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Imaging XAFS study of simulated high-level waste glass

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Introduction

Reprocessing spent nuclear fuels generates high-level radioactive liquid waste (HLLW). The HLLW is solidified with borosilicate glass in stainless canisters and cooled and stored in the storage facility. Behavior of fission product elements in a glass melting furnace is important for safe and efficient management. In the present work, distribution and chemical state of ruthenium in the simulated glass was examined by using an imaging XAFS technique.

Experiment

Imaging XAFS measurement was carried out at the NW10A beamline. A direct X-ray CCD camera is used in place of an ion chamber[1]. The image from the CCD camera was stored as a AVI format movie file. The CCD camera used in the present work is XCUBE H8481, Hamamatsu Photonics,K.K. The effective view and the resolution of the camera are 8.4mm×6.3mm and 20LP/mm (almost corresponding to 25μm).

Position sensitive X-ray absorption spectra were obtained by analyzing gray scale in images of the X-ray CCD camera. Energetic scan ranging from 21.8 to 22.6keV was carried out to obtain Ru K-edge XAFS spectrum (Ru K-absorption edge E_0=22.117keV).

Results and discussion

At first, we measured a test sample containing RuO_2 and Ru metal powder. In the sample, the metal and the oxide were scattered at random. The result of the imaging XAFS analysis is shown in Fig.1. We successfully obtained information on the Ru distribution in the sample. I addition, the chemical state (oxide or metal?) of each small Ru-rich spot was evaluated by the corresponding position sensitive XAFS spectrum. The imaging XAFS gives us accurate information on chemical state of each small spot (4 spots in the Fig.1).

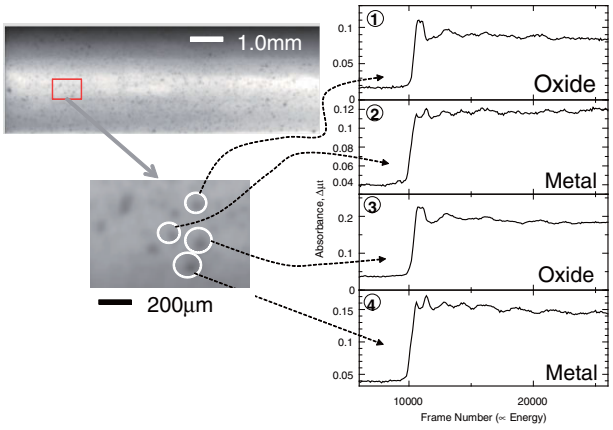

Fig.1 Imaging XAFS result of the test sample

The imaging XAFS technique was applied to the simulated high-level waste glass samples. Distribution and chemical state of Ru element in the glass were confirmed by image XAFSanalyses. The result in Fig.2 shows that Ru element scattered in the glass sample exists as oxide RuO_2.

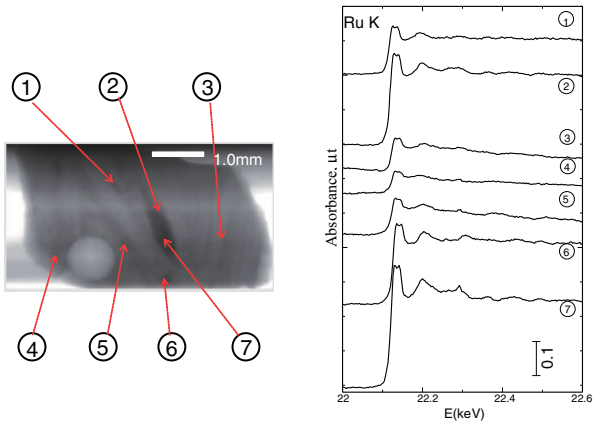

Fig.2 Imaging XAFS result of the simulated glass

Conclusion

Distribution and the chemical state of Ru element in the simulated high-level waste glass were examined by using the synchrotron radiation based X-ray imaging technique. It can be seen that Ru element scattered in the glass sample exists as oxide RuO_2.

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Reference

[1] Y.Okamoto et al., Adv. X-ray Chem. Anal. 42, 183 (2011).

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