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Improvements of Soft X-ray Projection Microscopy

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1 Introduction

We have developed soft X-ray projection microscopy system with the correction technique to improve blurred projection images due to Fresnel diffraction.

The microscopy system needs maintenance for the long period use in the experiment. We have already renewed the high-precision stage to shift the diffraction grating by 0.2 or 0.4 μm step. This time X-ray CCD camera underwent full maintenance to recover the water cooling system to demonstrate its high performance. In addition, the zone plate has also been renewed to get a clearer image. The specifications of these system renewal and obtained results will be mentioned in this report.

2 Experiment

Our soft X-ray projection microscopy system was constructed in 1998 and has been improved its performance for 25 years[1]-[3]. This time, we have conducted the system maintenances to keep or to improve the system performance.

We renewed the high-precision stage to shift the diffraction grating by 0.2 or 0.4 μm step ($2\mu m$ / 5) in 2018. The former high-precision sensor demonstrated inaccurate motion due to the contact failure of positioning sensors. This forced us to exhaust a long time to fix a precise position with high accuracy.

The back illuminated X-ray CCD camera (Hamamatsu photonics C3880) underwent full maintenance to recover the performance of the water cooling system. After the maintenance, the cooling problem was resolved.

The zone plate has also been renewed. It is utilized to focus the beam and illuminate the pinhole of $1\mu m\phi$ as a point light source for biological specimens. The specification of the zone plate is shown in Table 1. The specification of the renewed zone plate is almost the same as the current ones. The only difference is that the SiN thickness of the renewed one is thinner ($< 0.1\mu m$) than the current ones (0.2 μm), which is expected to increase the illumination intensity on biological samples.

The renewed zone plate was tested at BL-16A. The observed images of chromosome samples are shown in Fig.1. The illuminated beam and the imaging conditions were the same between two pictures with the energy of 700 eV. The viewing area looked more uniformly illuminated and brighter by using the renewed zone plate compared to the current ones. The influence of the center blight point to the surroundings also looked smaller.

The brightness was obviously improved as 2.5 times, which is nearly matched with the thickness improvement. Under the observation at higher magnification with low light intensity, it would be advantageous. Platinum blue staining was also tried to give higher contrast to the chromosome specimens. We are planning the higher contrast imaging with those technics and improvements at BL-16A and the new beam line 12A.

Table 1: Zone plate specifications.

Parameters	Nominal Values
Product	NTT-AT
Base plate size	10mm x 10mm x 0.625mm
SiN Film thickness	0.088μm
Ta Absorber	0.4μm
Diameter	625μm
Pattern (Inner/Outer)	14.2μm / 81nm

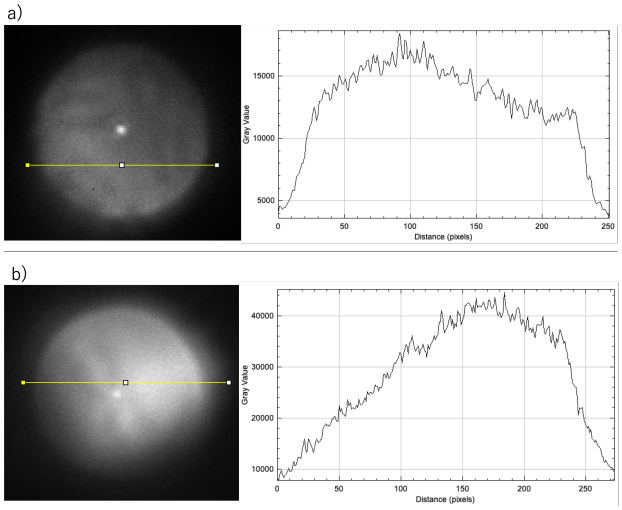

Fig.1 Observation results (Chromosome). Left: observation images Right: Brightness distribution on the image line. a) current zone plate b) renewed zone plate.

References

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