Banking on the spider for future fibres

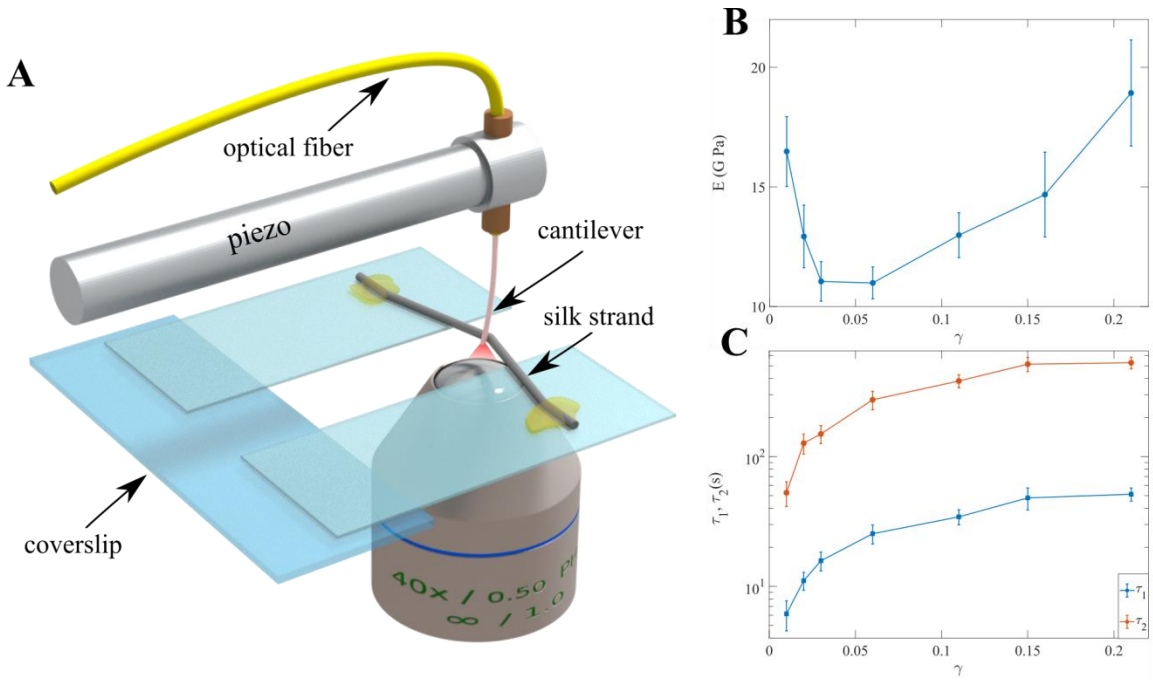
"Will you walk into my parlour?" said the spider to the fly. The firmness of the spider web or 'parlour' of the spider has fascinated us through ages. Probe of some scientists from the Raman Research Institute (RRI), an autonomous Institute of Department of Science and Technology along with IISER Thiruvananthapuram and Azim Premji University, have revealed interesting mechanical behaviour of the silk fiber of the spider. Such mechanical properties may be mimicked for designing future fibres that require a combination of flexibility and firmness.

The scientists found that at small values of applied strain, the silk fibers accommodate the strain by deforming relatively easily (softening), while they stiffen at higher values of applied strain. Nevertheless, it was observed that the time it takes for the spider silk to relax to an equilibrium stress after an applied strain increases monotonically with increasing values of strain. Currently available models are not able to satisfactorily explain this behaviour. The study was published in the journal Soft Matter.

Taking a leaf out of a model developed by Members of the Cell Biophysics lab at RRI along with collaborators for similar softening and subsequent stiffening behaviour of axons, the scientists speculate that this model along with existing models could explain the observed viscoelastic response of spider silk to applied strain.

An improved version of the Micro-Extension Rheometer - a device conceived, designed and built at RRI was used to investigate the linear and nonlinear mechanical response of a specific type of spider silk. The device helped probe the elastic response of social spider dragline silk fibers by applying a sequential step-strain plus small amplitude sinusoidal oscillation protocol. This method allows the measurement of the resistance of the silk fiber to applied strain under a quasi-equilibrium condition. This is unlike previous reports where, typically, the silk strand is extended continuously to highly non-linear regimes at a given strain rate. The measurement of relaxation time is novel and demands development of better models to explain silk elasticity.

Such studies can enable the development of better models and a better understanding of the structure-property relationships of spider silk fibers and may in the long run help develop synthetic fibers that could mimic the unique mechanical properties of spider silk.



(A) schematic of the Micro-Extension Rheometer developed at RRI. (B) Plot of the Young's modulus of silk as a function of strain showing an initial softening and subsequent stiffening. (C) Plot of the stress relaxation times as a function of applied strain.