Full field nanotomography: Towards time resolution and in situ applications

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The nanotomography setup at the imaging beamline P05 at the PETRA III storage ring at DESY (Hamburg, Germany) operated by the Helmholtz-Zentrum Geesthacht is optimized for full field hard X-ray microscopy and in situ applications [1]. It offers spatial resolutions down to 50 nm, scan times of below one minute in the fast scan mode and is therefore optimized for in situ studies. Thanks to the very versatile set-up not only X-ray microscopy (XRM) can be performed, but also Zernike phase contrast and cone beam (holotomography) experiments. Thus this instrument is serving as an ideal probe for a wide range of applications from engineering over medicine to biology. The development of innovative nano-materials for example, profits massively from an in-depth knowledge of their three-dimensional inner structures but also requires knowledge about their functional performance. Therefore in situ full field XRM, allowing a detailed analysis of the inner structure at reasonably short timescales, is a technique highly demanded by the nano-materials community.

Here, the latest developments of the synchrotron based nanotomography setup of the P05 imaging beamline are presented, setting a focus on the fast scanning mode. This mode allows the acquisition of a full tomographic scan in less than 10 s, enabling time resolved in situ studies. A comparison is drawn between two contrast methods, namely standard X-ray absorption microscopy and Zernike phase contrast, in terms of resolution and signal-to-noise ratio at different scan modalities. Nanoporous gold was chosen as a reference sample for absorption, since it has proven to be an ideal 3D test pattern for hard x-ray nanotomography [2]. For the Zernike phase contrast mode a magnesium alloy containing nano-sized grains has been selected as a test object (Fig. 1).

References

Figure 1: Reconstructed slices of Magnesium alloy (Zernike phase contrast, no filters applied): (a) 15 min scan (b) 1 min scan (c) 6 s scan. Grains of < 150 nm are resolved in the 15 min scan. Larger grains (> 300 nm) can be resolved in the 1 min scan and rough structures can still be resolved in the 6 s scan.