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Microfabrication of a spider-silk analogue through the liquid rope coiling instability[1] FREDERICK P. GOSSELIN, DANIEL THERRIAULT, MARTIN LEVESQUE, Ecole Polytechnique de Montreal — Spider capture silk outperforms most synthetic materials in terms of specific toughness. We developed a technique to fabricate tough microstructured fibers inspired by the molecular structure of the spider silk protein. To fabricate microfibers (with diameter $\sim 30\mu m$) with various mechanical properties, we yield the control of their exact geometry to the liquid rope coiling instability. This instability causes a thread of honey to wiggle as it buckles when hitting a surface. Similarly, we flow a filament of viscous polymer solution towards a substrate moving perpendicularly at a slower velocity than the filament flows. The filament buckles repetitively giving rise to periodic meanders and stitch patterns. As the solvent evaporates, the filament solidifies into a fiber with a geometry bestowed by the instability. Microtraction tests performed on fibers show interesting links between the mechanical properties and the instability patterns. Some coiling patterns give rise to high toughness due to the sacrificial bonds created when the viscous filament loops over itself and fuse. The sacrificial bonds in the microstructured fiber play an analogous role to that of the hydrogen bonds present in the molecular structure of the silk protein which give its toughness to spider silk.

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