doi: 10.1017/S1431927609093180
Microsc Microanal 15(Suppl 2), 2009

Application of Low Accelerating Voltage Aberration Corrected Dedicated STEM With Cold FEG.

M. Konno,* Y. Suzuki,* K. Nakamura,** and H. Inada**

* Naka application Center, Naka Division, Nanotechnology Products Business Group, Hitachi High-Technologies, 11-1, Ishikawa-cho, Hitachinaka-shi, Ibaraki-ken, 312-0057, Japan
** Advanced Microscope System Design 2nd Department, Naka Division, Nanotechnology Products Business Group, Hitachi High-Technologies, 882, Ichige, Hitachinaka-shi, Ibaraki-ken, 312-8504, Japan

Recently, the demands of structural characterization and elemental mapping at atomic level using an electron microscope equipped with an aberration corrector have been increased for the investigation of material science. In order to respond such demands, we have developed the STEM instrument with cold field emission source (Hitachi HD-2700 [1]), in which the CEOS aberration corrector has been equipped and optimized for the HD-2700. The cold field emission source is an ultimate emitter of analytical electron microscope due to highly dense brightness and small energy spread [2].
Moreover, the newly-designed lens system made the large convergent angle of aberration corrected STEM possible, where around 40mrad is availableAnd then the contrast of the elastic electron for aberration corrected STEM image is less than that of STEM without Cs corrector has an effect on imaging of light elemental materials such as nm-sized carbon particles and some polymers. In this study, we have examined the condition of low accelerating voltage for obtaining high performance in image contrast and elemental analysis.

FIG.1 shows the EELS energy time trace for zero loss peak for 40 second duration (a) and the zero loss peak spectrum of 1second (b) and 40 second (c) by accelerating voltage of 80kV. FWHM of zero loss peaks are 0.35eV for acquisition time of 1 second and 0.42eV for acquisition time of 40 second, respectively.

This result reveal of high stability of electron source and high performance of energy spread. Here, we have used Gatan Enfina EELS system for measurement of energy resolution [3].
FIG.2 shows the BF-STEM image of graphene carbon sheet by accelerating voltage of 80kV, in which lattice fringes can be clearly seen. The atom to atom space of graphene carbon is perfectly 0.142nm. This result emphasize that the aberration corrected lower accelerated electrons is effective to reduce the specimen damage and image with high resolution.
FIG.3 shows the EELS spectrum of carbon .The spectrum of 80kV shows the fine structure peak giving the information of chemical bonding state clearly. In addition, the height of the peak represents high peak to background ratio.

References
[1] K.Nakamura, et al proc. 16th International Microscopy Congress,(2006)633
[2] H.Inada, *Microsc. Microanal.* 14 (2008) 1374.
[3] R. F. Egerton, *Electron Energy-Loss Spectroscopy in the Electron Microscope* , Plenum, New York, 1996.

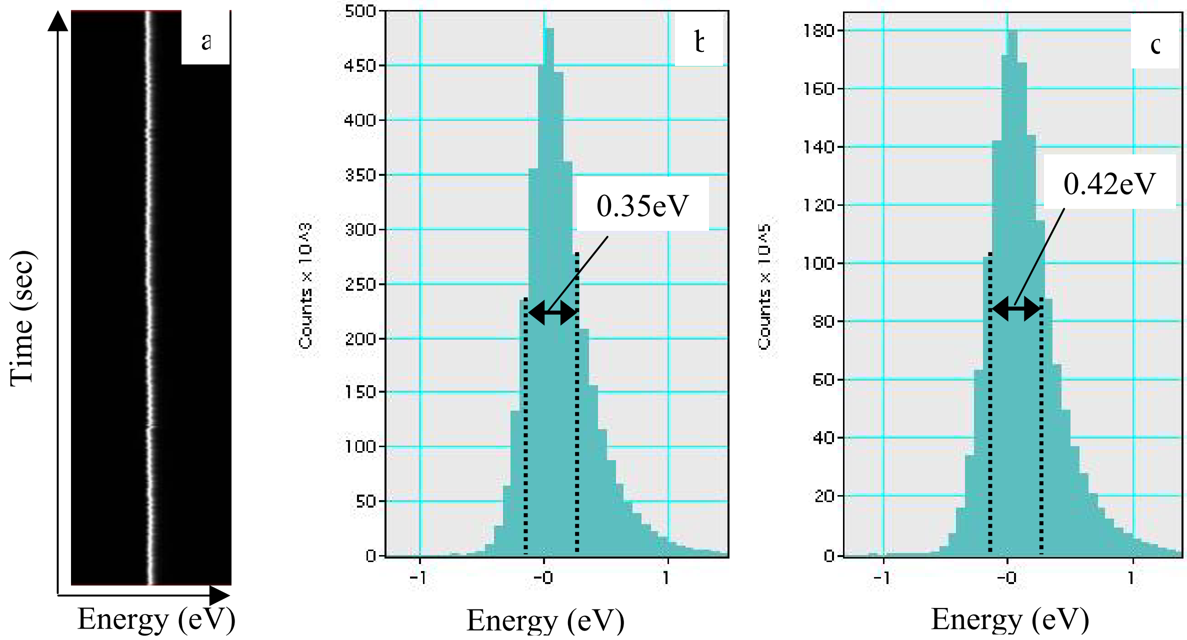

FIG. 1. EELS energy time trace for zero loss peak for 40 second duration. The corresponding zero loss peak spectrum FWHM is 0.35eV for acquisition time of 1 second, and 0.42eV for acquisition time of 40 seconds with cold field emission source of accelerating voltage of 80kV.

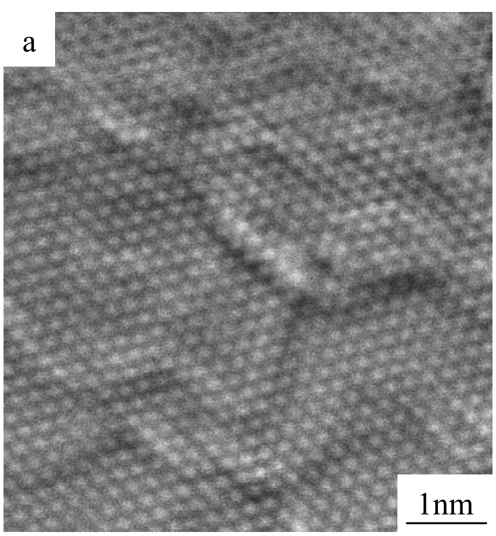

FIG. 2. BF-STEM image of graphene carbon sheet .

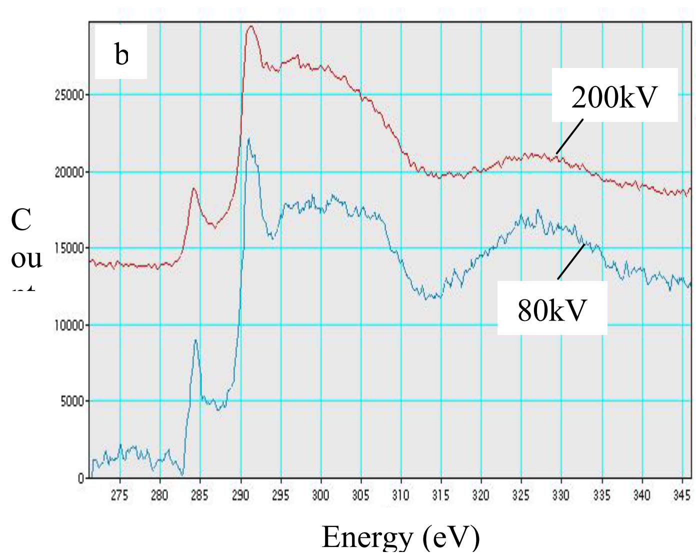

FIG. 3. Comparison of EELS spectrum accelerating voltage of 200kV and 80kV.

https://doi.org/10.1017/S1431927609093180