BIOMIMETIC FUNCTIONAL FIBERS INSPIRED BY SPIDER SILK

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ABSTRACT

Spider silks display interesting mechanical properties owing to their specifically designed amino acid building blocks. Territorial and cannibalistic nature of spiders makes them difficult to farm like silkworms. It is the dream of scientists to seek alternative methods to produce spider silk inspired fibers. The hierarchical difference in microstructure of silks give rise to variable mechanical properties to meet different needs of spider. Supercontraction is one of the characteristic properties of the dragline silk where the unrestrained fiber can contract up to 50% of the original length to generate ample stress under influence of humidity. This fascinating property of spider silk is produced by synergistic structure formed by highly ordered β-sheet crystals and less ordered malleable amorphous network Noteworthily, this behaviour of spider silk can be made repeatable after each supercontraction cycle by restraining the fibre to a fixed length and drying it. Furthermore, the fibres when restrained and allowed to supercontract high values of shrinkage and stress can be generated under free and constrained conditions. The moisture responsive behaviour of spider silk can be attributed with the typical property of shape memory materials. In this work, we had studied pseudo-biomimetic spinning of recombinant spider dragline silk protein to explore their response to humidity. Chimeric recombinant spider dragline silk proteins MaSp2 is expressed in E. Coli and spun into fibers mimicking pH environment in spider spinning duct. Interestingly, biomimetically spun fibers using this strategy demonstrated cyclic contraction in response to humidity. Furthermore, the fibers were able to memorize the stress applied to them that can be retrieved upon repeated wetting and drying under controlled conditions. Tubuliform silk is one of the seven different types of spider silks, which is well known for its unique tensile property with Flat Tensile Stress–Strain (FTSS) curve. It was found that anisotropic microstructure of β-sheets is responsible for this property. Our work aims to investigate a strategy to biomimic the FTSS behaviour of tubuliform silk in synthetic polymer composite fibres by blending polyurethane (PU) and regenerated silk fibroin (RSF) at different ratios. The composite fibres also display tuneable mechanical properties with respect to RSF contents.