Creation of Smart PDMS Sponge for Selective Recovery of Molybdenum from Radioactive Wastes

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A smart and functional polydimethylsiloxane (PDMS) sponge for Mo(VI) recovery was created. The adsorption/desorption behavior of molybdate [$Mo(VI)O_4^{2-}$] in various nitric acid solutions was investigated. We found that the surface-functionalized PDMS sponge enables to adsorb Mo(VI) selectively, showing potential for recycling Mo(VI) from HLLWs.

Keywords : Molybdenum, PDMS, adsorption, surface modification

1. Introduction

Solvent extraction and chromatography have been generally used for the separation of radionuclides from high-level radioactive liquid wastes (HLLWs), but generate negative impacts on the environment and safety such production of secondary wastes and fire and explosion. Therefore, in this research, we aimed to create a novel silica-based adsorption matrix, called as polydimethylsiloxane (PDMS) sponge, for the selective recovery of oxoanions such as molybdate [$Mo(VI)O_4^{2-}$] from HLLWs, and evaluate the adsorption performance and mechanism of Mo(VI).

2. Experimental

PDMS sponge was fabricated by curing the solution consisting of PDMS base elastomer, curing agent, and CAM (citric acid monohydrate) as template, and the OH groups were modified with 3-amio-propyltriethoxysilane (APTES). The surface could be chemically functionalized with amino acid derivatives such as glycine through amidation reaction. Batch adsorption/desorption experiments were carried out under various reaction times and solution conditions, and the changes of Mo(VI) concentrations were examined by ICP-MS.

3. Results and Discussion

ATR-IR spectra showed that the amino acid-terminated PDMS (AA-PDMS) sponge were successfully synthesized, and that the C=O stretching peak was shifted by the adsorption of Mo(VI). SEM-EDX results also showed that the AA-PDMS sponge has 3-dimensional (3D) porous structures and that Mo(VI) distributed evenly on the sponge surface. From the ICP-MS results, we found that the Mo(VI) adsorption efficiency exceeded 90 % when the solution pH and the reaction time reach to 5.0 and 24 h, respectively. Moreover, the Langmuir isotherm model could be successfully used to explain the Mo(VI) adsorption mechanism on the AA-PDMS sponge, and determine the adsorption kinetics. The results suggest that AA-PDMS sponge has highly potential for recovering Mo(VI) from radioactive waste solution.

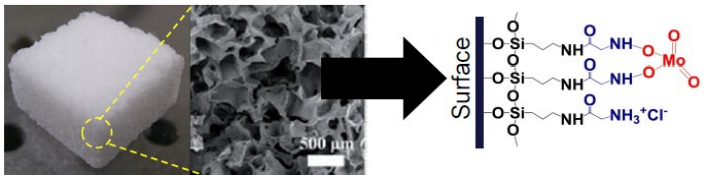

Fig.1 Schematic images of AA-PDMS sponge and Mo(VI) adsorption.

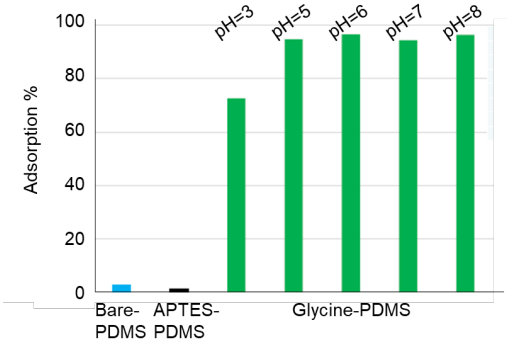

Fig.2 Adsorption performance of Mo(VI) on the synthesized PDMS sponges.

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