Resolution enhancement of transmission x-ray microscopy using coherent diffraction

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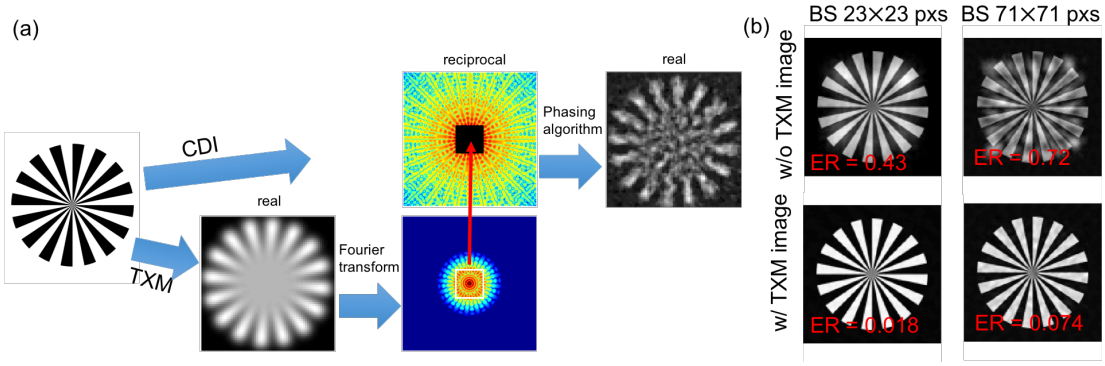
Coherent diffraction imaging (CDI) has been proposed for investigating the non-periodic structure of biological systems such as viruses and cells. In principle, the spatial resolution of CDI is only limited by the geometry of the detector and quantum noise. However, there are many practical factors (such as the missing data due to the beam stop) that complicate the image reconstruction and, subsequently, impair the image fidelity. Transmission X-ray microscopy (TXM) employing Fresnel zone plates has been used for such studies, however, the resolution is limited by the zone plate fabrication technique to 10-30 nm.

Here we describe and numerically demonstrate a new approach for X-ray microscopy that combines the strengths of coherent diffraction and zone plate based imaging techniques in a complementary fashion: the TXM image helps solve the missing data problem of CDI, while the CDI provides high resolution data. Therefore this approach may be capable of providing high fidelity biological images.



In our simulation, the object is imaged by CDI and TXM simultaneously, and the central part of the Fourier transform (FT) is incorporated into the CDI diffraction pattern as *a priori* information, as the red arrow in figure panel (a) indicates. The hybrid input-output (HIO)[1] algorithm is then employed to reconstruct the image, giving the results shown in figure panel (b). Our method can significantly enhance the image fidelity even when the beam stop (BS) area is large, i.e. when several low-*q* components are missing, and is still valid in the scenario where the FT of the TXM image has low resolution and doesn't fully cover the beam stop region (not shown here). The present method can be readily realized experimentally through the addition of a detector in a TXM that captures the required high-*q* information.

[1]Fienup, Opt. Lett. **3**, 27 (1978).