Watching materials form: In situ total scattering studies of nanoparticle synthesis
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We use a small capillary reactor for studies of hydrothermal and solvothermal syntheses and can study reactions taking place in water or other solvents at elevated temperatures and pressures. Specifically, we have recently investigated the hydrothermal formation of SnO₂, CeO₂, ZrO₂, TiO₂ and Fe₂O₃, which are all of technological relevance. From Pair Distribution Function (PDF) analysis of the in situ total scattering data, we have been able to identify the structures of the ionic complexes in the precursors as well as the amorphous nanoclusters that appear before full crystallization. By following the transformation of these structures to crystalline materials, we can deduce formation mechanisms of functional materials. The studies reveal the changes in material characteristics (atomic structure, particle size/shape/distributions, crystallinity) throughout the synthesis to give a comprehensive description, which may be used to design particles for syntheses on a larger scale.


Here, some of our most recent results from in situ total scattering studies of hydrothermal synthesis of metal oxide nanoparticles will be presented.