11A/2012G120

Advanced Correction of Blurred Image on Soft X-ray Projection Microscopy

Tatsuo SHIINA[1*], Jamsranjav ERDENETOGTOKH[1], Yasuhito KINJO[2], Atsushi ITO[3], and Kunio SHINOHARA[3]

[1]Graduate School of Advanced Integration Science, Chiba Univ., Chiba-shi, Chiba, 263-8522, Japan

[2]Tokyo Metropolitan Industrial Technol. Res. Inst., Koto-ku, Tokyo 135-0064, Japan

[3]School of Engineering, Tokai Univ., Hiratsuka-shi, Kanagawa, 259-1292, Japan

Introduction

Blurred Image correction by iteration procedure on a soft X-ray projection microscopy has been continued during a decade.[1] The correction of the blurred images was successful under adequate contrast by using the iteration procedure we have developed, while images with too low contrast and too high contrast were found to be inefficient to apply this correction method, especially in the case of cell and chromosome images with high transparency in the soft X-ray region. In this study we added the image modification to improve the contrast and to reduce the artifact of additional fringes on our itaration procedure. The beam line used was BL11A through this experiment, but the data from BL2C in PF-KEK, and BL20XU in Spring-8 were analyzed for comparison, too.

Results and Discussion

The former algorism of our burred image correction is the iteration procedure to generate the phase distribution of the propagated blurred image under the restriction of diffraction intensity. Both of the intensity and the phase distributions on the blurred image were restructured by the inverse Fourier transformation. The physical resolution of this microscope is about 0.2μm at the maximum magnification (x658), and the properly corrected image could achieve the same resolution by this iteration procedure.[1]

Our strategy to improve the image contrast is not new in the image processing, but the combination algorism of the iteration procedure and the contrast improvement needs the control of balance of their techniques (iteration number and degree of contrast modification).

Figure 1 shows a representative result of a latex particle of 10μmϕ. In this observation, 1μm pinhole and soft X-rays with a wavelength of 17.7 angstrom from the beam line BL11A was used and the observation was performed for 3 minutes by a back-illuminated X-ray CCD camera with the pixel pitch of 24.8 μm. The magnification was x219.3. Although it was hard to correct such a high magnification image with high contrast by only the iteration procedure, the contrast improvement could correct it clearly and sharply.

Figure 2 shows the good correction of low-contrast objects (latex particles of 2μmϕ) surrounded by a high contrast frame (Copper Mesh). The particles are reconstracted with its adequet size and feature.

Figure 3 shows the result of chromosome. In this image, The magnification was x164.5. One can see the faint fringe around the chromosomes. It is weak in comparison with the flinge of Figure 1. The former correction would disappear the low contrast object by the iteration procedure, while the new algorism refrained it by introducing the contrast increase. Now the low contrast and high magnification images of biological specimens are tried to correct by this new iteration procedure.

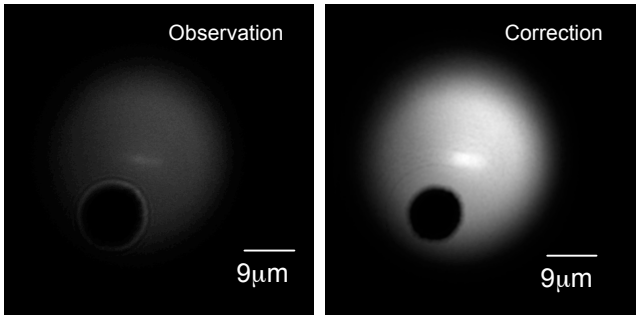

Fig.1 Blur and corrected images of Latex particle of 10μmϕ.

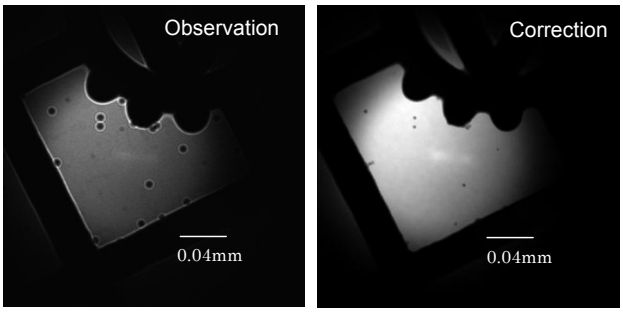

Fig.2 Blur and corrected images of the latex particles of 2μmϕ.

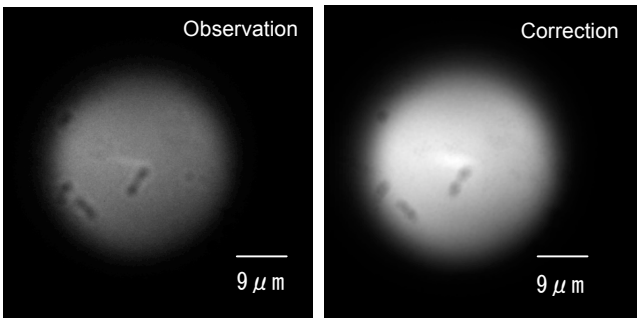

Fig.3 Blur and corrected images of chromosome.

References

[1] T. Shiina et al., PF Activity Report, 2013.

* shiina@faculty.chiba-u.jp