Cs-corrected High-Resolution Analytical STEM

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Recently, scanning transmission electron microscopy (STEM) has made huge progress owing to a stable field emission gun (FEG) [1] and sophisticated lens designing technologies [2]. Also, a spherical aberration corrected (Cs-corrected) lens [3] is now becoming widely spread as commercial instrument. In this paper, very high-resolution (atomic scale) elemental analysis was successively applied to a precipitate in the metal, with Cs-corrected STEM.

An instrument of Atomic Scale Analytical Electron Microscope is the JEM-2100F (200 kV FEG TEM/STEM) equipped Cs-corrector for probe forming lens. The data introduced in figure 1 was obtained from Si3N4 ceramics using this microscope. Figure 1(a) shows a high-resolution high angle annular dark-field (HAADF) image obtained with Cs-corrected STEM in the JEM-2100F. The data was obtained at beam diameter of 0.1 nm, and it shows high quality of S/N ratio owing to a high beam intensity of the Cs-corrected STEM. Figure 1(b) shows elemental maps of Si-L and N-K, reconstructed from data series of EELS spectrum-imaging for corresponding energies. Owing to fine beam and higher beam intensity of the Cs-corrected STEM, the elemental signals were well detected and the maps show atomic order resolution. Figure 1(c) shows atomic location model of Si3N4 ceramics projected at direction for incident electron beam orientation for a reference. It is ascertained that the elemental maps are similar to the atomic model.

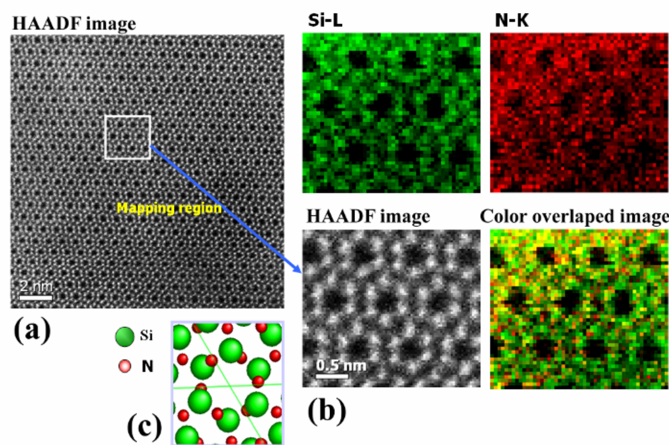

Figure 1. Atomic scale resolution of elemental mapping with EELS spectrum-imaging in Cs-corrected STEM. A specimen was *Si3N4* ceramics. **(a)** A HAADF image of *Si3N4* ceramics; **(b)** Elemental maps of Si and N constructed by EELS spectrum-imaging, showing with color overlapped image and magnified HAADF image; **(c)** Atomic location model projected at incident beam orientation.

Atomic order resolution EELS-maps of Si_3N_4 ceramics were reconstructed from a data series obtained by the EELS spectrum-imaging (SI) method. It is ascertained that the JEM-2100F / Cs-corrector is able to realize an atomic resolution elemental mapping.

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[2] K. Tsuno, J. Electron microscopy, 48, (1999), 801.
[3] M. Haider *et al.*, Nature, 392, (1998) 768.