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Mechanics of Silk: from molecules to orb-webs

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Silk fibers are an intriguing material which outstanding mechanical properties are imparted by a delicate –and mostly unknown– interplay between composition, micro-structure and processing. Detailed knowledge of their mechanism of assembly and deformation, from the molecular to the macroscopic scale, will largely benefit the quest to the development of synthetic high performance fibers.

Silks are semicrystalline polymers of proteins designed to specifically respond to forces on the molecular scale, the concerted action of which results on the biomechanics on the macroscale. In this regard, bottom-up or top-down approaches –spanning multiple scales– are required to make quantitative predictions on elasticity and plasticity, force transduction, and fracture.

A concerted effort of material scientists, physicists, chemists and biologists is needed to tackle the challenge of how silk evolved for a well-defined response to mechanical forces. Macroscopic measurements on silk dopes and fibers, microstructural data obtained from techniques like AFM, XRD or NMR, and computational multi-scale techniques can relate microscopic and macroscopic properties of biomolecules and thereby can provide invaluable insights into silk mechanics.

Consequently, the aim of this mini-symposium is to gather experts on the areas above to inspect current developments and envision new ones at all observational levels, with the goal of an integrative look at the mechano-deformational properties of this remarkable material.

As an expected result of the mini-symposium, critical questions of silk mechanics can be eventually answered, such as the molecular basis of strain hardening or supercontraction, sequence dependence, the effect of mechanical forces on fiber conformation, the origin of hysteresis and time-dependence. As a major outcome of the mini-symposium, we expect a fresh look onto the fascinating biomaterial silk, and a comprehensive update of our current understanding of its structure and mechanics, all of which can be also straightforwardly transferred to other complex (bio)materials.