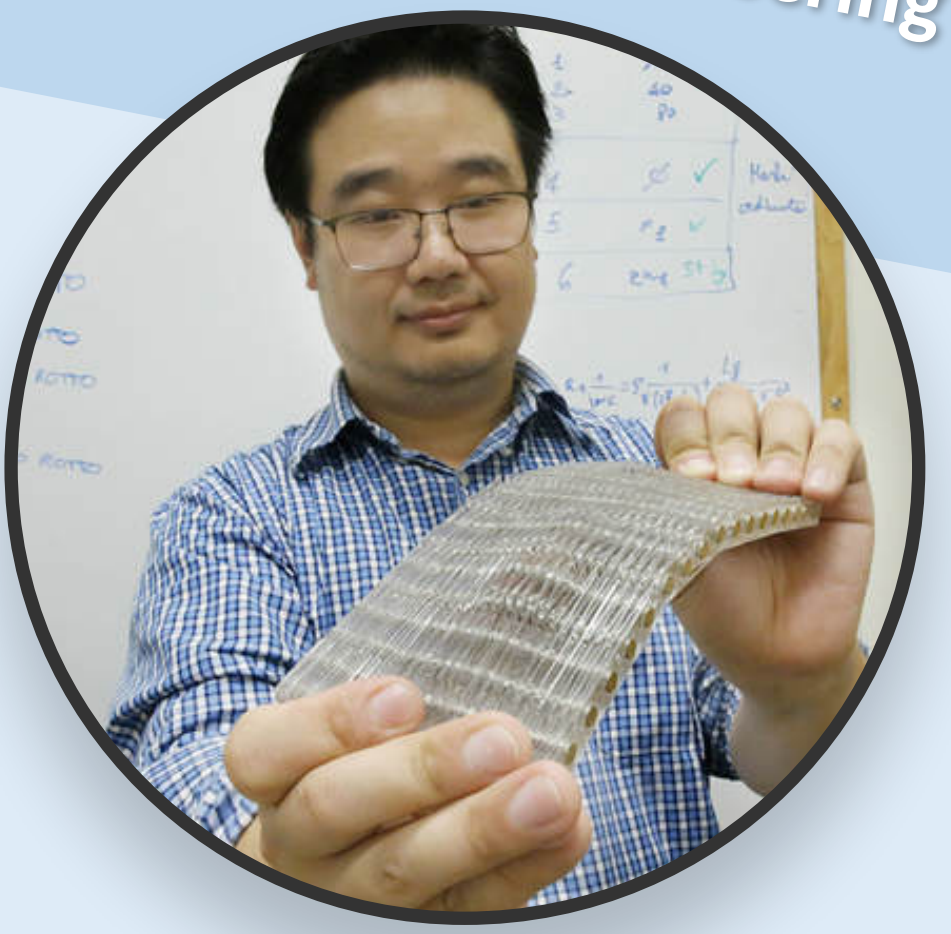
Multiscale Computational Design of Materials

from nature to engineering



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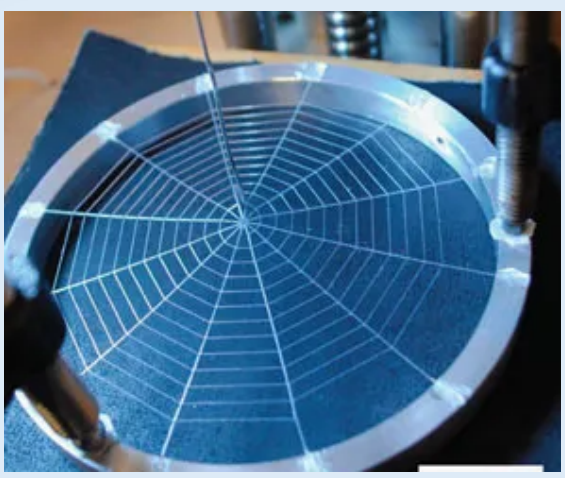

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Multiscale Computational Design of Materials: From Nature To Engineer

Abstract

Natural materials exhibit many fascinating functions (e.g., strength, low density, self-assembly, toughness, impact isolation) that take place at multiple scale levels. It is useful to decipher the mechanisms hidden behind and use them to improve the material function of engineering designs that can lead to stronger and environmentally-friendly materials with lower cost. In this talk, I will introduce my recent study in multiscale computational modeling of several biological materials of mechanical advantages including cellular networks, silk, butterfly wings and lobster membranes and illustrate how to apply the knowledge to design better composites. I will demonstrate how multiscale computational models, together with advanced machine learning methods, can be integrated to investigate the unique design-structure-function relationships in a cascade manner. I will also discuss the opportunities of integrating computational modeling with experimental synthesis and 3D printing for bio-mimicking designs. I will illustrate how these different techniques can work collectively for innovative material designs.

1. J. Wu, Z. Qin, et al., (2019) "Natural hydrogel in American lobster: a soft armour with high toughness and strength", *Acta Biomaterialia*.
2. Z. Qin, et al., (2017), "The mechanics and design of a lightweight three-dimensional graphene assembly", *Science Advances*, Vol 3, paper #: e1601536
3. S. Ling, Z. Qin, et al., (2017), "Design and function of biomimetic multilayer water purification membranes", *Science Advances*, Vol. 3, paper #: e1601939
4. Z. Qin, et al., (2015), "Structural optimization of 3D-printed synthetic spider webs for high strength", *Nature Communications*, Vol. 6, paper #: 7038
5. Z. Qin and M. J. Buehler, (2013), "Impact tolerance in mussel thread networks by heterogeneous material distribution", *Nature Communications*, Vol. 4, paper #: 2187

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Dr. Zhao Qin is an Assistant Professor in the Department of Civil and Environmental Engineering at Syracuse University. He graduated from the Department of Engineering Mechanics at Tsinghua University with Bachelor and Master Degrees in 2006 and 2008, respectively. He then went to MIT and received his PhD degree from Civil and Environmental Engineering department in 2012. After that, he worked as a postdoc associate and teaching fellow and then a research scientist till 2019. His study focuses on material by design which generally covers advanced mechanical properties of nano and biological materials. By revealing how the chemical structures relate to mechanical and biological functions of biological materials via multiscale computational modeling, he develop ways to model and design materials with advanced functions for engineering applications. Dr. Qin is currently working toward developing methods for additive manufacturing of biocomposite materials for optimized functions and welcome graduate students with interest to apply.