OPTIMAL DESIGN OF TRANSMISSION GRATING FOR X-RAY TALBOT INTERFEROMETER

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X-ray phase imaging attracts increasing attention in this decade. We proposed X-ray Talbot interferometry (XTI) as a novel X-ray phase imaging and phase tomography [1, 2]. The advantages of the XTI are summarized as follows: (1) its experimental arrangement is very simple, (2) it doesn’t need a high mechanical stability, (3) a wide area imaging is possible, (4) the detector for the area imaging doesn’t need a high resolution, and (5) it functions with a much broader energy band width than in the case of using crystal optics. The XTI therefore has a potential of phase imaging with a compact laboratory X-ray sources. These advantages have made the XTI attractive for applications to medical diagnostics.

The XTI is sensitive to the differential phase shift caused by a sample. The method uses two transmission gratings aligned in line. The principle of the XTI is based on the Talbot effect; that is, behind a transmission grating under coherent illumination a periodic pattern the same as that of the grating is generated at specific distances from the grating. When a sample is placed in front of the grating, or when a beam with a deformed wave front is incident on the grating, the periodic pattern (self-image) is correspondingly deformed, in which phase information is involved. In the XTI the deformation is then depicted as a moiré pattern, which is formed by the second grating placed on the self-mage.

For an application of the XTI to medical diagnostics it should work around 30 keV or higher energy of X-rays with a laboratory source. The second grating, which should be an amplitude grating to generate high-contrast moiré fringes, is required to have a thickness of at least several tens of microns and a period of less than several microns for such an application. It is, however, difficult to fabricate such an extremely high aspect ratio grating with conventional techniques, especially when the period approaches one micron. In this paper we will discuss how to design an optimal amplitude grating for the high-energy XTI, taking into account technical limits in fabrication processes of the grating (the LIGA process is a candidate) and various experimental conditions, such as the flux and the wavelength of the X-rays, the size of light source (spatial coherency), and the margin of error in determining differential phase shift by the sample.