Instrumentation and Technique

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Investigation of sensitivity of scanning x-ray differential phase contrast imaging with a wedge absorber

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Introduction

An x-ray phase contrast imaging is an important technique. Several techniques of the x-ray phase contrast imaging have been reported. A scanning x-ray differential phase contrast imaging using a wedge absorber is simple and effective technique [1, 2]. In this technique, the wedge absorber converts quantities of displacement of an x-ray beam into change of x-ray intensity. Then, quantities of differential phase of x-ray can be determined from the change of intensity. One of the features of this technique is flexibility for relation the change of intensity with the displacement by changing vertex angle or a material of the wedge absorber.

In this study, we investigated the influence of vertex angle of the wedge absorber on the change of x-ray intensity by the refraction.

Experiment

Experiments were performed at BL4A. An experimental setup is shown in Fig. 1. White x-rays from bending magnet were monochromatized by a double multilayer monochromator at 13 keV and focused by KB mirror. The beam size was 3×3 μm^2 at a sample position. Three types of the wedge absorber, which were made of aluminum, were used. The vertex angle of each wedge absorber was 35 °, 40 ° and 45 °. The slope directions of the first and the second wedge absorbers were set along y- and x-directions. Three ionization chambers and an x-ray photodiode were used to record x-ray intensity. The first ionization chamber recorded incident x-ray intensity (I_0). The second ionization chamber was placed behind the sample and recorded transmitted x-ray intensity through the sample (I_1). The third ionization and the x-ray photodiode were placed behind the first and the second wedge absorber and recorded transmitted x-ray intensity through them (I_2, I_3). A polystyrene sphere, which was50 μm of diameter, was attached on a nylon loop and used as a sample. Measurements were performed in step scanning mode.

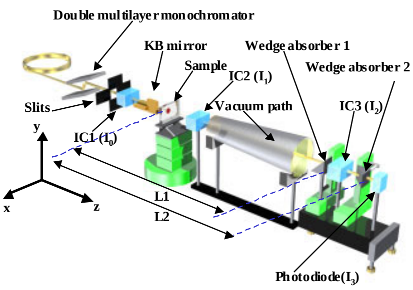

Figure 1: Schematic illustration of experimental setup.

Result and discussion

Figure 2 (a) shows an absorption image of the sample. The visibility of this image was very low because of high transmittance of x-ray. Figure 2 (b), (c) shows images of I_2 / I_1 and I_3 / I_2 that relevant to differential phase along y- and x-direction. In this study, transmittance of x-ray through the first and second wedge absorber without the sample is set at 30 % and 20 %, respectively.

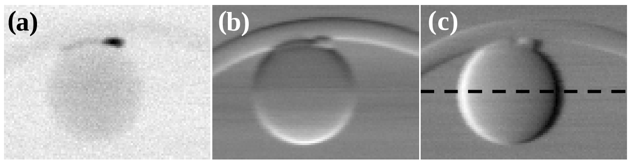

Figure 2: Images of the polystyrene sphere. (a) An absorption image. (b) I_2 / I_1 image. (c) I_3 / I_2 image.

Figure 3 shows line profiles along a dash line in Fig. 2(c) using each type of wedge absorber. Ratio between the displacement of an x-ray beam and detected x-ray intensity by the x-ray photodiode was increased with the smaller vertex angle. On the other hand, detection limit of the x-ray displacement is relevant to signal-to-noise ratio of detected intensity and the vertex angle. The signal-to-noise ratio is improved by shortening length of x-ray path in the wedge absorber but detection range of the displacement of x-ray in the vertex direction become narrow. In other words, we can choose these parameters on the condition of the sample in this technique.

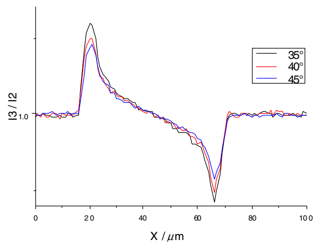

Figure 3: Line profile of dash line in Fig. 2(c)

References

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