Combining Diffraction Contrast Tomography and Bragg Coherent Diffraction Imaging on embedded micron-sized ceramic grains

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Residual stresses and strains have a large impact on the mechanical properties of ceramic materials,affecting their ultimate strength and fatigue properties. While the macro-and microscopic stress/strain relationship has long been studied, the ability to study strain fields at the grain level has so far been limited. This poster presents a study of a 20 µm diameter cylinder of Cerium doped Zirconia containing grains of a few microns in size.

Based on the Bragg Coherent Diffraction Imaging (BCDI) techniques [1], we studied the feasibility of retrieving the 3D shape and strain tensor of micrometer-sized grain in the bulk of a polycrystalline specimen after indexing by means of Diffraction Contrast Tomography (DCT) [2]. At the ESRF beamline ID01, the grain mapping from DCT allowed us finding quickly a specific grain in its diffraction condition (Fig. 1), from which we collected full rocking curves (0.025^o step, 1.2^o range) to be reconstructed with BCDI algorithms (Fig. 2).

While reconstruction of nanocrystalline objects using Bragg CDI has been successful on a subset of samples like isolated nanocrystals/wires and epilayers and is becoming more accessible with the development of more user-friendly algorithms and software for data analysis [3], the technique remains challenging for other types of samples, e.g grains of micrometer size matching the one of the defocused beam (> 1um). In these cases, the longitudinal coherence length of the X-ray beam becomes the essential limitation, and we will discuss to what extent quantitative information can be retrieved.

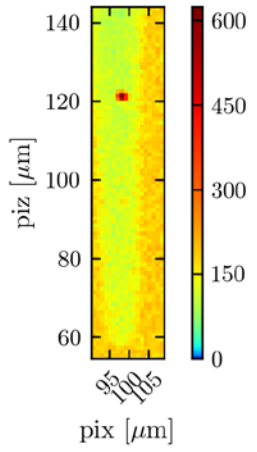

Fig.1. Fast k-map [4] of piezo stage to find a grain along a ZrO2 cylinder (integrated intensity near a 111 reflection). (Coordinates in um)

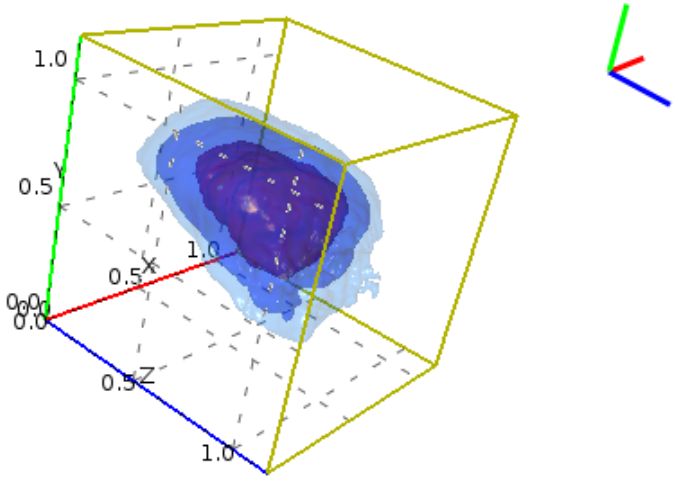

Fig. 2. 3D CDI reconstruction, with isosurface at 20%, 30% and 50% of the maximum amplitude. (Coordinates in um)

References

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