Nanoscale structure and dynamics of soft matter probed by synchrotron SAXS

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While modern synchrotron sources offer high photon flux and small beam size, the ability to detect weak structural features and probe the underlying dynamics by means of scattering techniques is not guaranteed. In order to overcome the detection limit, concomitant improvements in the sensitivity and dynamic range of the detector and the reduction of scattering background are essential. Owing to recent advances in detector technology, this barrier has been significantly reduced. As a result, nanoscale dynamics of dilute and weakly scattering systems can be studied in the millisecond range [1,2]. This is an appropriate time-range for studying a wide range of self-assembly processes in soft matter that will be demonstrated by several representative examples. For instance, the self-assembling properties of amphiphilic molecules have been widely exploited in the design of nanostructured materials. This micellar self-assembly process can be initiated by rapid mixing of equimolar amounts of anionic and cationic micelles using a stopped-flow device. The millisecond time resolution permits to identify the different structural intermediates and their dynamics which in turn can be related to the microscopic elastic properties of the membrane [1]. In a second example, the multi-scale self-assembly of aerosol particles (volume fraction ~ 10^{-7}) in flames will be presented. Quantitative scattering experiments reveal the growth dynamics and the resulting morphology at different structural levels such as primary particles, aggregates and agglomerates [3]. Similar kinetic studies can be extended to a wide range of soft matter and biological systems.

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