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HANDS-ON SESSION

Chitin self-assembly into hierarchically structured materials

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Think of an annoying fly, a scary spider, a delicious shrimp or a funny looking mushroom – they all have something in common! They all heavily rely on a biopolymer chitin for making up their skeleton, which is most obvious in the case of arthropods as their skeleton is on the outside. While chitin may appear boring to you as it has a relatively simple molecular structure, it is actually an invigorating material to study due to its hierarchical architecture.

The linear molecules of chitin really like to associate with one another. In fact, chitin is virtually always found as nanofirbils made of 18-25 chitin molecules, which are generally considered the elementary building block. Such nanofibrils are then wrapped by proteins and aligned to form sheets, which are further stacked on top of each other with or without an angular offset. The latter case, which looks somewhat like a circular staircase, is known as a helicoidal architecture and is known to reduce crack propagation or induce structural coloration in the case of some brightly iridescent beetles. Nevertheless, it is little known how so many levels of hierarchy can be orchestrated using a simple starting material chitin.

One of the hypothesis is that chitin, when being produced by cells, simply self-assembles with little to no guidance. Such a theory is backed up by the observations that lab-made chitin nanoparticles, extracted from purified chitin, spontaneously self-assemble in water. In fact, they exhibit liquid crystalline properties and form structures, analogous to those found in the arthropod cuticle, which can be even reserved when such artificial chitin water dispersion is dried into a solid film.

In this tutorial we will:

- use chitin nanoparticles as a model colloidal and liquid crystalline system
- use polarised optical microscopy to investigate their self-assembly behaviour
- use dynamic light scattering (DLS) to characterise nanoparticles
- prepare solid-state films with hierarchical architecture and characterise their microarchitecture using scanning electron microscopy (SEM)
- evaluate purity and composition of chitin nanoparticles using Fourier transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA)