Towards a novel "silky" way to detect chemical species using spider threads

(Keynote Talk)

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Silk possesses extraordinary properties that scientists are currently working hard on harnessing. Amongst them, this primeval material has shown early potential of having excellent optical properties. Through a regeneration process, it is possible to obtain silk films made from fibres of silk cocoons, by casting a silk fibron solution on an appropriate surface. These transparent films have been used to make optical devices such as diffraction gratings, phase masks, and photonic crystal lattices [1].

A more natural approach involves using dragline silk, extracted directly from the major ampullate glands of spiders, as a natural, tough, biodegradable and biocompatible light conveyor in biological media [2]. Unlike its silica counterpart, commonly used for sensing physical parameters such as temperature and strain but poorly sensitive to chemical elements, silk threads can be used as chemically sensitive optical fibres to detect the presence of compounds such as proteins, nucleic acids, etc. More specifically, these protein-based biopolymers contain millions of repetitive protein sequences and domains that can interact with a multitude of chemicals via their unique molecular structures, which significantly multiplies the responsivity compared to conventional fibre optic-based chemical sensors (sensitised fibre-tip, evanescent-field based fibre sensors). In the end, this makes spider silk an excellent candidate for our targeted application.

In this presentation, we will first review the optical properties of dragline spider silk, used as an optical fibre in its pristine condition [3], and explore the potential of using spider silk as a new type of fibre-optic chemical sensor in a fully bio-inspired approach [4].

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