Materials Science

NW10A/2009G044

XAFS spectroscopic analysis of Antimony in various sized particles of dust of MSWI

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Introduction

Antimony (Sb) is one of the 32 rare metal elements. Antimony can exist in four oxidation states (-III, 0, III, and V), and it is not only used in alloy but also as a catalyst in plastics and so on for industrial activities[1]. In Japan, Sb and its compounds are considered pollutants of priority interest because of its toxicity. The toxicity of Sb compounds are depends on the oxidation state, especially Sb(III) compounds are higher toxicity than other oxidation Sb compounds, so it is important to identify chemical forms of Sb in the target materials. In this study, we analyzed the structure around Sb atom in the various sized particles dusts collected in municipal solid waste incinerator (MSWI) by using X-ray Absorption Fine Structure (XAFS).

Experiment

The dusts in flue gas of MSWI were isokinetically sampled using an in-stack cascade impactor (Andersen stack sampler Model AS-500) in the stack, following a standard procedure [2][3]. The impactor could sample various sized particles in the MSWI by varying the size of holes in the plate at each stage. The properties of the dusts are shown in Table 1. Antimony existed about 300 ~ 2000 mg/kg in the dusts of each stage. Sb-K edge XAFS spectra were measured at the beamline NW10A in the PF-AR, KEK. The spectra of Sb, Sb_2O_3 and Sb_2O_5 were measured for the spectra of reference materials. The spectra of the dusts samples were collected in the fluorescence mode using a 19-element Ge semiconductor detector. All of XAFS spectra data (XANES:X-ray Absorption Near Edge Structure and EXAFS:Extended X-ray Absorption Fine Structure) were analyzed by REX2000 (Rigaku Co. Ltd.).

Table 1 Properties of dust sampled in MSWI

sampling position	particle sizes (μm)	ash weight(mg)	conc. of Sb(mg/kg)
stage1	18.4<	30.4	245
stage2	11.9~18.4	11.1	357
stage3	8.0~11.9	6.8	438
stage4	5.5~8.0	5.7	540
stage5	3.5~5.5	6.0	720
stage6	1.8~3.5	7.6	2231
stage7	1.02~1.8	7.4	1790
stage8	0.76~1.02	6.0	1710
backupfilter	<0.76	6.2	1275

Results and Discussion

The XANES spectra of the references and the dusts samples are shown in Fig.1. In each particle size, the spectra of the dusts almost fitted in the spectrum of Sb_2O_5. As the dust particle size got smaller, those positions of XANES peak tops shifted to lower energy levels slightly. This suggests that Sb in the dusts is in the form of Sb(V) and as the dust particle size get smaller, minor part of Sb is present as Sb(III). In the fourier-transformed EXAFS spectra, as the dust particle size got smaller, positions of second peak of the dusts were appeared at about 2.7Å and shorter than those of Sb oxides of the references. Those position was nearly same position of Sb-Sb bond of Sb metal of the reference. Or, this suggests that those position means the existence of a bond between Sb and other element [4],[5]. These results appear that the chemical forms of Sb in the dusts of MSWI are different in the dust particle size.

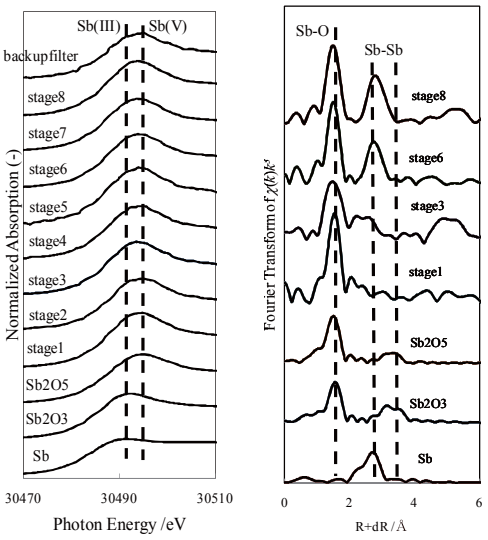

Fig.1 XAFS spectra for Sb (a) Sb-K edge XANES, (b) Fourier transform spectra of reference compounds and fly ash samples

References

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