MS44-1-9 Coherent X-ray diffraction imaging on the D2AM (BM02) beamline
#MS44-1-9

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Abstract
Coherent diffraction imaging (CDI) is a lensless imaging technique[1], allowing to reconstruct isolated two- or three-dimensional objects from their measured diffraction pattern using computational inversion algorithms. In Bragg geometry (BCDI), the technique relies on the measurement of the 3D intensity distribution around a Bragg peak to recover the displacement and strain fields within finite crystals[2]. A strong reason for developing the capability to image strain in nanocrystals in the context of materials science is that it can be altered substantially by processing of the material, either as part of its design function or to test fundamental materials science principles.
Coherent X-ray beams are typically obtained from synchrotron sources, whose high brilliance and small source size allows to obtain coherent X-ray beams of reasonable intensity and of nearly macroscopic spatial extension. The intensity Ic available from a source in a coherent scattering experiment is connected to the average source brilliance B. The brilliance achieved by BM sources is significantly lower (typically 2 orders of magnitude) than the brilliance offered by undulator sources [3]. However, the large reduction of the source size after the EBS upgrade opens new avenues for the use of coherence on BM beamlines. Here, we explore the use of coherence and in particular of Bragg Coherent X-ray Diffraction Imaging (BCDI) on the D2AM beamline. We used Platinum nanoparticles (NPs, 100 nm to 1 µm in size) on a Yttria-stabilized zirconia (YSZ) obtained by solid-state dewetting to evaluate the feasibility of the technique. We managed to reconstruct 5 NPs using two Bragg reflections, clearly demonstrating the potential of the beamline for such measurements (Fig. 1). This is the first demonstration of BCDI on a bending magnet (BM) beamline, opening new avenues for the use of coherence on this type of beamlines. In order to optimize the experimental setup for future experiments, we evaluated the coherent properties of the beam using different approaches, i.e., diffraction from a 5 microns pinhole, analysis of the scattering from an aerogel sample, and ptychography on a Siemens star sample to reconstruct both the sample and the incoming X-ray beam.

References
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