Scanning X-ray Nanodiffraction – from strain mapping to in situ microscopy

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Scanning X-ray nanodiffraction is an excellent tool for materials science related in situ studies. It readily serves structural information with sub-μm spatial resolution from crystalline and semi-crystalline materials (metals, biomaterials, synthetic compounds). That way grain orientation, residual stress profiles, crystal structure or texture can be obtained in a non-destructive analysis. Because of the long focal distance focusing, the wide X-ray energy range and a flexible sample positioning system, high resolution nanodiffraction experiments can be performed even under demanding conditions e.g. on strongly absorbing metallic samples or in extended sample environments.

The Nanofocus Endstation of beamline P03 (PETRA III, Hamburg) is part of the German Engineering Materials Science Center (GEMS) and is operated jointly by Helmholtz-Zentrum Geesthacht and the University of Kiel. It is one of only few places in the world where the experimental conditions for scanning X-ray nanodiffraction are provided and it offers a sub-micron sized, hard X-ray beam. The strong focus on materials science at P03 is demonstrated by the wide range of experiments already performed with in situ sample environments: pressure, indentation force, tensile stress, fluid shear, magnetic fields - all of these parameters were successfully modified in situ and combined with the high spatial resolution provided by nanofocused beam.

This contribution will provide a comprehensive introduction to the experimental facilities at P03 Nanofocus Endstation and showcase a compilation of past experiments where in situ applications have been combined with X-ray nanodiffraction.