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XAFS and distribution analysis of selenium in human oral mucosa

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Introduction

Selenium (Se) is an essential element in humans. It is important not only as a cofactor in enzymes but also in detoxification of heavy metals such as mercury. The relationship between the level of Se and heavy metals, especially mercury (Hg) and silver, had been studied[1]. A positive correlation between Se and Hg in blood was reported. As the detoxification mechanism, the formation of Hg-selenoprotein complex was suggested. However, the distribution of Se in the areas surrounding heavy metals in the human body has not yet been studied, because of its low concentration.

In this study, X-ray scanning analytical microscopy (XSAM) and fluorescence XAFS were employed to determine the selenium distribution in the human oral mucosa containing metallic dental restoratives.

Materials and Methods

Two oral mucosa excised from two different patients, which contained particle like foreign bodies, were subjected to XSAM and XAFS analyses. These specimens were excised for pathological diagnosis for pigmentation. The specimen was fixed and embedded in paraffin by the conventional method. The embedded tissue blocks were subjected to elemental distribution analysis using XSAM (XGT-2000V, Horiba, Japan). The distribution images were integrated 100 times.

The XAFS spectra were measured at BL-9A of the Photon Factory. The specified area of the specimen where Se was enriched was analyzed. The XAFS spectra of the Se K-edge were measured in a fluorescent mode using a multi element solid-state detector (Camberra). I_0 signals were monitored using an N_2 filled ionization chamber.

Results and Discussion

Figure 1 shows the transmission X-ray image and S, Hg, Ag and Se distribution images of the specimen with XSAM. The S distribution image shows the shapes of specimens. In the transmission X-ray image, spot-like untransparent parts were found. In these untransparent spots, Hg and Ag were observed. Dental amalgam consists of Ag-Sn-Cu alloy powder and mercury. The foreign bodies in specimen A were considered to be dental amalgam. Se was existed in the vicinity of the Hg and Ag localized spots. Usually, Se is not detected in the tissue by XSAM image because of its low concentration. Therefore, Se localization would be caused by the existence of Hg and Ag. Figure 2 shows Se K-edge XANES spectra of the part indicated by arrows in the Se distribution images in Figure 1. Yamamoto reported that the absorption edge of Se shifts toward higher energy with the increase of valence of Se[2]. The absorption edges of the spectra of the mucosa was slightly shifted to higher energy than that of metallic Se and there is shoulder structure at 12.66 KeV. This suggests the Se in those specimens would be mostly in the low-valence state (nearly zero) and there would be some variety in the valency of Se.

In this study, the localization in the vicinity of dental amalgam which contained Hg and Ag was clearly visualized using XSAM and their chemical states were estimated using XAFS[3].

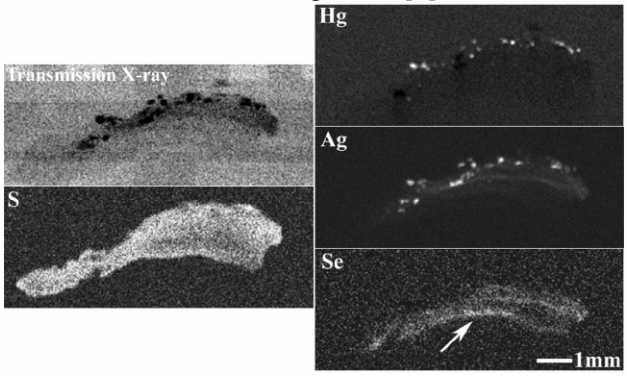

Figure 1. Elemental distribution images of dental amalgam-like particles in human oral mucosa.

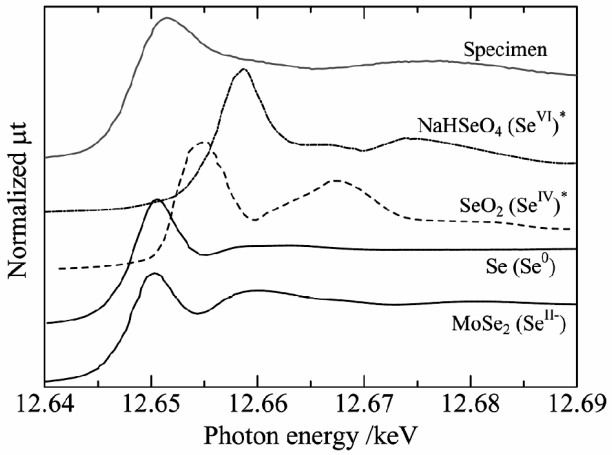

Figure 2. Elemental distribution images of dental amalgam-like particles in human oral mucosa.

References

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