1B2) (특강) The Third-generation Synchrotron Radiation Technique for Single Particle Analysis

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1. INTRODUCTION

To know the properties of single aerosol particle is an essential prerequisite for understanding its chemical reactions in the atmosphere. Single particle analysis has the advantage of providing a great amount of information that cannot otherwise be obtained using methods of bulk analysis. And single particle analysis needs the short sampling time and the small sampling mass for analysis. This allows for a better determination of the temporal variation of the component concentrations in aerosol particles. Moreover, in some cases the single particle analysis data can be used for "finger printing" of diverse aerosols, natural as well as anthropogenic. This study introduces the Super Photon ring-8 GeV (SPring-8) which is the world's largest third-generation synchrotron radiation facility and provides the most powerful synchrotron radiation for the analysis of infinitesimal trace elements from various samples including individual airborne particles.

2. METHODS

Atmospheric particles were collected by 2-stage filter pack sampler at Kosan super site, Korea in Asian dust storm (ADS) event during ACE-Asia. The 50% cut-off diameter of the first-stage filter with 25 l min^{-1} flow rate was estimated to be about 1.2μm equivalent aerodynamic diameter (Ma *et al.*, 2001). Also, to determine the physicochemical properties of individual solid particles retained in raindrops, the size-segregated individual raindrop sampling (Ma *et al.*, 2002) was carried out at ground-based site in Kyoto, Japan during ADS event in 2002. For the quantification analysis of the ultra trace elements in individual particles, X-ray microprobe system equipped at SPring-8 BL-39XU was applied. This method has been successfully used to carry out reconstruction of elemental map and quantification analysis for multiple elements with fg level sensitivity. Figure 1 shows the schematic illustration of the experimental setup for X-ray fluorescence (XRF) microprobe.

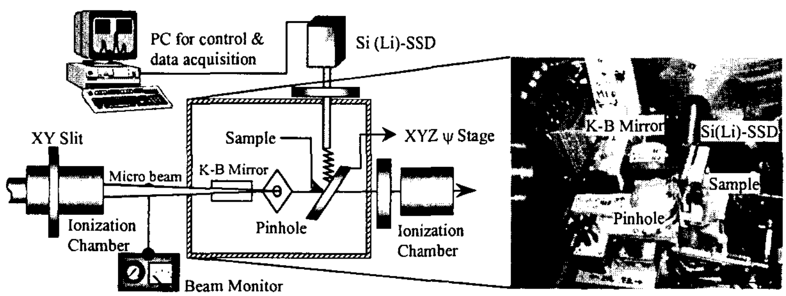

Fig. 1. Schematic illustration of the experimental setup for XRF microprobe at SPring-8 BL39XU.

3. RESULTS AND DISCUSSION

The example XRF spectra of individual 4-particle (>1.2μm) collected at Kosan in ADS event on 7

April, 2001 are shown in Figure 2. X-ray absorption near edge structure (XANES) spectrum was calculated by normalizing the intensity of the fluorescent X-rays with that of the incident X-rays and by plotting against the X-ray energy. As shown in Figure 2, the chemical forms of Fe (Fe^{2+}, Fe^{3+}) can be clearly characterized by its K-edge micro-XANES spectra.

Figure 3 shows the XRF elemental maps for four components taken on separate individual particles. Row and column are pixels corresponding to beam scan area. From these elemental maps replayed corresponding to individual particles, it is possible to get more detailed information such as inner-structure and chemical mixing state in single particle.

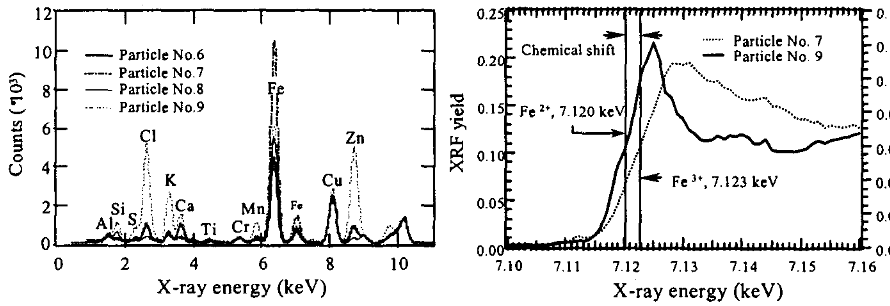

Fig. 2. The XRF spectra of individual four particles collected in ADS (left) and the normalized Fe K-edge XANES spectra of two Fe-rich particles (right).

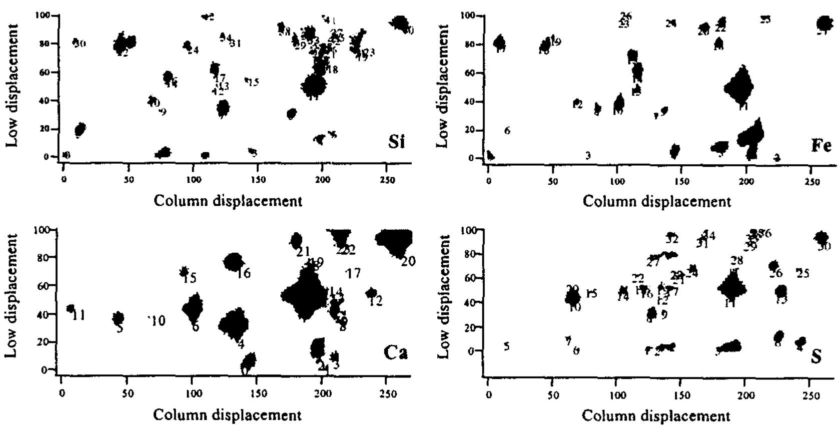

Fig. 3. Si, Fe, Ca, and S XRF images of individual particles collected in ADS event.

REFERENCES

Ma, C.J., M. Kasahara, R. Höller and T. Kamiya (2001) Characteristics of single particles sampled in Japan during the Asian dust-storm period, Atmospheric Environment, 35, 2707-2714.

Ma, C.J., M. Kasahara and S. Tohno (2002) Application of PIXE to characterization of size-segregated single raindrops, International Journal of PIXE, 12, 7-18.