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Sample Observation by Talbot Optics installed Soft X-ray Projection Microscopy

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1 Introduction

To extend the application of soft X-ray projection microscopy, we tried to incorporate Talbot optics into projection microscopy to obtain phase information that is not accessible by normal projection microscopy. Last year we installed a grating and a nano-positioning stage into the current soft X-ray projection microscopy system.[1] This time, fundamental samples were analyzed with 6 fringe shifted images to obtain the phase image.

2 Experiment

The setup of Talbot optics installed at soft X-ray projection microscope is shown in Fig.1. The pinhole of 1μm or 2μm diameter was utilized as an imaginary light source. The grating with 2μm interval was put after the pinhole with the distance determined by Talbot optics. They were produced by Silson Ltd and had the uniform grating fringe patterns. The grating was shifted perpendicular to the optical axis with 0.4μm interval. The sample can be moved within the distance of 4mm to the grating. It enables the magnification of images. The projection of this microscope is effective, and the sample is magnified 40 – 76 times depending on the sample position. The experiment was conducted using soft X-rays of 1keV at BL-11A. Talbot effect is self-imaging effect to make the intensity distribution due to the grating period at a certain distance. Furthermore, it can extract the phase information by shifting the grating fringe with a certain phase interval.

Figure 2 shows the observation example of partially overlapped Mylar films and slice sample of a human hair. Partially overlapped Mylar film of 1.5μm thickness was observed at 40 times magnification (Fig.2(a)). The different transmission intensities were indicated in observation image(i) and their phase image is shown in (ii). Here, there was no film in ①, single layer in ②, ③ and double layer in ④. Each area in both images was uniform. The difference of intensities in each area is clear in observation image(i). Phase shift in each area looks small in phase image(ii), while it depended on the layer thickness. Human hair slice sample was observed at 76 times magnification (Fig.2(b)). In observation image(i), medulla (center part) had clearly different transmission intensity than cortex (surrounding part). In phase image(ii), phase distribution of medulla part is different from the transmission intensity distribution. It come from their structure. The cortex part had the unique distribution reflected by slicing thickness. They seem to have the different phase orientation. We are continuing the improvement of the analysis procedure.

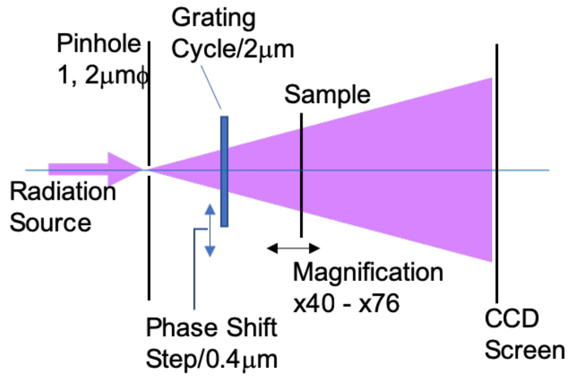
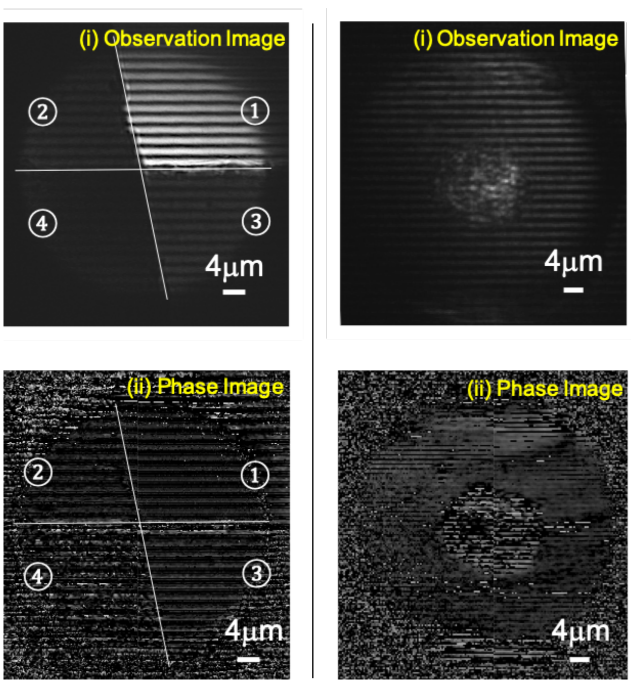


Fig.1 : Talbo optics installed soft X-ray projection microscopy.



(a) Mylar film (b) human hair

Fig.2 : Observation of Mylar film and human hair sliced sample.

References

[1] T. Shiina et al., PF Activity Report 2018 #36 (2019). http://pfwww.kek.jp/acr/2018pdf/u_reports/pf18b0261.pdf

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