Deformation mechanisms and spinning conditions controlling the mechanical response of spider silk fibers

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Abstract

Spider silk is a fibrous protein material with a unique microstructure that leads to exceptional mechanical properties such as high stiffness and toughness. The behavior of the silk depends on the microstructure, which is determined through the spinning process (i.e. fibers can be naturally spun or forcibly silked). The microstructure can also be controlled via post-processing. Yet, the relations between the microstructure and the macroscopic response is not fully understood.
In this talk, we present an energy-based multi-scale model that sheds light on the influence of microstructure on the overall response. Specifically, the model accounts for the spinning conditions, the composition and alignment of the chains, and the density of intermolecular bonds. The model is validated through comparison to a wide range of experimental results.

Our findings provide a comprehensive framework that enables one to tailor the mechanical response of silk fibers and offers insights that can be used for the design of advanced bio-inspired materials with superior mechanical performance.

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