TOMOGRAPHIC DIFRACTIVE MICROSCOPY WITH TRANSMISSION AND REFLECTION MODES

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Tomographic Diffractive Microscopy (TDM) is a technique, which permits to image specimens from the knowledge of the measured scattered fields sampled under various viewing and illumination angles. TDM is usually implemented in two ways, by either rotating the sample using fixed illumination [1] or by rotating the sample illumination keeping the specimen fixed [2]. The varying illumination direction method has often the preference, because it permits to classically prepare the specimens to be observed, between a glass slide and a cover. This technique however presents a strong anisotropic resolution along the optical axis due to the so-called “missing cone” of non-captured frequencies [3]. In view of overcoming this limitation, one can consider a combined reflection and transmission setup, in a two-objective configuration similar to 4Pi microscopy [4].

As a first step, we have built a mono-objective system, which detects waves diffracted by the observed sample in both transmission [2] and reflection [5]. Figure 1 shows the images of a USAF test sample (etched into a 75 nm aluminium layer deposited onto a cover glass), and observed in both modes, (a): in the (x-y)-plane, (b) and (c): in the (x-z)-plane in transmission and reflection, respectively, (d): FIB image for reference. While the lateral resolution is the same in both modes [4], note the drastically different image characteristics in the longitudinal views. The transmission mode (b) exhibits a strong elongation along the optical axis, characteristic of transmission-only systems. The reflection mode is characterized by better optical sectioning capabilities, but also displays reconstruction artefacts. Merging the data obtained in both acquisition conditions should permit to further synthesize the aperture process and the final 3D resolution.

Figure 1: Experimental images of a microscopic USAF test pattern with tomographic diffractive microscopy in reflection and transmission modes