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Chemical States of Sulfur on Kosa Aerosol Particles in East Asia

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Introduction

Kosa (yellow sand) is transported in form of aerosol by the westerlies from the desert and loess areas of interior China to eastern Asia or the Pacific region. Heavy metals and various toxic materials such as sulfuric acid are adsorbed on the aerosol particles during the flight and cause damage on human health, animals or vegetation. To elucidate the chemical states of sulfur adsorbed on the Kosa aerosol particles, it was intended in this study to perform XAFS spectrometry of the aerosol particles with simultaneous measurements of total electron yield (TEY) and X-ray fluorescence yield (XFY).

Experimental

Two types of free-fall Kosa aerosol particles were obtained at Shenyang and Harbin of China in 2003 and 2004. Two standard Kosa samples CJ-1 and CJ-2, which were prepared by NIES, Tsukuba, Japan, were used as reference samples, in addition to the sand particles of Taklamakan Desert. Measurements of XAFS spectra were carried out at BL-11B of Photon Factory. The beam energy ranged from 2450 to 2550 eV, by 0.2 eV steps, 1 sec per step, using a Ge (111) monochromator crystal. The pressure in the sample chamber was kept at 10^{-4} Pa during the measurement.

Results and Discussion

The obtained spectra of samples are shown in Fig. 1 (TEY) and (XFY). It should be noted that the intensities were divided by the incident beam intensity, which was detected as drain current when penetrating the Ni mesh, to avoid the spectral peak emergence due to fluctuation of incident beam intensity. Spectral peaks in Fig. 1 indicate absorption spectra profiles of the representative sulfur derivatives, determining S^{2-}, SO_3^{2-}, SO_4^{2-} absorption edges as 2470.6, 2477.1, 2481.4 eV respectively. The spectrum of Harbin aerosol has a distinct absorption peak near 2481 eV for both TEY and XFY, indicating that sulfur mainly exists in form of SO_4^{2-} for both nano- to micrometer-depth from the particle surface. The spectrum of the Shenyang aerosol also exhibits peaks near 2481 eV in both TEY and XFY but a relatively small peak is additionally observed in the TEY spectrum near 2477 eV, which indicates that the distribution of SO_3^{2-} is limited only in nanometer-depth. On the other hand, spectra of Taklamakan and CJ-2 samples have a smaller peak near 2481 eV in TEY diagram, indicating the existence of SO_4^{2-} at the nanometer level surface. No peaks were found for CJ-1. Thus it was concluded that sulfur in Kosa aerosol mainly exists in form of SO_4^{2-}, one of the most oxidized condition, due to adhesion of atmospheric pollutants during the transportation over the industrialized area in China.

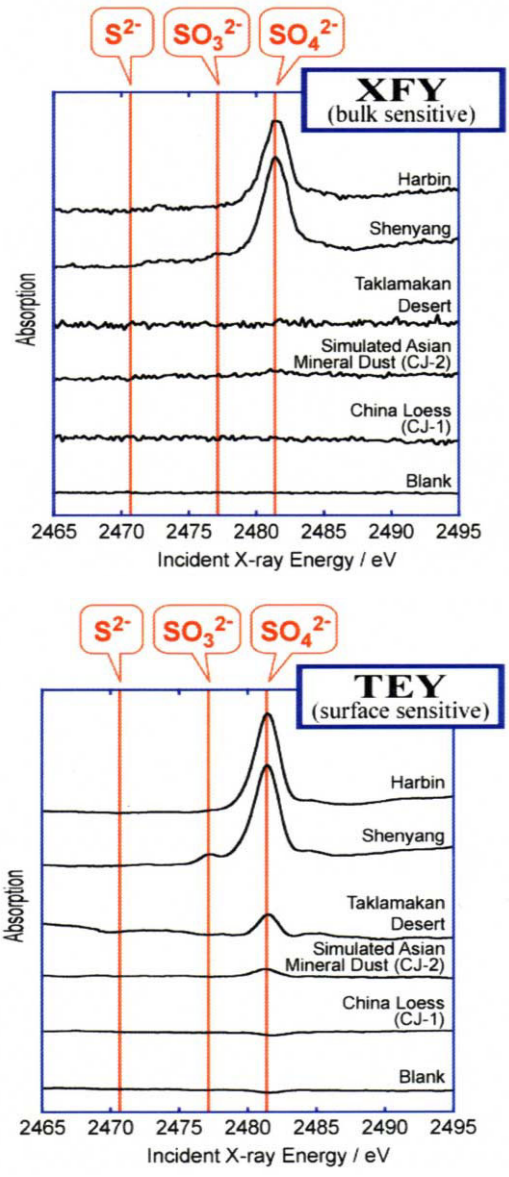

Figure 1:XAFS spectra of Kosa aerosol samples; XFY (upper) and TEY(lower).

References

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