

Latest Developments in Micro and Nano Tomography at PETRA III

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Studying technological innovations over the last decades it is obvious that prominent developments of novel materials and production technologies are significantly promoted by fundamental understanding of the materials characteristics, especially the three dimensional inner structures.

Characteristic length scales, which influence the structural properties, are often in the range of some micrometers down to a few nanometers. Therefore the Imaging Beamline (IBL) at the new storage ring PETRA III will be structured into two experimental stations for both, micro and nano tomography.

Due to the extraordinary high brilliance of PETRA III, the extremely low emittance of 1 nm rad, and the high fraction of coherent photons even in the hard X-ray range, an extremely intense and sharply focused X-ray light will be provided. These unique beam characteristics will promote novel applications of tomographic techniques enabling high speed in-situ measurements as well as highest spatial and density resolutions. Additionally, the highly coherent beam enables the application of phase contrast methods in an exceptional way.

The imaging beamline will be equipped with two monochromators: A silicon single crystal monochromator dedicated for tomographic experiments requiring a very high monochromatization additionally to a double multilayer monochromator that will be optimized for applications that benefit particularly from high photon flux. The energy range for both types of monochromator will be tunable between 5 and 50 keV.

The field of view in the largest distance from the source will be large enough to investigate samples of some millimeters in diameter by micro tomography in (sub-) micrometer resolution. In addition, the feasibility to focus the X-ray beam on a nanometer scale enables also nano-tomographic imaging. Two different dedicated nano-tomography setups are planned using compound parabolic refractive lenses and crossed cylindrical lenses to achieve a beam geometry for magnified imaging. In both cases a spatial resolution below 100 nm is expected.

Fields of application for this beamline will be materials science (e.g. imaging and quantitative analysis of pores, cracks, precipitates, grains, small components, phase transitions, and morphological transitions), biology and geology (e.g. plants, insects, stones, soil) and medicine (e.g. implants, structures of bones, tissues, and teeth).