Sorption of Sr^{2+} into Mn oxides produced by MnO_4^- reduction using biomass

T. KATO[1,2*], T. OHNUKI[2], AND Q. YU[2]

[1]1 Ibaraki University, Ibaraki, Japan
(*kato.tomoaki36@jaea.go.jp)
[2] Japan Atomic Energy Agency, Ibaraki, Japan

Various radionuclides such as ^{90}Sr were released into seawater during the accident of the Fukushima Daiichi nuclear power plant. We need to establich techniques to eliminate such radionuclides from the contaminated seawater.

Mn oxides, particulary biogenic Mn oxides (BMOs) are known to sorb various metal ions [1, 2]. BMOs have been produced by microbial oxidation of Mn^{2+}. However, rate of microbial oxidation is usually slow. Therefore, it will take several day for production of BMO. On the other hands, they can be also produced by reduction of MnO_4^- using biomass (biomass-MnO_X) [3]. Nevertheless, there are little information on metal uptake mechanisms during the formation of biomass-MnO_X. In this research, we have demonstrated the uptake of Sr^{2+} during the formation of biomass-MnO_X.

Biomass-MnOx ware produced by reduction of 10 mg/L $KMnO_4$ with *Pseudomonas fluorescens* in 40 mL of 0.1 M NaCl containing 4 mg/L Sr^{2+}. The concentrations of Mn and Sr in the aqueous phase were determined by ICP-OES after filtration. Oxidation states of Mn and Sr in BMOs were characterized by Extended X-ray Absorption Fine Structure (EXAFS) analysis.

The concentration of Mn and Sr decreased up to 10% and 73% within 4 h, respectively, after inoculating the cells into the Mn(VII) and Sr^{2+} containing solution. The blackish precipitates were formed in the bottom. In the precipitates, Mn(VII) was reduced to Mn(IV), Mn(III), and Mn(II) by XANES analysis, showed the formation of biomass-Mn oxides. EXAFS analysis of Sr showed that the presence of Mn around Sr. These results indicate that Sr was formed inner-sphere complex with Mn during coprecipitation.

At 24 h after the inoculation, the concentration of Sr increased from 73% at 4 h to 83%, suggesting the dissolution of Sr from biomass-Mn oxides. In the absence of Sr, higher amounts of Mn ions were dissolved from the biomass-Mn oxides than without Sr.

These results indicate that Sr^{2+} was sorbed by the biomass-Mn oxides in the initial stage of the coprecipitation, followed by the dissolution by the exchange with Mn^{2+} produced by the reduction of the biomass-Mn oxides.

[1] Suarez DL. *et al*. (1976) *Geochim. Cosmochim. Acta* **40**, 589-598.
[2] Yu Q *et al*. (2013) *Geomicrobiol. J*. **30**, 829-839.
[3] Lei L *et al*. (2014) *Environ. Sci. Technol* **48**, 2885-2892.