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Characterization of Sulfur in Airborne Particulate Matter by XANES Technique

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Introduction

Chemical species of elements which are comprised in airborne particles represent their origin. Understanding the chemical species of elements in airborne particles has become useful information to assess the source of the particle and to elucidate behavior of the particle in the atmosphere. Sulfur compound, which is one of the most abundant chemical species in airborne particulate matter, is introduced from various natural and anthropogenic sources into the atmosphere. The chemical species of sulfur in atmosphere are reported widely according to origin and atmospheric chemical reaction. Wide variety of instrumental analytical methods, such as gas chromatography and ion chromatography, has been applied to characterization of sulfur compounds. Among these methods for direct determination of the chemical states of elements, XAFS spectroscopy is one of the most powerful methods for liquid- and solid-phase samples. We have previously applied XANES technique to characterize the chemical species in airborne particles [1]. In this report, we have applied XANES to characterize the chemical species of sulfur in airborne particles.

Experimental

The sampling was carried out at heavy traffic roads. Airborne particles were collected by four-staged Andersen air sampler equipped with a back-up filter. The chemical reagents such as elemental sulfur, sulfide, sulfate and so on, the possible chemical species in airborne particles, were measured to compare with the airborne particle samples. In addition, tire samples were also measured. The XAFS measurement was performed using synchrotron radiation ring at BL-9A, Photon Factory, KEK, Japan [2,3]. A Si (111) double-crystal monoclometer and high order rejection mirror was used. The sulfur K-edge XANES spectra of the samples were measured in fluorescence mode using a Lytle-type detector modified for soft X-ray region analysis. To detect fluorescence X-ray, the sample chamber of the detector was displaced to Helium ambience.

Results and Discussion

Figure 1 (a) shows sulfur K-edge XANES spectra of the airborne particles collected from arterial road areas by Andersen air sampler. The position of absorption edge of the different particle size samples is almost same. From comparison with reference materials, the major comportment of sulfur in the particulate samples was estimated to be sulfate. However, at larger particle size, small peaks were detected near the absorption edge. They were ascribed to sulfide from comparison with spectrum of reference materials. About the coarse particles in road area, it has been supposed that the contribution of tire material is large. Figure 1 (b) shows XANES spectra of the tire samples. The small peak observed near the absorption edge of the coarse particle was close to that of tire samples. It is considered through the comparison of the samples, that the contribution of tire material is small for sulfur compounds in arterial road area.

In conclusion, we were able to show the wider application of XANES to chemical speciation of sulfur in airborne particle samples.

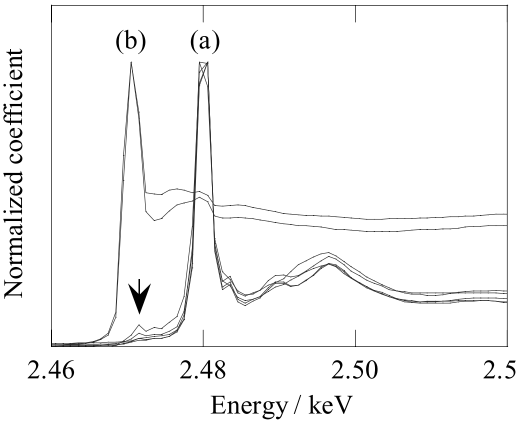

Figure 1. Sulfur K-edge XANES spectra of (a) the airborne particles collected by Andersen air sampler and (b) the tire samples.

References

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