Nanoparticles have attracted much attention due to their unique properties and promising applications. Though synthetic procedures are known and have been investigated since Faraday's ground-breaking experiments on gold colloids more than 150 years ago[1], a deeper understanding of the underlying nanoparticle formation processes is still missing. This is mainly caused by the absence of reliable experimental information on the actual size evolution and concentration of nanoparticles during the growth process. Thus, the development of experimental setups for time resolved in-situ measurements represents the most capable approach to reveal the key steps of nanoparticle formation.

Recently, we introduced novel setups and techniques that enable the investigation of nanoparticle formation processes and deliver the demanded time resolved in-situ data based analysis via small-angle X-ray scattering and X-ray absorption. These methods were employed to study several wet-chemical syntheses of gold and silver nanoparticles and revealed sophisticated, yet simple nanoparticle growth mechanisms.[2-5]

The comparison of the different mechanisms reveals fundamental principles of nanoparticle growth which are in contrast to present nucleation and growth theories. Furthermore, it could be verified that in the investigated synthetic systems, a process of nucleation either does not occur or has no effect on the final particle size distribution of the investigated systems. As a result, a novel model of metal nanoparticle growth is presented that provides a comprehensive understanding of the fundamental principles of nanoparticle growth which can allow a purposeful design of advanced nanoparticle synthesis processes in the future.