Title:	The processing and heterostructuring of silk with light
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Abstract:	Spider silk is a tough, elastic and lightweight biomaterial, although there is a lack of tools available for non-invasive processing of silk structures. Here we show that nonlinear multiphoton interactions of silk with few-cycle femtosecond pulses allow the processing and heterostructuring of the material in ambient air. Two qualitatively different responses, bulging by multiphoton absorption and plasma-assisted ablation, are observed for low- and high-peak intensities, respectively. Plasma ablation allows us to make localized nanocuts, microrods, nanotips and periodic patterns with minimal damage while preserving molecular structure. The bulging regime facilitates confined bending and microwelding of silk with materials such as metal, glass and Kevlar with strengths comparable to pristine silk. Moreover, analysis of Raman bands of microwelded joints reveals that the polypeptide backbone remains intact while perturbing its weak hydrogen bonds. Using this approach, we fabricate silk-based functional topological microstructures, such as Mobiüs strips, chiral helices and silk-based sensors.
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