# Differential Interference Contrast X-Ray Microscopy with Diffractive X-Ray Optics

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In the X-ray wavelength region, the real part of the atomic scattering factor, describing the phase shift, exceeds the imaginary part, responsible for absorption, by far. As a result of this fact, several methods for converting the phase signal of the specimen into image contrast in X-ray imaging have been developed in the last years, especially for X-ray microscopy. One of these methods utilizes zone plates not only as imaging optics but also for beam splitting and combining. An appropriate combination of two zone plates result in an optical device that forms a high resolution image in X-ray differential interference contrast (X-DIC). The strong Nomarski-like contrast enhancement for low absorbing specimen could be demonstrated at 4 keV photon energy at ESRF beamline ID21. The X-DIC optics works in full field mode as well as with the STXM.

In order to reduce difficulties in the demanding manufacturing process of the first X-DIC zone plates, so called zone plated doublets, single diffractive optical elements (DOEs) showing the same DIC imaging properties were designed, manufactured and tested. These DOEs can be treated as computer generated holograms that virtually superimpose two spherical waves originating from two points shifted with respect to each other either in lateral or axial position with a plane wave. Imaging and interference properties – soon including partially coherent illumination – of the DOEs can be simulated by especially created wave propagation software tools.

An important aspect of full field X-ray microscopy – not only but in particular for X-DIC – is the illumination arrangement in the microscope setup, as it deals with the intensity distribution in the object plane as well as spatial coherence properties. Especially at undulator beamlines, the high degree of spatial coherence in the illumination path often creates trouble when applied to full field imaging. To somehow control the spatial coherence and at the same time provide an evenly illuminated object field for X-ray microscopy, a special DOE acting as condenser has been developed, tested and successfully implemented at the TWINMIC microscope installed at ELETTRA, resulting in better imaging quality of the X-ray micrographs and opening up the possibility to employ X-DIC for the full field mode of the TWINMIC.