Penn Engineering
University of Pennsylvania
Chemical and Biomolecular Engineering

Spring 2023 Seminar Series

MARKUS J. BUEHLER

"Multiscale Bioinspired Material Intelligence"

Wednesday
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3:30 PM
Wu and Chen Auditorium
Levine Hall

McAfee Professor of Engineering
Massachusetts Institute of Technology

ABSTRACT

Digital biomaterials are designed through an integrated approach of large-scale computational modeling, material informatics, and artificial intelligence/machine learning to optimize and leverage novel smart material manufacturing for advanced mechanical properties. Through the use of nanotechnology and additive manufacturing, and bio-inspired methods, we can now mimic and improve upon natural processes by which materials evolve, are manufactured, and how they meet changing functional needs. In this talk we show how we use mechanics to fabricate innovative materials from the molecular scale upwards, with built-in bio-inspired intelligence and novel properties, while sourced from sustainable resources, and breaking the barrier between living and non-living systems. Applied specifically to protein materials, this integrated materiomic approach is revolutionizing the way we design and use materials, and has the potential to impact many industries, as we harness data-driven modeling and manufacturing across domains and applications. The talk will cover several case studies covering distinct scales, from spider webs and silk, to collagen, to biomineralized materials, as well as applications to food and agriculture, and focuses on mechanistic insights using scaling laws and size effect studies.

BIO

Markus J. Buehler is the McAfee Professor of Engineering at MIT (an Institute-wide Endowed Chair), a member of the Center for Materials Science and Engineering, and the Center for Computational Science and Engineering at the Schwarzman College of Computing. He holds academic appointments in Mechanical Engineering and Civil and Environmental Engineering. In his research, Professor Buehler pursues new modeling, design and manufacturing approaches for advanced biomaterials that offer greater resilience and a wide range of controllable properties from the nano- to the macroscale. His interests include a variety of functional material properties including mechanical, optical and biological, linking chemical features, hierarchical and multiscale structures, to performance in the context of physiological, pathological and other extreme conditions. His methods include molecular and multiscale modeling, design, as well as experimental synthesis and characterization. His particular interest lies in the mechanics of complex hierarchical materials with features across scales (e.g. nanotubes, graphene and natural biomaterial nanostructures including protein materials such as intermediate filaments and hair, collagen, silk and elastin, and other structural biomaterials). An expert in computational materials science and AI, he has pioneered the field of materiomics, and demonstrated broad impacts in the study of mechanical properties of complex materials, including predictive materials design and manufacturing. Between 2013-2020, Buehler served as Department Head of MIT's Civil and Environmental Engineering Department. He has held numerous other leadership roles at professional organizations, including a term as President of the Society of Engineering Science (SES).