12C/2003G086

Characterization of Nickel in Airborne Particulate Matter by XANES Technique

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Introduction

The chemical species and concentration of elements in airborne particulate matter provide important information, when considering emission sources and complicated mechanisms of aerosol pollution. The chemical species of the element contained in the airborne particulate matter vary with the emission source[1]. Even if it is the same element, in the case of iron, it differs with the soil particle, automobile emission particle, and so on. Therefore, it is useful to know the chemical species of the element contained in particulate matter, when determining the origin and solving the pollution dynamics in the atmosphere. In a big city, the contribution of anthropogenic sources, such as a car, to the particulate matter concentration in the atmosphere is large. Precise source contribution on airborne particulate matter is needed for the creation of a reduction program. Elemental nickel is listed as priority air pollutant in Japan due to its high toxicity. XAFS spectroscopy is one of the most powerful methods to identify chemical species in liquid- and solid-phase samples. In this report, nickel species of possible sources and airborne particulate samples were determined by XANES to investigate source apportionment and pollution mechanisms of nickel.

Experimental

The following vehicle exhaust particulates and city waste incineration ashes were used for measurement as source samples. As vehicle exhaust particulates, the environmental standard reference material #8 “vehicle exhaust particulates” from National Institute for Environmental Studies was used. As city waste incineration ashes, BCR reference materials #176 “city waste incineration ash” from Institute for Reference Materials and Measurements was used. In addition, the chemical reagents such as nickel nitrate, oxide, sulfate and so on, the possible chemical species in airborne particles, were measured to compare with the airborne particle samples. The XAFS measurement was performed using synchrotron radiation ring at BL-12C, Photon Factory, KEK, Japan[2]. A Si (111) double-crystal monochromator was used. The nickel K-edge XANES spectra of the samples were measured in fluorescence mode using a multi-element solid state detector[3].

Results and Discussion

Nickel K-edge XANES spectra of NIES #8 and BCR #176 are shown in figure 1. From comparison with the spectrum of various nickel compounds used as authentic reference materials, it was found that nickel in both particulate samples is divalent. Moreover, nickel species in NIES #8 were suggested to be $NiSO_4$ or $Ni(NO_3)_2$, and those in BCR #176 were suggested to be NiO. The results of chemical speciation of nickel in the two emission source samples indicated the effectiveness of such approach for source characterization, which suggested possibility of source apportionment by chemical speciation on environmental samples. Further studies on emission source samples and environmental samples are required to establish the presented methodology.

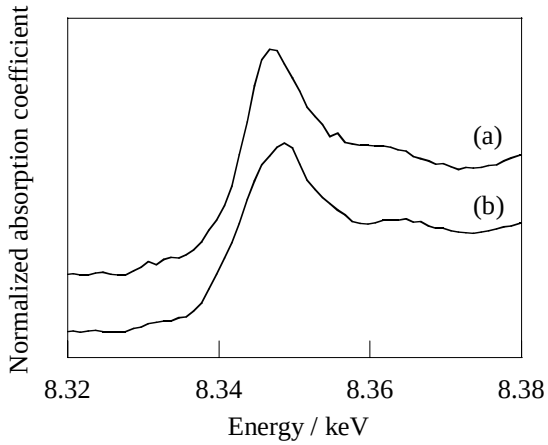

Figure 1. Nickel K-edge XANES spectra of (a) vehicle exhaust particulates (NIES #8) and (b) city waste incineration ash (BCR #176).

References

[1] M. Hirabayashi and M. Matsuo, Anal. Sci., 17, i1581 (2001).
[2] M. Nomura and A. Koyama, KEK Report 95-15 (1996).
[3] M. Nomura, KEK Report 98-4 (1998).

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