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How soap dissolves micelles: solubilisation kinetics of mixtures between anionic surfactants and block copolymer micelles

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Fundamental understanding of the solubilisation process in self-assembly systems is important for many applications including membrane solubilization and protein extraction. The kinetic processes involved in mixtures of surfactants and block copolymer micelles are not well understood. However, it is commonly known that surfactants exhibit rather fast equilibration kinetics, in the order of micro- to milliseconds, while polymers are much slower, in the order of minutes to months. In this contribution, we will present a study of the stability and solubilization kinetics of block copolymers micelles upon addition of sodium dodecyl sulphate (SDS) using small angle X-ray scattering (SAXS) and time resolved neutron scattering (TR-SANS). We compare the ability of the surfactant to dissolve and form mixed micelles with three amphiphilic polymers; poly(ethylene propylene)-poly(ethylene oxide) (PEP-PEO) and end-capped PEO (C28-PEO and C21PEO5). The exchange kinetics of C28PEO occurs over 5 seconds and C28PEO occurs on time scales on the order of minutes-hours on ambient temperatures, and that of PEP1-PEO20 is known to be frozen on practical time scales. Addition of SDS to PEP1-PEO20 shows close to no change, even after extended period of time. However, time-resolved SAXS data of addition of SDS to C21PEO5 shows a fast dissolution and formation of mixed micelles over seconds, while under the addition of SDS to C28PEO5 we observe a dissolution over hours. The solubilisation process can be analysed by a combination of two processes. Initially, a fast concentration dependent fragmentation process takes place, before a re-organization step of the polymer chains occurs which rate is dependent on length of the hydrophobic block. The results provide insight into the role of dynamic asymmetry in self-assembly, which is transferable to many multi-component systems.

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