STATE-OF-THE-ART LECTURE S2
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Unravelling the secrets of spider silks

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The extremely low environmental costs of production and decommissioning make silks interesting materials for the 21st century, especially if it were possible to use state-of-the-art bio-technology methods of manufacture. To this end, we need to fully understand the structure-property relationships of this complex bio-material. In my talk I shall discuss the biology and evolutionary history of silks in order to unravel not only their work requirements but also the historical and physiological constraints under which they evolved.

In silks, proteins are the structural components and water is the solvent. Protein and water combine and separate - under ambient pressures and temperatures - to make a silk fibre, which is so tough that it outperforms even the best man-made fibres. Spider silk is a case in point for outstanding mechanical performance and hence an excellent starting material in the quest to untangleanimal silks and their many trade-secrets. The tools we use to study silks are all based on comprehensive biological understanding and include the 'mining' for natural silks with interesting properties in combination with state-of-the-art experimental analysis and polymer modeling. Such studies provide us with novel insights into the behaviour of silk proteins and their interaction with water, the great modifier of material properties. So far, these studies have lead us to a number of important discoveries ranging from tunable nano-scale composite structures (that absorb energy hydro-electrically) to complex self-assembling micro-machines (that absorb energy mechanically) all the way to the building of complex webs cleverly engineered to absorb energy aerodynamically. All these ways-and-means are the works of Nature and its 'Design by Evolution'. This procedure is a most marvelous and powerful process, albeit rather time consuming, to create and fabricate highly functional - and energy efficient - materials, devices and systems.