11A/2008G098

Blur correction of high-contrast images in Soft X-ray Projection CT Microscopy

Tatsuo SHIINA[1*], Moriaki KOYAMA[1], Hideyuki YOSHIMURA[2], Yasuhito KINJO[3], Atsushi ITO[4], Toshio HONDA[5], Keiji YADA[6] and Kunio SHINOHARA[7]

[1]Graduate School of Advanced Integration Science, Chiba Univ., Chiba-shi, Chiba, 263-8522, Japan
[2]School of science and Technology, Meiji Univ., Kawasaki-shi, Kanagawa, 214-8571, Japan
[3]Tokyo Metropolitan Industrial Technol. Res. Inst., Setagaya-ku, Tokyo 158-0081, Japan
[4]School of Engineering, Tokai Univ., Hiratsuka-shi, Kanagawa, 259-1292, Japan
[5]Honda Hikari Giken, Chiba-shi, Chiba, 260-0856, Japan
[6]Tohken Co., Ltd. Chofu-shi, Tokyo 182-0025 Japan
[7]Waseda Univ., Shinjuku-ku, Tokyo 169-8555, Japan

Introduction

In the previous studies, our project achieves some positive results on the processing of soft X-ray projection images: blur correction by iteration procedure with aperture restriction [1], image reconstruction with projection CT microscope [2], and blur correction of cell image by phase-considered iteration procedure [3]. The coverage of the developed blur-correction iteration procedure has been extended step-by-step. However, the blur correction of the high-contrast image remains as a demanding task. When a specimen is moved close to the virtual light source at the position of a post-pinhole, the specimen reflected largely on the CCD camera and the contrast of the image becomes high. To apply the developed iteration procedure to the high-powered microscope image, the blur correction of high-contrast image is essential. This report states the cause of the poor correction and a new approach for the solution.

New Approach and Results

The computer simulation was conducted to examine the cause of poor correction on the blurred image of high-contrast. At first, an image of the specimen illuminated by the soft X-rays was prepared as a simulated image. Next, the projection image was calculated from the specimen image by the propagation of Fresnel diffraction. The calculated image was compared with the experimental result (the projection image of the specimen). The experiment was performed at BL11A. The energy of the soft X-ray was 0.7keV. The power of the projection microscope was x110. The specimens were latex particles with the diameter of 8μmϕ and 1μmϕ. In this case, the observation image of latex particle of 8μmϕ becomes high-contrast. The experimental result had a few fringes (Fig.1), while the simulated image after the projection had ten and more fringes. In the simulated image the diffraction blur can be eliminated perfectly by the iteration procedure. The experimental image cannot be corrected with the blur adequately because of the lack of fringes. The bright point appeared at the center of the particle in Fig.2. The lack of fringes will be due to the finite size and the partial coherence of the light source. Considering the CT application, we tried to improve the blur correction for the high-contrast image with a simple method. The experimental image was filtered by edge reinforcement and rebuilt the lacked fringes (Fig.3). As a result, the blur correction was improved as shown in Fig.4. We confirmed that this new approach could be efficient not only in the high-contrast image, but also in the normal contrast image (Fig.5 and Fig.6).

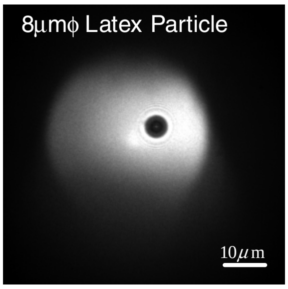

Fig.1 Observation image.

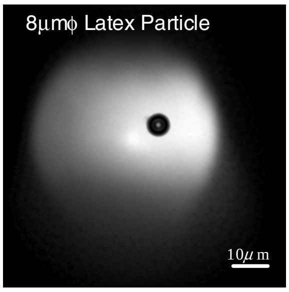

Fig.2 Blur-corrected image.

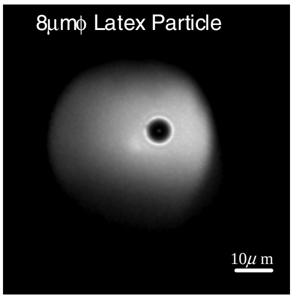

Fig.3 Edge reinforcement on The observation image.

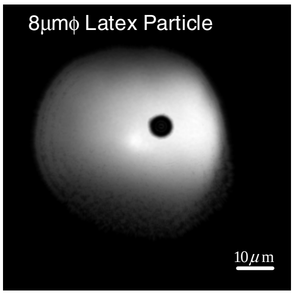

Fig.4 Result of new approach. Blur-corrected image

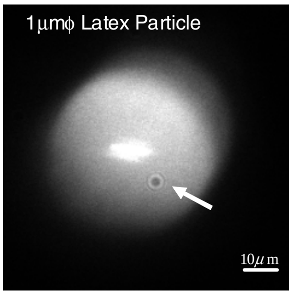

Fig.5 Observation image.

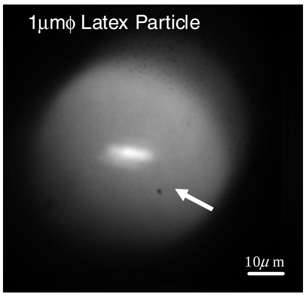

Fig.6 Result of new approach. Blur-corrected image

References

[1] A. Ito et al., PF Activity Rep. 2003, 21, 210 (2003)
[2] Shiina et al., IPAP Conf. Series 7, pp.363-365 (2005)
[3] Shiina et al, JPCS, in press

* shiina@faculty.chiba-u.jp