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Phononic band gap and mechanical anisotropy in spider silk PERIKLIS PAPADOPOULOS, Institute of Experimental Physics, University of Leipzig, NIKOS GOMOPOULOS, Max Planck Institute for Polymer Research, FRIEDRICH KREMER, Institute of Experimental Physics, University of Leipzig, GEORGE FYTAS, Max Planck Institute for Polymer Research — Spider dragline silk is a semi-crystalline biopolymer exhibiting superior properties compared to synthetic polymers with similar chemical structure, such as polyamides. This is ascribed to the hierarchical nanostructure that is created in the spinning duct. During this process the aqueous solution of the two protein constituents of dragline silk is crystallized, while the macromolecules maintain their high orientation, leading to a high value of the Young's modulus (in the order of 10 GPa) along the fiber. We employed spontaneous Brillouin light scattering to measure the longitudinal modulus $(M_{//}, M_{\perp})$ along the two symmetry directions of the native fiber with increased (decreased) pre-strain created by stretching (supercontracting after hydration). A strong mechanical anisotropy is found; at about 18% strain $M_{I/}/M_{\perp} \sim 5$. Most important, an unexpected finding is the first observation of a unidirectional hypersonic phononic band gap in biological structures. This relates to the existence of a strain-dependent correlation length of the mechanical modulus in the submicron range along the fiber axis.

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