

Dynamics in soft matter systems probed by small-angle neutron scattering

Wednesday, 11 November 2020 13:00 (20 minutes)

Due to the lower intensity of neutron sources when compared to synchrotron X-rays, it is often assumed that small-angle neutron scattering (SANS) is best suited to the study of equilibrium samples or processes with slow dynamics. However, over the last 10 years, my group (and many others) have shown that along with ‘slow’ processes taking minutes or hours, even fast dynamic processes in soft matter systems can be accessed using neutron scattering. Such measurements provide information on how systems rearrange at the nanoscale, and ultimately, how this informs their bulk properties and behaviour. This talk will explore some interesting cases where dynamic studies using SANS uncover unique properties of self-assembled systems.

Dense microemulsions are particularly suited to study using dynamic SANS ¹, as their scattering intensity tends to be rather high. However, this means that analysis of obtained scattering is often compounded by the convolution of form with a strong structure factor contribution from local interactions or structuring between droplets. Dynamics of a dilution-induced phase change between lamellar and droplet-like microemulsion systems could be monitored with time resolution as low as 20 ms, offering new insight into fast processes where the neutron contrast offered by isotopic variation proves essential ¹.

Light as an external stimulus to cause dynamic changes in soft matter is particularly appealing, as photons are seen as a ‘green’ reagent that ideally allow spatiotemporal control of chemical systems. To incorporate this feature into surfactant systems, molecules that photoisomerise are used, termed photosurfactants [2]. By monitoring the changes in self-assembly structure as such systems undergo isomerisation, insight can be obtained on their packing and dynamics, aiding the design of stimulus responsive complex fluids.

Finally, the deformation of self-assembled systems in flow is a fascinating manifestation of the complex interplay between structure and dynamics. Perhaps the most prototypical example of this is how long, threadlike micelles align with a flow field, lowering their entanglement and therefore viscosity. By exploring different shear speeds, information on how structure relates to flow, which is essential in product design using these industry-favourite viscoelastic texture modifiers.

References

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3. Kelleppan, V. T., Moore, J. E., McCoy, T. M., Sokolova, A. V., de Campo, L., Wilkinson, B. L., Tabor, R. F. Self-Assembly of Long-Chain Betaine Surfactants: Effect of Tailgroup Structure on Wormlike Micelle Formation. *Langmuir* 2018, 34, 970–977.

Level of Expertise

Experienced Research

Speakers Gender

Male

Do you wish to take part in the poster slam

No

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