SIMPLIFIED APPROACHES TO TOMOGRAPHIC DIFFRACTIVE MICROSCOPY

L. Foucault, N. Verrier, M. Debailleul, O. Haeberlé
IRIMAS, University of Haute-Alsace,
61 rue Albert Camus, 68093 Mulhouse Cedex, France

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Tomographic Diffractive Microscopy (TDM) is a technique, which permits to image unprepared specimens by numerical recombination of measured scattered fields [1], according to the diffraction tomography theorem for weakly scattering specimens, like isolated cells, or using more sophisticated inversion procedure for highly diffractive samples. This necessitates precise recording of both the amplitude and the phase of the light diffracted by the specimen. Using an adapted model of diffraction, a numerical reconstruction then permits to obtain an estimation of the 3-D permittivity map of the observed sample.

The method necessitates multiple acquisitions, which may be difficult in some cases, or may slow down the acquisition speed. For example, precise sample rotation as done in [2,3] may be difficult to perform with interferometric precision. With sample rotation, data recombination necessitates accurate image registration [4]. When varying the illumination, tens to hundreeds of images [5-7] may be necessary to accurately reconstruct the image, depending on the reconstruction method, and the targeted resolution and image quality.

Having real-time acquisition-reconstruction-display of the final image would however permit to propose an attractive alternate to standart optical microscopes [8]. For such an application, one should increase reconstruction speed, as well as data acquisition rate. This may be performed two ways. Diminishing the number of interferograms required for image reconstruction increases data acquisition speed, but then often involves applying advanced reconstruction approaches, which is detrimental with the obective of fast image reconstructions. In some cases, one could also take benefit of the sample characteristics, and/or adapt the experimental configuration.

We propose two alternate approaches to classical TDM configurations, to simplify and/or accelerate data acquisition for TDM in transmission.

The first approach is inspired from tomographic reconstructions of axisymmetric samples, usually performed using Abel inversion [9]. We show in that case, that only one acquisition could permit to obtain high-resolution images of cylindrical samples, and that annular illumination permits isotropic-resolution images, as in [2], but with a single sample position.

The second approach is a simplification of mirror-assisted tomography [10], which, for weakly diffracting samples, could permit to obtain high resolution images using only an annular illumination, with the advantage, compared to previously proposed simplified approaches, of not having to make assumptions about the sample optical properties [11,12].

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