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Evaluation of 10-cm Grating Fabricated for X-ray Talbot Interferometer

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Introduction

X-ray phase imaging based on X-ray Talbot interferometry (XTI) [1] is attractive because its practical use particularly at laboratories and hospitals is feasible in combination with a compact X-ray source. An important issue in the development of XTI is the fabrication of a high-aspect-ratio X-ray transmission grating with a wide area for generating a large field of view. We report an evaluation result of a 10 cm × 10 cm grating.

Experimental

An X-ray Talbot interferometer consists of a phase grating and an amplitude grating aligned along an optical axis with a specific spacing between them. Moiré fringes are generated by XTI, and a differential phase map is obtained from several moiré patterns obtained by displacing one grating against the other grating in the direction of its diffraction vector.

One index that can describe the performance of the interferometer is the visibility of the moiré fringes. Of course, the higher the visibility is, the better the quality of a phase image is. A map of the visibility was calculated from the data identical with those acquired to obtain a differential phase map. Because the quality of the amplitude grating is directly related to the visibility map, we evaluated the grating with the visibility map.

We tested a currently largest amplitude grating, which had an area of 10 cm × 10 cm (Fig. 1). The grating was fabricated by X-ray lithography at NewSUBARU and gold electroplating. The pitch of the grating was 5.3 μm and the height of its gold pattern was about 30μm. An X-ray beam monochromatized at 25 keV was expanded with an asymmetrical Si crystal and introduced to an X-ray Talbot interferometer, where a π/2 phase grating with a pitch of 5.3 μm was employed. A 4k ×4k CCD-based X-ray image detector, whose effective pixel size was 18 μm, was placed behind the amplitude grating.

Result and Discussion

Figure 2 shows a visibility map, which was formed with several images because the X-ray beam size was smaller than the grating size. A stripe feature seen in the direction parallel to the grating lines is considered to be line defects in the grating pattern. Although point defects are also found, in general the visibility is homogeneous with an average value about 0.5.

This quality of the grating is satisfactory for fundamental X-ray phase imaging. Although we need to improve the quality of gratings of course, this result opens up the possibility of wide-area X-ray phase imaging with a laboratory source.

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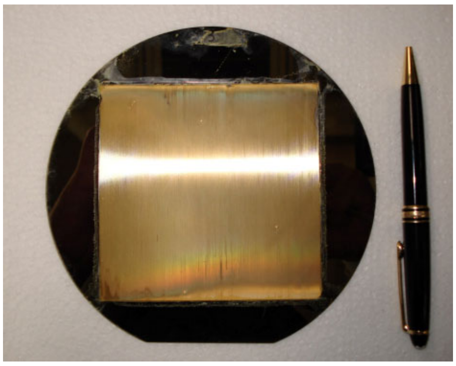

Fig. 1 10 cm × 10 cm X-ray amplitude grating.

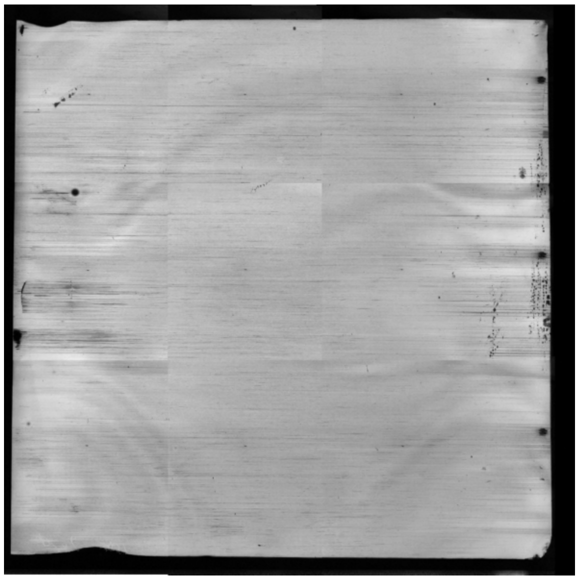

Fig.2 Map of moiré-fringe visibility generated by X-ray Talbot interferometer that used the 10 cm × 10 cm amplitude grating. The gray scale corresponds to the visibility from 0 to 0.7.

References

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