ISOTROPIC RESOLUTION TOMOGRAPHIC DIFFRACTIVE MICROSCOPY COMBINING SAMPLE AND ILLUMINATION ROTATION

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Tomographic Diffractive Microscopy (TDM) is a technique, which permits to image unprepared transparent specimens. Three-dimensional images are reconstructed from measured scattered fields sampled under various viewing and/or illumination angles, according to the diffraction tomography theorem [1]. TDM is commonly implemented in two ways, by either illumination rotation (TDM-IR) with still specimen [2], or by sample rotation (TDM-SR) [3]. The first approach presents a strong anisotropic resolution due to the so-called “missing cone” [4], while the sample rotation method presents an almost isotropic resolution, but with a reduced extension of the captured frequencies [5].

To overcome these limitations we propose to combine both approaches, to obtain a high and isotropic resolution in TDM-IRSR. Figure 1 compares the Optical Transfer Functions (OTF) of the three approaches, and the device we develop for rotating samples under a microscope objective, inspired from Ref. [6]. Figure 2 shows examples of objects, which observation could benefit from this technique. In Ref. [6] the optical fibre itself was the subject of interest. We propose to use it as a rotating support for the specimen, to be attached at its tip, as depicted for a microbead. Figure 2 also shows preliminary TDM-IRSR reconstructions of a tapered fibre tip, with one acquisition (TDM-IR in fact) and two orthogonal acquisitions, which are recombined. Note the elongation along the optical axis, characteristic of transmission microscopy, which is partially corrected with even only two orthogonal views.

Figure 1: Left: OTF of TDM-SR, OTF of TDM-IR, and OTF of the combined approach: TDM-IRSR. Right: sketch of the device for specimen rotation developed at MIPS

Figure 2: a microbead attached to an optical fibre (O. Soppera IS2M-UHA-CNRS). Specimens, which could benefit from TDM-IRSR: zeolite microcrystal, pollen grain, and diatom frustule (here observed in TDM-IR). Right: TDM-IRSR of a tapered optical fibre tip. (a) One angle (b) Two acquisitions at 90°.