

Mechanical testing of spider silk

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ABSTRACT

Spider silk has become a benchmark for modern polymer fibres and extensive research is being devoted to understanding and, eventually, copying these silk fibres [1]. It is an exceptional material; produced by the animal under ambient temperatures and pressures, and with water as solvent, and yet with mechanical properties comparable to those of the toughest man-made high-performance fibres.

Mechanical testing of spider silk is a means of linking information on molecular structure and composition with the properties of the silk. Measurement of the mechanical properties of silk is however not a trivial task. Spider silk fibres are only a few micrometers thick, and to avoid damaging or even breaking the fibres, micro-manipulators are needed for the handling. Moreover, sensitive equipment is needed to accurately measure their dimensions, as well as their load-displacement characteristic. Finally, spider silk is produced by living organisms, i.e. the spiders, which are controlling its properties, and this makes the species of spiders, the living conditions of the individual spiders and the sampling of silk important aspects in the mechanical testing of spider silk [2-4].

The presentation will give an introduction to spider silk and its properties. The applied method of mechanical testing of spider silk will be presented, as well as some of the obtained results; Figure 1 shows results of testing of silk from different spider species giving strength in range 0.8-1.5 GPa and toughness in the range 120-200 MJ/m³. Finally, some findings of the current spider silk research will be shown.

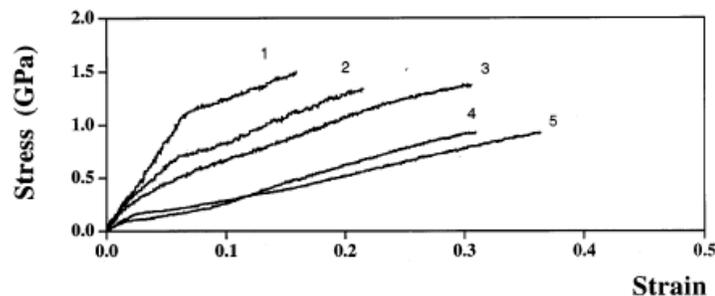


Figure 1: Stress-strain characteristics of silks sampled from 5 different species of spiders [3].

References

- [1] D. Porter, F. Vollrath: Silk as a biomimetic ideal for structural polymers. *Advanced Materials*, 21 (2009), 487-492.
- [2] B. Madsen, F. Vollrath: Mechanics and morphology of silk drawn from anaesthetized spiders. *Naturwissenschaften*, 87 (2000), 148-153.
- [3] B. Madsen, S. Zheng Zhong, F. Vollrath: Variability in the mechanical properties of spider silks on three levels: interspecific, intraspecific and intraindividual. *International Journal of Biological Macromolecules*, 24 (1999), 301-306.
- [4] F. Vollrath, B. Madsen, S. Zheng Zhong: The effect of spinning conditions on the mechanics of a spider's dragline silk. *Proceedings of the Royal Society B*, 268 (2001), 2339-2346.