2013
doi:10.1017/S1431927615010843 Paper No. 1005 Microsc. Microanal. 21 (Suppl 3), 2015

EDX Analysis of Low Concentration Dopant using HD-2700 Aberration Corrected STEM Equipped with Dual SDD

Takahiro Sato[1], Yuya Suzuki[1], Hiroaki Matsumoto[1], Takahito Hashimoto[1], Kuniyasu Nakamura[1], Taiga Miura[2], and Hisaharu Yoshida[2]

[1.] Science Systems Design Div., Hitachi High-Technologies Corporation, 1040 Ichige, Hitachinaka, Ibaraki 312-0033, Japan
[2.] Vacuum Device Inc., 1285-5 Iijima-cho, Mito, Ibaraki 311-4155, Japan

A STEM instrument model HD-2700 equipped with two detectors (X-Max^{N}100TLE Silicon Drift Detector (SDD)) was useful for high special analysis of objects [1], in which each SDD has a 100 mm^2 sensor and windowless configuration. High sensitivity and high through-put analysis with atomic resolution can be expected from this system. In the field of material sciences, especially next generation semiconductor, the analysis demand of lower concentration dopant elements such as arsenic, phosphorus and boron in silicon device has been increased. Generally, the detection of boron by EDX was not so successful because of the lower detection efficiency of characteristic X-ray for light element. The signal of electron energy loss spectroscopy (EELS) for light element is better than heavy element, so the EELS has been used to detect the boron [2]. In this study, we examined the sample preparation and analysis conditions using large solid angle dual SDD.

A boron doped silicon wafer was used as an experimental specimen. Herein, the density of the irradiation boron is 3.89 x 10^{14} atom/cm^2. Specimens were prepared by an NB5000 FIB-SEM with the Hitachi in-situ micro-sampling technique® [3]. After fabrication at 40 kV, final thinning was performed at 5 kV, and a 100 nm thick sample was prepared. Subsequently, the sample was onto a double tilt analytical holder. The conditions for obtaining the EDX map were as follows: acceleration voltage is 200 kV, field of view is about 30 μm x 25 μm, pixel size is 128 x 96, acquisition time is about 30 minutes.

Figure 1 shows a result of the EDX analysis. (a) is a BF-STEM image of the analysis area, Areas 1 and 2, in which amorphous layer in Area1 was observed on the top surface of silicon [110] single crystal in Area 2. (b) is superimposed EDX spectra of each area, in which boron peak were recognized in Area 1 spectrum (blue) and in Area 2 boron was not detected about 15 nm depth area (red). Figure 2 shows the elemental map (a) and its ADF-STEM image (b). Herein, two dimensional distribution of boron was successfully visualized. Figure 3 shows the line profile of B, O and Si from surface to 15 nm area extracted from the mapping results using spectrum imaging. Boron was mainly exists in range from surface to about 5 nm depth area. These results indicate that the EDX analysis using high sensitive dual SDD system is effective to the detection of low concentration dopant element. And the cold filed emission gun was also useful for the detection of lower concentrated materials due to the reduction of scattering of incidental electron beams.

References

[1] T. Hashimoto et al., Microsc. Microanal. **20**, 2014, p.604-605.

[2] K. Asayama et al., Applied Physics Express **1** (2008) 074001

[3]T. Ohnishi et al., Proc. 25th International Symposium for Testing and Failure Analysis, 1999, pp. 449-453

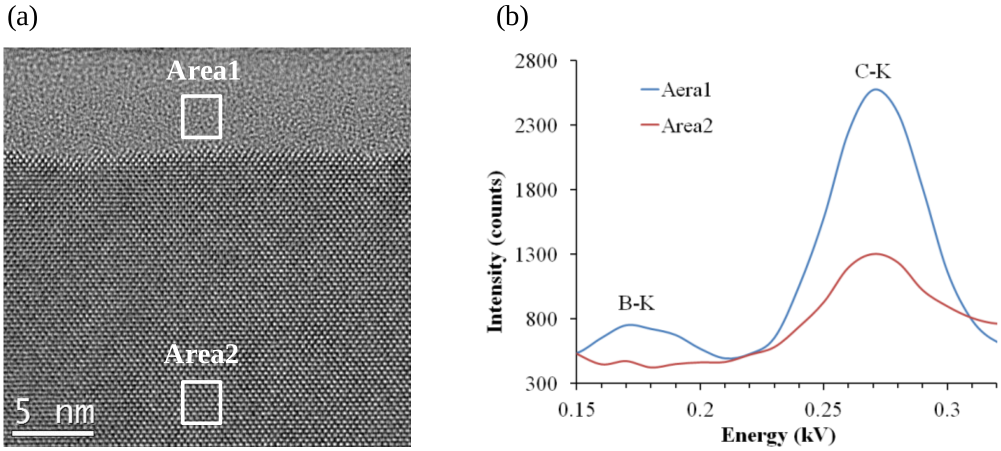

Figure 1. Result of EDX analysis
(a) BF-STEM image of the analysis area, (b) EDX spectra of each area
V.acc., : 200 kV, Magnification : 4,000,000

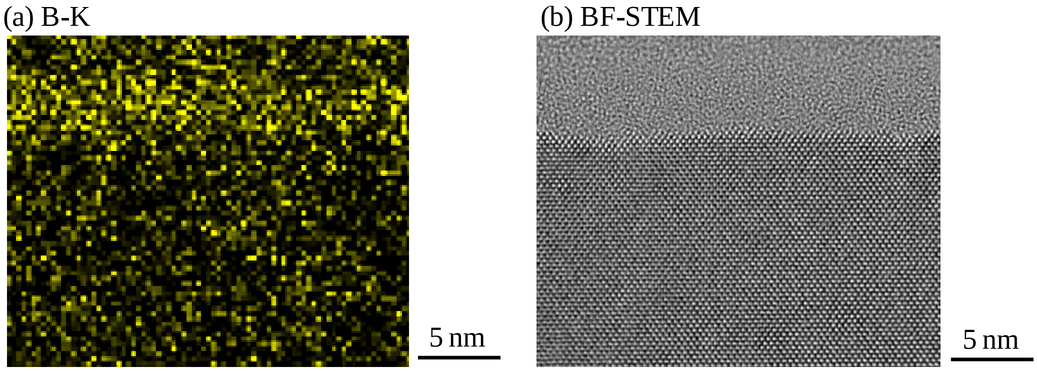

Figure 2. EDX mapping result
(a) B-K map, (b) BF-STEM image
V.acc., : 200 kV, Magnification : 4,000,000

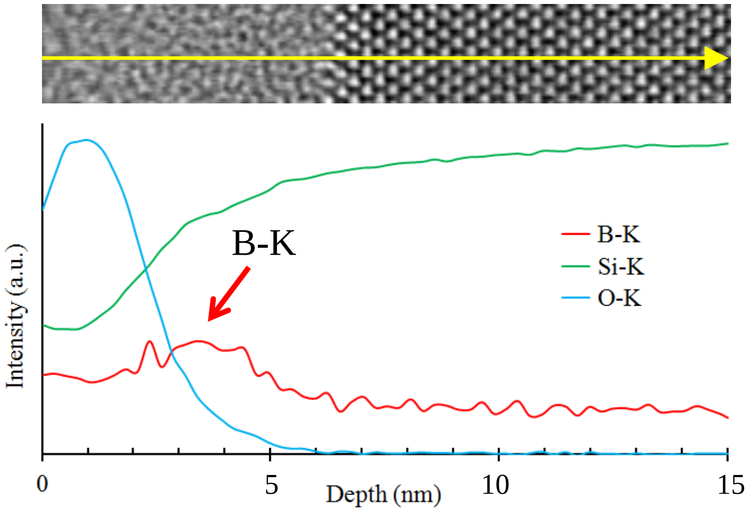

Figure 3. The line profile of B, O, and Si extracted from the mapping results using spectrum imaging.