Studies on ANS 16.1 Leaching Test of Vitrified Forms for the Korean Low-level Radioactive Solid Wastes and Their Leaching Mechanisms

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1. Introduction

Korea Hydro & Nuclear Power Co. Ltd (KHNP) has developed a SG glass for spent resin and a DG-2 glass for dry active waste [1]. In this study, we conducted leaching experiments by following the American Nuclear Society (ANS) standard 16.1 [2] for two commercialized glass wasteforms, SG and DG-2, and analyzed the morphology of the surfaces of these glasses using a scanning electron microscope (SEM) and the compositional depth profiles and 3-dimensional (3D) mappings using a glow discharge optical emission spectrometer (GD-OES) and a time of flight – secondary ion mass spectrometer (ToF-SIMS). Finally, based on all these results, we suggested the leaching mechanisms for the two glasses.

2. Results and Discussion

2.1 Leaching Tests

Table 1 shows the leachability indices of the target nuclides such as Co, Cs, and Sr obtained from the ANS 16.1 test for the SG and the DG-2 glasses, respectively. All the leachability indices satisfy the requirements (> 6) of the US-Nuclear Regulatory Commission.

Table 1. Leachabilities of the SG and the DG-2 wasteforms

	Co	Cs	Sr
SG	18.00	16.93	16.00
DG-2	∞	14.14	14.76

2.2 GD-OES Depth Profiles

2.2.1 SG.

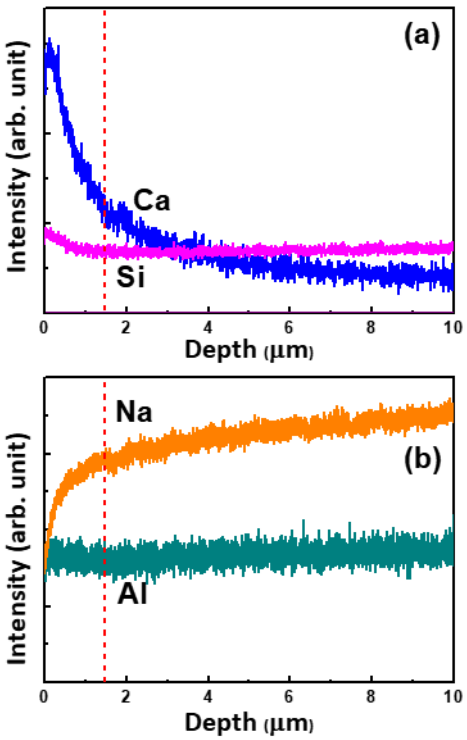

Fig. 1. GD-OES depth profiles of (a) Si and Ca, and (b) Na and Al of the SG.

We found the boundary around 1.5 μm (the vertical lines in Fig 1). Si and Al are accumulated

(Figs. 1a-b) and Na is depleted (Fig. 1b) up to nearly 1.5 μm compared to an internal glass. Especially, Ca is highly accumulated in the alteration layer of the SG. Relatively high Ca concentration of 21% in the SG glass could make the behavior more remarkable.

2.2.2 DG-2.

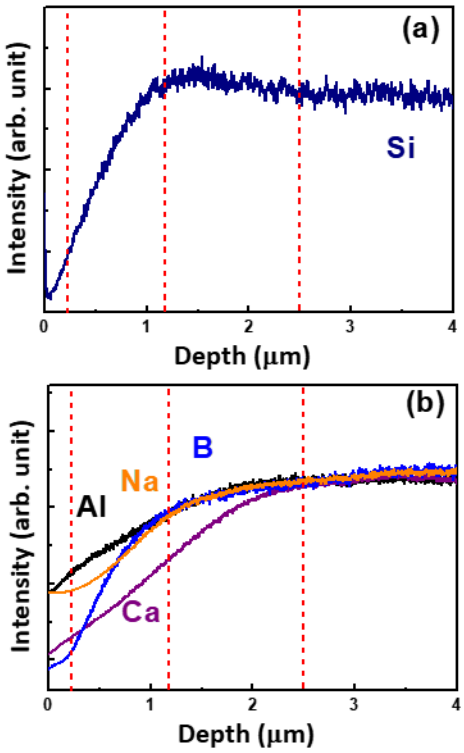

Fig. 2. GD-OES depth profiles of (a) Si and (b) B, Na, Ca, and Al of the DG-2.

The concentrations of all elements in the deeper-depth than 2.5 μm remain constant as the same level as an internal glass. In 1.2 – 2.5 μm, only Si slightly enriched in this section (Fig. 2a). Most major elements including B, Na, Ca, and Al gradually or linearly leached out from the certain depth of the glass to the solution (Fig. 2b). Particularly, Ca starts to decrease rapidly from around 2.5 μm compared to other elements.

2.2.3 Comparisons of the SG and the DG-2. Behaviors of whole elements in the DG-2 generally different from those from the SG. Especially, highly enriched constituents such as Ca and Al at the surface of the SG are not accumulated at the DG-2 surface.

3. Conclusions

We performed leaching experiments, ANS 16.1 test, to two commercialized glass wasteforms, the SG and the DG-2. The leachability values of target nuclides such as Co, Cs, and Sr from the SG and the DG-2 are all more than 14, which satisfy the requirements of the US-Nuclear Regulatory Commission. We analyzed the compositional depth profiles and 3D mappings by a GD-OES and a ToF-SIMS. Based on these results, we suggested the leaching mechanisms of the SG and the DG-2 wasteforms.

REFERENCES

[1] Kim, CW et al. “Glass Formulations for Vitrification of Low- and Intermediate-level Waste” Journal of the Korean Ceramic Society 40(10) (2003).

[2] Measurement of the Leachability of Solidified Low-level Radioactive Wastes by a Short-term Test Procedure, ANSI/ANS-16.1-1986, American National Society, La Grande Park, IL, (1986).