The Silky Way: Biomimetic sensing through changes in structural proteins

Executive Summary

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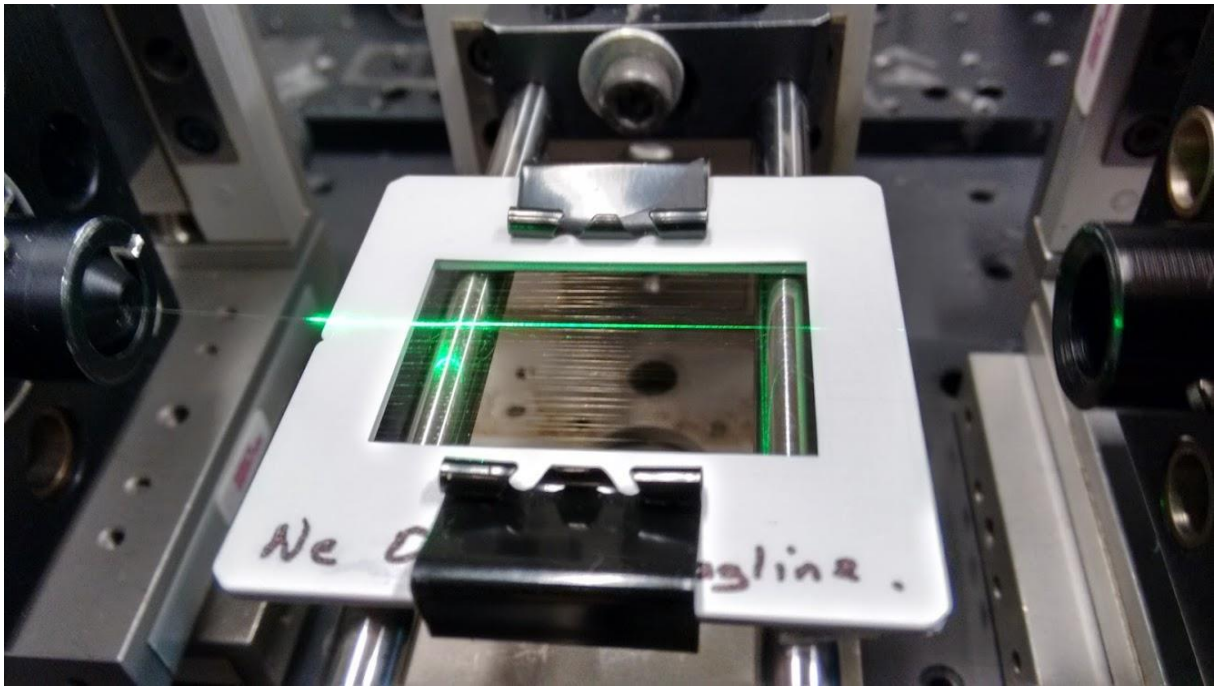
Picture:



Motivation:

The objective of Silky Way is to explore the possibility of using spider dragline silk as sensing element for fibre-based biosensors by transmitting light through silk fibre and monitoring the change in the silk's optical properties induced by biochemical compounds.

Methodology:

Light injection inside a dragline silk, which is controllably reeled from a female *Nephila edulis* spider, is demonstrated by using evanescent field coupling and direct end-fire methods. The ability to couple light into these silk fibres enables to determine their optical characteristics such as transmission window, propagation losses and optical birefringence.

Detection of several biochemical compounds is also demonstrated by observing the change in the state of light polarisation. As polar compounds are placed near to the silk fibre, they modify hydrogen bonds within and between molecular chains of silk, causing them to coil-uncoil. This results in a change in silk's birefringence, which has been detected by monitoring the polarisation state of the transmitted light with polarisation state analyser.

Results:

- Light coupling and guiding inside a dragline silk.
- Optical characterisation (transmission window, attenuation losses at different wavelengths, birefringence) of the dragline silk.
- Proof-of-concept of polar biochemical compound detection with spider silk.

Publications:

- K. Hey Tow, D. M. Chow, F. Vollrath, I. Dicaire, T. Gheysens and L. Thévenaz, "*Spider silk: a novel optical fibre for biochemical sensing*," OFS-24 24th International Conference on Optical Fiber Sensors, Curitiba, 2015 (submitted).
- D. M. Chow, K. Hey Tow, F. Vollrath, I. Dicaire, T. Gheysens and L. Thévenaz, "*Optical Characterisation of Spider Silk*," IPC-28 28th Annual Conference Of The IEEE Photonics Society, Reston, Virginia USA, 2015 (to be submitted).

Highlights:

The fast response and high sensitivity of the silk fibre in response to polar compounds paves the way for promising applications for biochemical sensing. This sensor can potentially be used to detect the presence of water and ammonia traces in Martian atmosphere since it is not sensitive to non-polar compounds such as carbon dioxide and methane, which mainly compose the Martian atmosphere. Preliminary experiments have shown that ammonia and water vapours could be detected in a flow of carbon dioxide gas.