Nanoparticle concentration determination with Small Angle X-ray Scattering (SAXS)

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Like Dynamical Light Scattering (DLS), Small Angle X-ray Scattering (SAXS) is an ensemble method where nanoparticles can be studied in liquid suspension. Due to the much shorter wavelength of X-rays well below 1 nm, SAXS is ideally suited for the investigation of nanoparticles. The difference of the electron density between the nanoparticles and the suspending medium gives rise to X-ray scattering in a small angular range (typically < 5°) around the transmitted beam. For sufficiently monodisperse particles, the observed oscillations of the scattered intensity as a function of the momentum transfer, which is directly related to the scattering angle and the wavelength of the incident X-rays, enable the size determination of nanoparticles.[1] In order to determine as well their concentration in a suspending medium, the ratio of the scattered intensity to the incident intensity has to be determined. Furthermore, the electron density difference between the particles and the suspending medium needs to be known.

In the synchrotron radiation laboratory of PTB, the German national metrology institute, at the electron storage ring BESSY II in Berlin, all relevant parameters for a traceable size determination of nanoparticles with SAXS are determined directly with low uncertainty: the wavelength, the sample-detector-distance and the pixel size of the area detector.[2] For the concentration determination, the detectors for the incident photon flux and the area detector are absolutely calibrated. For nanoparticles with low density, the electron density can be determined by continuous contrast variation.[3] For other SAXS setups, the momentum transfer scale and the intensity scale can be calibrated with available reference materials without the need for reference nanoparticles. [4]

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