

SEMINAR

Department of Biological Sciences



Wed, 29 February 2012 | 4pm | DBS Conference Room 1

Hosted by A/P Li Daiqin

The Hierarchy of Structure-Property-Function Relations in Natural Silks

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The production of natural silk requires a complex combination of processes in order to function cooperatively. This series of processes starts with the synthesis of the proteins and proceeds via the stable storage of a concentrated protein solution through the rheological conversion of the liquid dope to the oriented solid fibre with controlled material properties tuned to satisfy a wide range of biological functions. Here we discuss this hierarchy of processes in terms of a self-consistent series of structure-property-function models based upon our extensive empirical and experimental work on natural silks. The aim is to show how events at the molecular-, nano-, and micro-scale have evolved into a synergistic production system for a massive range of materials that can all be classed as silk by virtue of the key defining processing step of 'spinning'. The main link across this hierarchy of processes and scales is the management of energy, which is common to both our biological theme of evolved processes for survival and also the physical mechanisms that nature uses to achieve its functional goals. The lessons learned from silk can then be used to understand a wide range of other biological materials and also as ancient models for modern biologically derived polymers that could combine environmental and performance advantages over current synthetic analogues.

About Speaker: Prof. Porter gained his PhD in Physics at Loughborough University and worked for 16 years with Dow Chemical on polymer research and development in Switzerland, The Netherlands and USA. While at Dow, he wrote a book 'Group Interaction Modelling of Polymer Properties' on predicting structure-property relations in polymers. He joined QinetiQ in The UK in 1995 as a QinetiQ Fellow on materials modelling, and worked on all material types over a wide range of applications. His speciality is prediction of structural properties of materials from molecular composition and morphological structure, through their micro- and fracture mechanics to engineering application. As part of his work on composite materials, he became a visiting professor in the department of Engineering Materials at the University of Sheffield. After a few years working as an associate scientist, he joined Professor Vollrath at Oxford to work on silk and other biological materials in January 2009, where the group is making significant progress on understanding all aspects of silk properties, from spinning to final fibre and natural silk composite properties