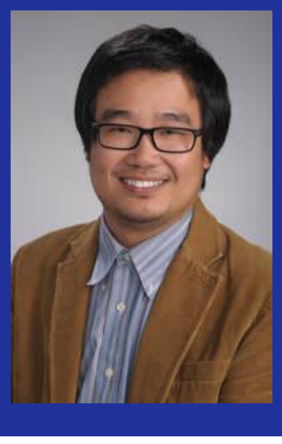
Laboratory for Multiscale Material Modeling (LMMM)



Zhao Qin, Ph.D., PI, Assistant Professor
Department of Civil and Environmental Engineering

Purpose

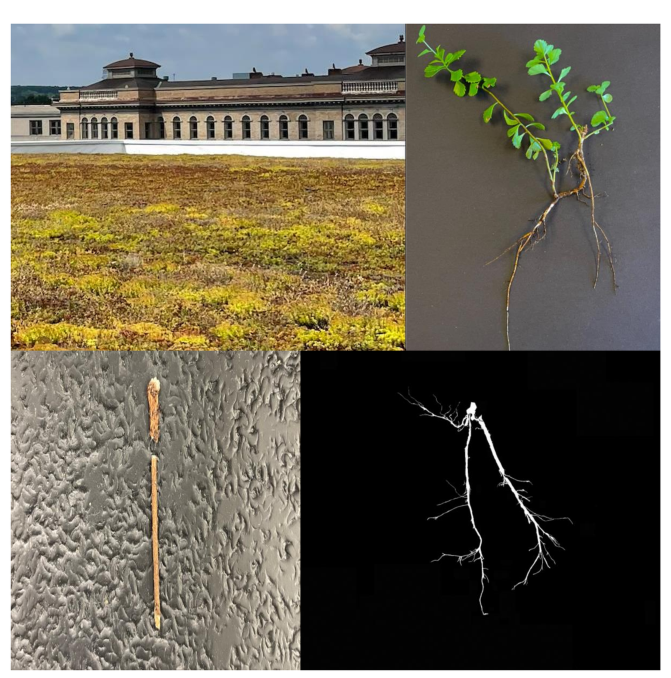
LMMM's main purpose is the fundamental design of structural materials with lightweight and bio-inspired functionality, in general is two-fold:

- Develop multiscale modeling and experimental tools to reveal the nanoscopic mechanisms governing the large-scale behavior of biological materials, specifically for their multiple advanced material functions (e.g., thermal, electromagnetic, biological, optical, tunable mechanics, and acoustic) over-engineering materials.
- Develop high-throughput computational algorithms to enable the design and optimization of bio-inspired composite materials by using nanoscopic building blocks. Integrate computational designs with customized additive manufacturing and make structural materials suitable for advanced mechanical, energy, electronic, biomedical, or multiple applications.

Current Research

Long-term goals are to discover fundamental principles that govern the multiscale mechanics of solid and lightweight composite materials and closely integrate research into education and outreach to advance education in Science, Technology, Engineering, and Math. These goals are enabled by studying a few typical natural systems and revealing their structure-mechanics relationship, including 1. Mycelium 2. Natural composites 3. Carbon-based cellular materials.

Mycelium Growth and its Structure

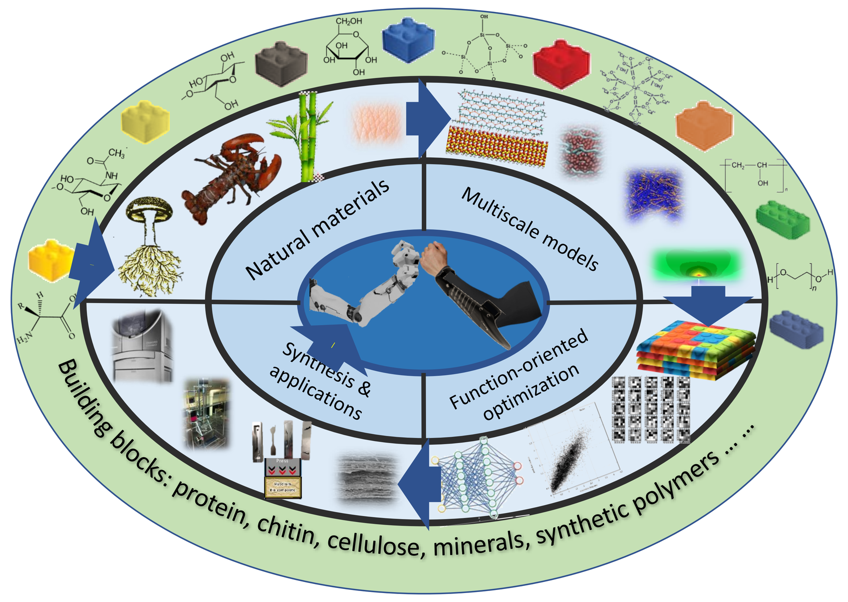


Sedum Root Architecture

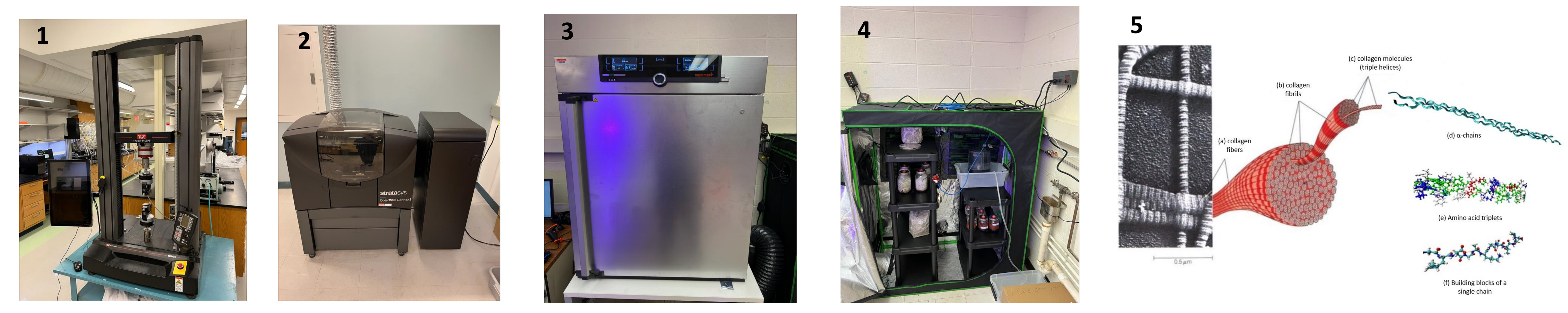
Bamboo Skin Structure

Team Members

Dr. Zhao Qin, Assistant Professor
Mr. Libin Yang, Ph.D. Candidate
Mr. Mingrui Jiang, Ph.D. Student
Mr. Milad Masrouri, Ph.D. Student
Ms. Gargi De, Graduate student
Mr. Saif Elsayed, Graduate student
Mr. Stephen Goffredo, Graduate Student
Mr. Aymeric Destrée, Graduate Student
Mr. Ruohan Xu, Undergraduate Student
Mr. Jose Arturo Venegas, Undergraduate Student



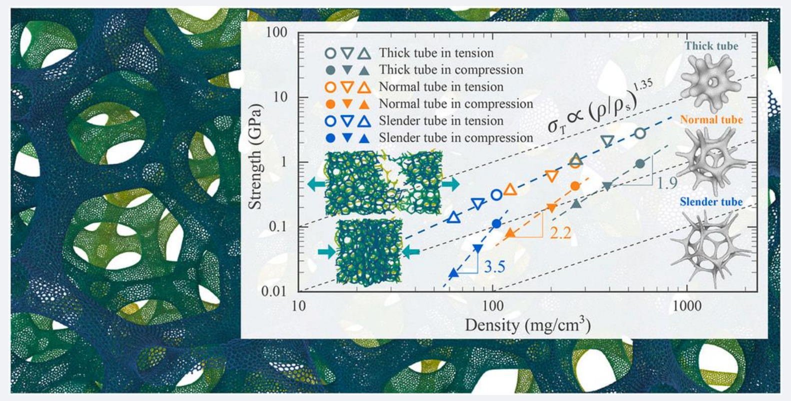
Capabilities

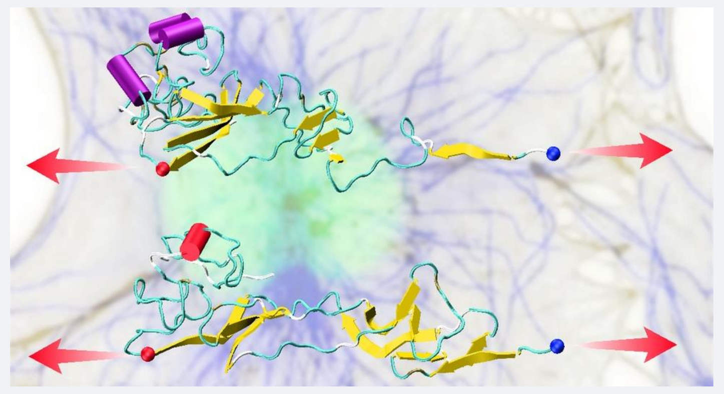


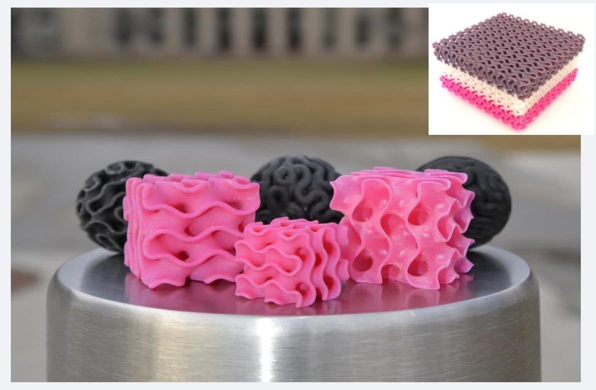
1) INSTRON 5966 Machine; 2) Objet260 Connex3 3D Printer; 3) HPP260ECO Memmert Constant Climate Chambers; 4) Self-build green tent to provide the mycelium growth; 5) Multiscale Material Modeling Capability

Active Projects

- Multi-scale analysis of the structure-mechanics relationship of mycelium-based bio-composites
- In silico design and machine learning of materials
- Exploring how natural materials reach their mechanical strength through their complex self-assembled structures
- The use of waste materials in various construction materials
- Understanding and predicting the mechanical strength of materials through molecular dynamics simulations
- Bio-inspired mechanical enhancement of common construction materials
- Studying the pattern of silica particles in the skin of bamboo
- Mechanical structure of materials
- Construction materials like composites by testing their architecture and properties







Major Contributions

- Why Mussel Byssal Plaques are Tiny yet Strong in Attachment
- Design, manufacture, and testing of customized sterilizable respirator
- The design of strongly bonded nanoarchitected carbon materials for high specific strength and modulus
- Shell microelectrode arrays (MEAs) for brain organoids
- Design of lightweight and ultrastrong nanoarchitected carbon by a coarse-grained model
- Material Function of Mycelium-Based Bio-Composite: A Review
- Imaging and analysis of a three-dimensional spider web architecture
- Printing stronger silk than its natural form (Polymorphic, hierarchical, regenerated silk fibers assembled through bioinspired spinning)

Sponsors

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