There is a strong need for improving our understanding of complex multiphase materials. Functional materials such as batteries and catalysis particles as well as natural materials like bone and shells are structured over several length scales. To understand their properties it is essential to characterize them structurally in three dimensions. Diffraction scattering computed tomography (DSCT)[1], [2], [3], has great potential in this regard.

DSCT combines the merits of tomography with diffraction and/or small angle scattering to obtain powder diffraction data from inside an intact material. DSCT is conveniently implemented at synchrotrons using high energy X-rays. A pencil beam is employed and the sample is raster scanned through the beam at a number of angular orientations; in each point powder diffraction data are collected. This allows tomographic reconstruction of diffraction signal to yield spatial resolved powder information from within the specimen. These powder data can be processed by Rietveld refinement, e.g. using the multi-refinement tools recently developed [4]. This allows not only mapping of the spatial distribution of phases within a sample, but also determination of nanocrystal size of crystalline phases within multiphase materials [5], chemical substitutions through peak shift analysis [6,7] and concurrent determination of nanocrystal anisotropic sizes and identification of amorphous phases [8] all as function of position within a specimen. It is typically straightforward in high energy implementations to add full-field phase contrast tomographic imaging of the specimen, which provides significant additional insights [7,8]. When combined with small angle scattering, intermediate length scale information can be additionally obtained to the point that one single experiment probes length scales ranging from the 1-10 μm (tomography), 1-100 nm (small angle scattering), 1-50 nm (line profile analysis of diffraction data), to the atomic scale (diffraction data). DSCT delivers information in a non-invasive manner, suitting the technique ideally to follow structural development in samples under applied stimuli e.g. load.