Spatially Multiplexed Fourier Transform Holography

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Fourier transform holography is a simple, robust and efficient implementation of lensless imaging [1] capable of overcoming many constraints typically imposed by samples, detectors and sources. We demonstrate this by presenting two new experimental methods, which combine spatial multiplexing with Fourier transform holography. Both techniques are applicable at third generation light sources, but are especially well suited for single shot experiments at ultrashort pulsed X-ray lasers.

The first method employs multiple object waves to extend the effective field of view of lensless imaging. [2] In doing so, isolated regions spanning 180 μm of a sample are imaged without compromising spatial resolution. While each isolated region must be coherently illuminated the transverse coherence does not need to span the entire sample. The ability to capture such a wide field of view in a single shot is particularly useful for studying the evolution of ultrafast systems.

In the second experimental method, multiple reference sources are used to improve the signal-to-noise ratio in images without increasing sample exposure. [3] We demonstrate this technique's capability by imaging in the weak illumination limit a nanoscale test object by detecting only ~2500 scattered photons.

The figure below provides a general example of how spatial multiplexing is applied to Fourier transform holography.

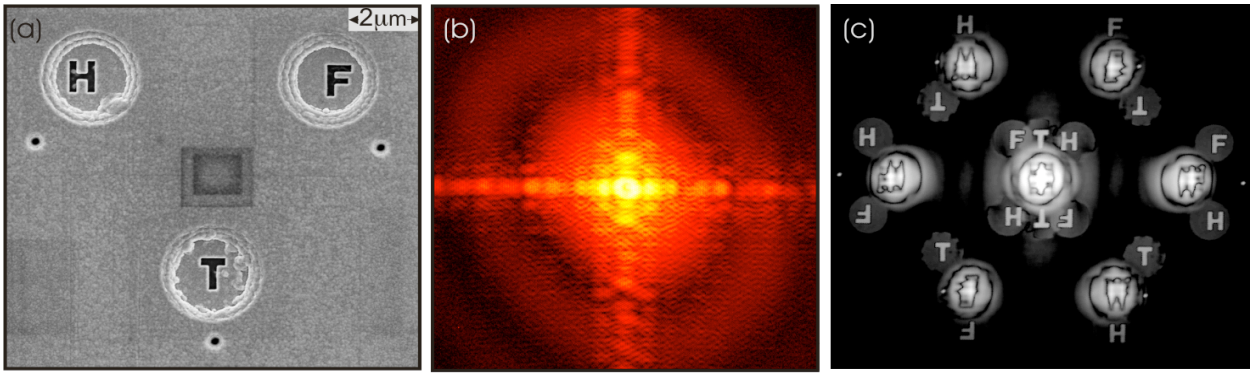

Figure (a) SEM of a Fourier transform holographic absorption mask. The three unity transmission reference holes have been strategically placed near the object circles each of which contains a high transmission block letter sample. (b) The Fourier transform hologram recorded at λ=1.58 nm. (c) The autocorrelation reconstruction resulting from the Fourier transform of the hologram. Note the rearrangement of the orders of the sample letters near the center.

[1] S. Eisebitt, *et. al*., Nature, **432,** 885 (2004)
[2] W. F. Schlotter, *et. al*., (in preparation)
[3] W. F. Schlotter, *et. al*., Appl. Phys. Lett. **89,** 163112 (2006)