Type of presentation: Poster

IT-2-P-2594 Aberration correction through auto-iteration system utilizing diffractogram analysis by profile fitting technique

Morishita S.[1,3], Nakamichi T.[1], Takano A.[1], Satoh K.[1], Hosokawa F.[1], Suenaga K.[2,3], Sawada H.[1,3]

[1]JEOL Ltd., [2]National Institute of Advanced Industrial Science and Technology, [3]Research acceleration program, Japan Science and Technology Agency

Email of the presenting author: shmorish@jeol.co.jp

Spherical-aberration-corrected TEM/STEM has become widely used in the past decade. To automatically correct the aberrations in the correction system, a precise measurement of residual aberrations and an optimized correction procedure are crucial. Several methods have been reported for quantitative measurement of the aberrations [1-5]. We have developed corrector control software JEOL COSMO (Corrector System Module), in which aberrations are measured by diffractogram tableau method in TEM and SRAM method [6] in STEM. In the diffractogram tableau method, measurement precision for measurable defocus (*df*) and two-fold astigmatism (A_2), at diffractograms with tilted illuminations, determines the final precision of the correction, since residual aberrations and the intrinsic A_2 and *df* to be corrected are calculated from these measurable parameters. This paper reports a profile fitting technique to analyze the diffractograms incorporated into our developed auto-iteration system, which enables us to correct aberration with an improved precision.
In the diffractogram analysis, radial intensity profiles are used. Each of the radial profile is fitted with a phase contrast transfer function to pick up a parameter of the first-order components, that is, amount of defocus in particular azimuth. For searching the local minima in the profile that determine the parameters of the transfer function, profiles around local minima instead of simple detection of local minima are utilized to reduce affection of noise on the profile in our system. With thus obtained first-order components at many azimuths, the intrinsic *df*, A_2 and other aberrations are calculated. Figure 2 compares the plots of A_2 obtained using only the position of first zero and using the devised fitting method over 20 diffractograms. With this method, standard deviation of measured intrinsic A_2 is improved from > 1 nm to a few angstroms.
Next, we developed the auto-iteration system for aberration correction using a script language integrated in the JEOL COSMO. The system automatically chooses the next targets of aberration to be corrected and corrects them. Our algorithm for correcting procedure preferentially corrects aberrations of lower-order or large higher-order to minimize the phase disturbance. Finally, we successfully performed the auto aberration correction in TEM with the improved procedure, which results in the residual third-order aberrations from about 10 µm to < 1 µm within 15 min.

[1] F. Zemlin, et al., Ultramicros. 3, 49 (1978).
[2] S. Uhlemann, et al., Ultramicrosc. 72, 109 (1998).
[3] M. Haider, et al., Ultramicrosc. 81, 163 (2000).
[4] J. Barthel, et al., Ultramicrosc. 111, 27 (2010).
[5] M. Vulovic, et al., Ultramicrosc. 116, 115 (2012).
[6] H. Sawada, et al., Ultramicrosc. 108, 1467 (2008).

Acknowledgement: This work is supported by Japan Science and Technology agency, Research Acceleration Program.

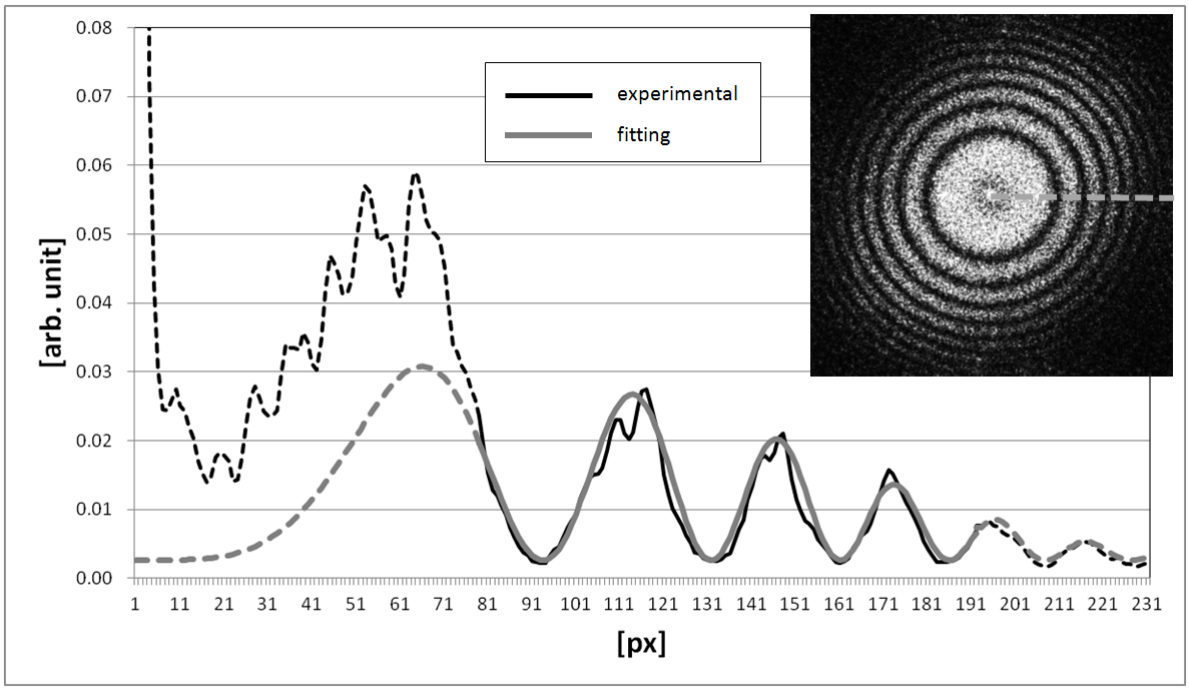
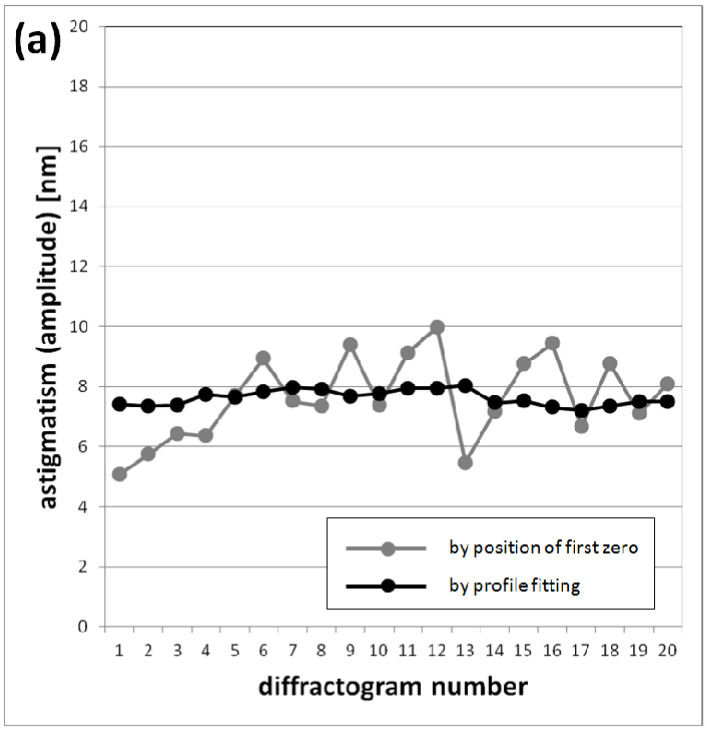


Fig. 1: Example of a diffractogram and its line profile. The experimental profile indicated by solid line is used for profile fitting.



(b)

Standard deviation [nm]

position of first zero	profile fitting
1.41	0.26

Fig. 2: (a) Results of two fold astigmatism measurements by using positions of first zero (gray) and by using profile fitting (black). (b) Standard deviation of (a), which includes both measurement error and actual fluctuation.