will specifically highlight three seismic design developments that FPL researchers are involved with; (1) Code approval of CLT Shear Seismic Design Procedures, (2) development of a resilient Post Tensioned CLT Rocking Wall Seismic System, and (3) the development of a Buckling Resistant Braced Frame Seismic Resistant System. Each of these systems provides examples of innovative wood and wood-based composite materials that have been developed for effective seismic mitigation applications.

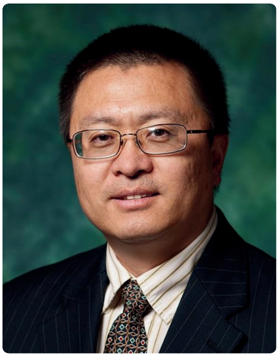
Orlando Rojas

University of British Columbia

Advancing Wood Technologies Through the Lens of Colloid Science

Bio: Professor Orlando Rojas is the Canada Excellence Research Chair at the University of British Columbia and Director of the Bioproducts Institute. His research focuses on bio-based materials and soft matter. He is internationally recognized for his contributions to renewable materials science, and has received several prestigious honors, including the Anselme Payen Award, the highest distinction in cellulose and renewable materials research.He is an elected Fellow of the American Chemical Society (2013), the Finnish Academy of Science and Letters (2017), and the TAPPI Association (2025). Earlier in his career, he served as a Finland Distinguished Professor and was named an inaugural Faculty Scholar at North Carolina State University. Prof. Rojas maintains active collaborations with institutions across Europe, the Americas, and Asia. He serves on the Selection Committee of the Marcus Wallenberg Foundation and holds scientific advisory roles with organizations including the Max Planck Institute of Colloids and Interfaces, the VALUED Project (with Imperial College London, University of Bristol, and University of Cambridge), and the Materials Institute of the University of Santiago de Compostela. He is Emeritus Editor of the Journal of Dispersion Science and Technology and Associate Editor of ACS Biomacromolecules. He is ranked among the top 1% of researchers globally by citations (Clarivate, Web of Science).

Abstract: I introduce some emblematic cases associated with our recent work that highlight the great possibilities of biobased-colloids derived from wood and plants. I show the control over renewable surfaces and chemistry as highly relevant to the design of adhesives, coatings and structured assemblies. The correlation that exists between strength and physicochemical characteristics is offered as a powerful route to identify technological uses that benefit from the functionality and cost-effectiveness of biogenic systems. I further discuss processing routes that transforms low-value, residual wood and use examples to synthesize all-green materials from related structures. These are demonstrated for their recyclability and biodegradability in natural environments, addressing the limitations of circularity and end of life of non-renewable products. Given the low-cost of the raw materials, their natural micro-structural design and self-adhesion, this presentation shows fully sustainable alternatives to products based on non-renewable carbon. The impact of related technologies is shown to depend on our ability to control water interactions.



Sheldon Q. Shi

University of North Texas

Self-flow Lumber Treatment Technology

Bio: Dr. Sheldon Q. Shi earned his Ph.D. from Michigan Technological University (MTU) in 1997, followed by postdoctoral research at MTU and the University of Maine. He began his career at APA – The Engineered Wood Association in 1999, focusing on product evaluation and quality assurance for engineered wood products. In 2004, he joined Mississippi State University (MSU) as an Assistant Professor, where he earned tenure and received both the Early Career Achievement Award and the Research Excellence Award in Computational Manufacturing & Design. After seven years at MSU, Dr. Shi joined the Department of Mechanical and Energy Engineering at the University of North Texas through a cluster hire initiative. His research centers on the processing and evaluation of bio-based composites using biomass materials such as wood, plant fibers, and soybean. His expertise includes natural fiber functionalization, adhesive science, and biomass-to-carbon conversion.

Dr. Shi is an Associate Editor for Frontiers in Materials and has served on the Executive Board of the Society of Wood Science and Technology (SWST) from 2008 to 2015, including a term as President (2013–2014). He has published over 300 peer-reviewed papers and has been recognized internationally, including the George Marra Award for Excellence in Writing and appointments as a research fellow or dissertation examiner in Malaysia, Australia, and India.

Abstract: Wood has complex composition and structure, which make it difficult to achieve consistent and controllable treatment. A self-flowing process presented for the chemical treatment of wood is inspired by liquid transportation in trees during photosynthesis and tree growth, whereby liquid in the soil is brought through the natural vessels and/or fiber tracheids. In this process, wood lumbers are placed in a tank containing treatment chemicals such as preservatives, fire retardants, or reactive agents. Through an absorbent sheet bridging the untreated lumber to an overflow tank, the chemicals are drawn into the lumber under capillary force and pressure difference, so that continuous treatment occurs inside the wood. Effectiveness of the self-flowing process is evaluated and compared to conventional immersion and vacuum wood treatment methods. The self-flowing method is very effective for wood delignification, which is six and four times more effective than that from immersion and vacuum pressure treatment methods, respectively. The self-flowing process allows a more uniform wood treatment compared to that from the immersion and vacuum pressure methods. A mathematical model was developed to describe the self-flowing process. This model can accurately predict the treatment time required for achieving desired results under various conditions.

Mehdi Tajvidi

University of Maine

Wood Binding Wood: Opportunities for Cellulose Nanomaterials in Composites Technology

Bio: Mehdi Tajvidi joined UMaine School of Forest Resources and Advanced Structures and Composites Center in September 2013. Starting his scientific career at Forest ProductsLaboratory, Madison, WI in 2001 working on dynamic mechanical analysis of wood plastic composites, Mehdi later joined the University of Tehran's Department of Wood and Paper Science and Technology before moving to the University Tokyo in 2007 and University of Waterloo in 2011. Mehdi's areas of research interest are production, characterization and performance evaluation of renewable nanomaterials and their composites. He is particularly interested in mechanical properties of nano-materials and nanocomposites, structure-property relationships, viscoelastic behavior, dynamic mechanical analysis and magnetic cellulose nanocomposites. Mehdi's core research area at UMaine is focused on utilization of cellulose nanomaterials in high volume applications such as coatings, packaging and building products. To date, Mehdi has published over 160 papers in academic journals, presented over 80 presentations at international conferences and advised/co-advised over 70 graduate students and postdocs.

Abstract: Cellulose nanomaterials (CNMs) are emerging materials with a wide array of potential applications from additives for rheology modification, to barrier coatings to composite materials and structures. Various research groups around the world have focused on applications in composite materials with variable degrees of success. This presentation will provide an alternative perspective towards cellulose nanomaterials in composite material development by shifting the focus from "additive/reinforcement" to "binder" and "matrix". Recent progress in CNF binder technology developed at UMaine and implications for traditional composite materials will be discussed as well as some futuristic pathways for further development.

Lars Wågberg

KTH Royal Institute of Technology

The Interaction Between Water and Cellulose-Rich Materials

Bio: Professor Emeritus in Fibre Technology at KTH Royal Institute of Technology, Stockholm, Sweden. His main competence is in physical chemistry and colloid and interface science as related to biomaterials from wood. His work has spanned all dimensions of cellulose-rich materials, from the molecule to fibrils to macroscopic fibres, and also materials made from these base components. He has long-standing experience with the polyelectrolyte Layer-by-Layer technique for surface modification and tuning of material properties using nm-thick compositions. Twelve years were spent in the industry focusing on hygienic products and colloid interface science in papermaking processes and materials. He has graduated around 50 PhDs and published numerous papers with them.

Abstract: The interaction between water and cellulose-rich materials is intricate and has attracted significant attention. The strong interaction between the components impacts properties of materials made from fibrils, fibres, and wood, and enables efficient processing of fibre-based materials. Water interaction can be split into processes where both thermodynamically driving forces and the ultrastructural properties of cellulose-rich materials are considered. Moist air is adsorbed into cellulose-rich fibres due to release of heat upon adsorption. This process is enthalpically driven, and heat release is significant and accompanied by entropy loss of the water molecules upon adsorption. The first 1–1.5 layers of water at the interface are strongly affected by the surface, but additional layers have bulk properties. There is also fast exchange between different states of water. The first layer of water is so strongly associated with cellulose that it is termed non-freezing water. Reorientation of hydroxyl groups of cellulose at the interface may alter interaction between components. Nano and micro cavities of fibres fill with water, and the structure of the fibre wall changes. Hemicellulose content increases swelling due to polymer–water interactions. Swollen fibres are softer and more prone to adapt to other solids, creating larger molecular contact. As water is removed, fibres shrink, forming internal stresses that affect final properties. The paper covers aspects of both moisture adsorption and swelling of the fibre, as well as trends influencing final material properties.

Xinfeng Xie

Michigan Technological University

Durability Testing of Wood Materials: Laboratory and Field Approaches Across Diverse Climates

Bio: Dr. Xinfeng Xie received his Ph.D. in Forest Resources from the University of Maine in 2008 and has since worked in both academia and the forest products industry. He is currently an Associate Professor of Forest Biomaterials at Michigan Technological University, where he leads the Wood Protection Group, an ISO 17025 accredited laboratory specializing in the durability testing of wood materials.

Abstract: Wood continues to be a widely used building and construction material due to its sustainability and versatility. However, its organic nature makes it susceptible to biological degradation, particularly from decay fungi and insects. Ensuring the durability of wood-based materials is essential for maintaining the long-term performance and safety of structures. The Wood Protection Group (WPG) at Michigan Technological University (MTU) operates an ISO 17025-accredited laboratory specializing in the evaluation of biological durability of wood and wood-based building products. For over 40 years, WPG has supported the forest products industry through an integrated approach that combines accelerated laboratory testing with long-term field exposure. WPG maintains eight field test sites spanning all major U.S. climate zones—from the cold conditions of Michigan's Upper Peninsula to the subtropical environment of Hawaii. In addition, WPG operates two tropical test sites in Panama and Suriname, enabling durability assessments under high-hazard conditions. This extensive testing infrastructure allows for comprehensive evaluation of wood products, supporting innovation, product validation, and the development of performance-based specifications.

Yuan Yao

Yale University

Life Cycle Systems Modeling for Sustainable Wood Utilization from Local to Global

Bio: Dr. Yuan Yao is an Associate Professor of Industrial Ecology and Sustainable Systems, and Chemical & Environmental Engineering at Yale University. Her research focuses on understanding the potential environmental impacts of emerging technologies and biomass utilization. Dr. Yao received many awards, including the U.S. National Science Foundation CAREER Award, 35 Under 35 Award from the American Institute of Chemical Engineers, and the Laudise Medal from the International Society of Industrial Ecology. Dr. Yao is the associate editor for the journal Resources, Conservation & Recycling. She served on the provisional committee for the U.S. National Academies to assess the current life cycle analysis methods for low-carbon transportation fuels in the United States. Her research has been published in high-impact journals such as *Science*, *Nature Chemical Engineering*, and *Proceedings of the National Academy of Sciences*. She received her Ph.D. degree in Chemical Engineering from Northwestern University.

Abstract: Forests represent one of the most abundant biomass sources on Earth, providing essential resources for renewable energy, pulp and paper, and durable wood product industries. They also play a crucial role in various carbon dioxide removal (CDR) solutions, such as afforestation, reforestation, biochar production, and bioenergy combined with carbon capture and storage. Achieving a sustainable forest-based bioeconomy requires a comprehensive understanding of the environmental, economic, and societal impacts of diverse biomass pathways, as well as their CDR effectiveness across different technologies, regions, and timeframes. This is particularly challenging due to a lack of robust assessment methodologies for interlinked ecological and industrial systems across spatial and temporal dimensions. This presentation will introduce the innovative multi-scale life cycle systems frameworks developed by Dr. Yao's research group to address these challenges. By integrating life cycle assessment with advanced techniques from various fields, such as machine learning, engineering process simulations, and economic and ecosystem modeling, these frameworks provide versatile toolsets for analyzing complex forest biomass systems. Several compelling case studies will be presented, ranging from the local utilization of urban tree waste to the global utilization of forest resources in developing novel products, such as high-performance engineered wood for construction and biochar for climate-smart agriculture. These case studies illustrate how integrated modeling frameworks can enhance our fundamental understanding of the interconnected forest and engineered systems across various scales. Furthermore, the talk will discuss insights for engineering design, forest management, and policy-making. It will demonstrate how the findings from these case studies can inform system-level designs, fostering a resource-efficient and sustainable forest-based bioeconomy that aligns with global sustainability goals.

Jun Zhang

Koppers Performance Chemicals

Extending the Service Life of Engineered Wood Products

Bio: Jun Zhang is Vice President of R&D at Koppers Performance Chemicals (KPC), where he leads global research and development activities, including new product development, process innovation, and cross-functional alignment with commercial objectives. He also oversees North American regulatory affairs, advising on regulatory risks and implementing compliance strategies. Zhang joined Koppers in 2014 as Director of R&D and was promoted to Vice President in 2017. From 2020 to 2025, he served on the Operating Council of Koppers Inc. Prior to that, he held leadership roles in R&D and regulatory affairs at Osmose Inc. from 2000 to 2014. He earned his B.S. in Applied Chemistry from Fudan University, an M.S. in Polymer Chemistry from the Chinese Academy of Sciences, and a Ph.D. from Michigan State University in 1999. Zhang is an active member of the American Wood Protection Association (AWPA), the American Chemical Society (ACS), and the International Research Group on Wood Protection (IRG), where he has chaired multiple technical and scientific committees. He also served on the AWPA Executive Board from 2022 to 2025. Zhang has authored numerous peer-reviewed publications, delivered dozens of scientific presentations, and holds approximately 40 U.S. patents.

Abstract: Engineered wood products (EWPs) are fabricated by using base wood elements like dimensional lumber, strands, particles, timber boards or veneers with adhesives to form a composite material. These wood elements are subject to attack by natural enemies of wood, such as UV-weathering, fire, mold fungi, sapstain fungi, rotting decay fungi, termites and insects, especially when EWPs are used in adverse environments. As a result, to extend the service life of EWPs and to maintain a sustainable future for EWPs, the base wood elements or EWPs need to be protected through preservative, fire-retardant, and anti-UV weathering treatments. Common treatment methods include surface treatments, such as dipping, brushing, spraying and microwave processing, and pressure impregnations, such as vacuum, vacuum/pressure treatments. Colorant, anti-UV weathering resistant, biocidal formulations and/or fire-retardant formulations are often used in these treatments. American Wood Protection Association (AWPA) standardized test methods and ASTM methods are used to evaluate the performance of chemical treatments. AWPA Use Category system also specifies the usage level of the standardized preservatives for various wood species under different environment conditions.

Yunfeng Zhang

University of Maryland

Hybrid Mass Timber Structures with Superwood Components

Bio: Dr. Yunfeng Zhang is a Professor of Civil Engineering at the University of Maryland. His research experiences include integration of sensing, actuation, and artificial intelligence in design and construction for smart and sustainable buildings, seismic resilience of mass timber structures and modular building structures, digital twin of highway infrastructure assets. Dr. Zhang received the Best Paper Award from the ASCE Journal of Computing in Civil Engineering in 2006. He also won the NSF CAREER Award for interdisciplinary research in information technology and structural health monitoring.

Abstract: Mass timber products exhibit excellent load-carrying capacity, enabling their use in larger and more complex structures, making them a sustainable and versatile choice for modern construction. To address affordable housing needs in urban areas, seismic resilient modular structural systems are proposed and investigated through numerical simulations. We are currently developing modular mass timber construction systems that can be rapidly installed, uninstalled upon building decommissioning, and repurposed by swapping out different container units. The portable self-centering modular panel is designed for both new construction and retrofitting pre-code or low-code structures. This prefabricated panel can be transported to the site and bolted onto framed structures, making it particularly suitable for modular construction. Additionally, the enhanced strength of hybrid glulam and CLT structural members by adding advanced wood laminates allows for beams and floor panels with reduced section sizes. Advanced numerical simulation study was performed to address the complexity in analysis and design of hybrid mass timber structures with combined superwood and conventional mass timber components.

Junyong Zhu

USDA Forest Products Laboratory

Sustainable Delignification of Dimensional Wood for Producing of Advanced Wood Structural Materials

Bio: Dr. J.Y. is a ST Scientist at the USDA Forest Products Laboratory, Madison, Wisconsin. Currently, he holds adjunct appointments in the Dept of Biological Systems Engineering at the University of Wisconsin-Madison, and Dept. of Materials Science and Engineering at the University of Maryland-College Park. His research covers broad areas of wood and fiber utilization for energy, chemicals, and materials applications and encompasses from laboratory studies to commercial demonstrations. His scientific accomplishments were honored with many national and international awards, including AIChE (American Institute of Chemical Engineers) Andrew Chase award in 2016, USDA Undersecretary and US Forest Service Chief's honor award, and the Scientific Achievement Award by the International Union of Forest Research Organizations (IUFRO) in 2019. Dr. Zhu is a Fellow of AIChE, TAPPI, and IAWS (International Academy of Wood Science).

Abstract: The groundbreaking concept of substantial wood densification through delignification to produce super strong wood as a sustainable structural material has attracted great interest. Unfortunately, delignification of dimensional wood carries a significant economic and environmental cost, and the requirement of a capital and operation intensive alkali chemical recovery is a huge barrier to commercialization despite that alkaline wood pulping is in commercial practice, not even mention delignification of dimensional wood requires to maintain the integrity of wood structure as oppose to complete disintegration of wood chips into fibers in alkaline wood pulping. Here, we demonstrated for the first time oxygen delignification (O2-delig) of dimensional wood for producing super strong wood after subsequent densification with the aim to facilitate commercialization of dimensional wood densification technology. Equivalent wood mechanical strength (tensile and bending strength greater than 500 and 350 MPa, respectively) was achieved to that reported in literature using alkaline sulfite delignification. LCA analyses show that densified wood has substantial advantages in terms of environmental impacts compared with metals even with high recycling content. O2-delig can be conducted at substantially low temperatures of 85°C to 115°C in semi-gas-solid phase reaction conditions with lower base chemical charge of ~5% on wood compared with 150°C to 170°C for alkaline delignification with alkali charge of more than 20%, which reduced energy and chemical consumption. The smaller amount of spent liquor (semi-gas phase reaction) can be repurposed as fertilizer without the need of expensive chemical recovery operation.

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