

Dynamic Mechanical Properties of Silkworm Silk under Strain

Zuyuan Wang^{C, S} and George Fytas

Max Planck Institute for Polymer Research, Mainz, Germany

wang.zuyuan@mpip-mainz.mpg.de

Silkworm silk possesses superior static mechanical properties compared with synthetic polymers with similar chemical compositions. In real applications, silkworm silk is likely subject to dynamic loadings. However, the dynamic mechanical properties of silkworm silk have remained largely unknown so far. Here we study the dynamic response of silkworm silk by Brillouin Light Scattering (BLS) experiments, a technique based on the inelastic interactions between photons and hypersonic phonons. We report the hypersonic phonon dispersions and elastic moduli of silkworm silk under contraction or stretching strains. Contrary to the elastic moduli of spider dragline silk, which show strain-hardening effects at low strains and strain-weakening effects at large strains, the elastic moduli of silkworm silk display only strain-weakening effects. We quantitatively capture the differences by using a nonlinear 1D lattice model, and attribute the different dynamic mechanical properties of the two types of silk to their different hierarchical structures. This study improves the current understanding of the dynamical mechanical properties of silkworm silk, and is potentially useful for tuning the properties of silkworm silk for the relevant applications.