4–5 Toward the Evaluation of Minor Actinide Transmutation Fuel Behavior
— Preparation of a High-Purity Curium Sample at the Milligram Scale —

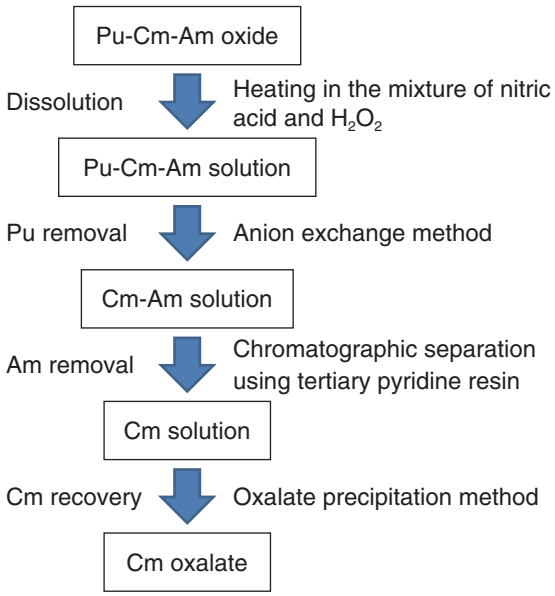

Fig.4-12 Outline of the method for preparing a high-purity curium sample from aged ^{244}Cm oxide samples
A 20% ^{244}Cm–80% ^{240}Pu oxide sample containing an ^{243}Am impurity (about 1%) was dissolved in the mixture of nitric acid and H_2O_2 with heating. A high-purity Cm oxalate sample was prepared from a Cm solution purified by the removal of Pu with an anion exchange method and the removal of Am with chromatographic separation using tertiary pyridine resin.

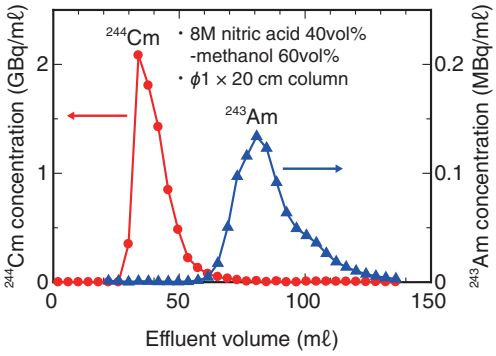

Fig.4-13 Chromatographic separation of Am and Cm using tertiary pyridine resin
After a Cm–Am solution was fed into a chromatography column packed with the tertiary pyridine resin (developed and manufactured by the Tokyo Institute of Technology), effluent from the column with the flow of 8M nitric acid/methanol mixed solution was collected in fractions. Separation of Am and Cm occurred because of a difference in their affinities to tertiary pyridine resin.

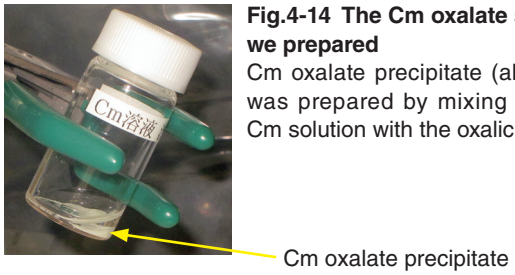

Fig.4-14 The Cm oxalate sample that we prepared
Cm oxalate precipitate (about 10 mg) was prepared by mixing the purified Cm solution with the oxalic acid.

Research and development of technologies for partitioning and transmutation is active in many countries including Japan. These technologies aim at reducing the burden of waste disposal by partitioning elements such as fission products and minor actinides (MA: neptunium (Np), americium (Am), curium (Cm)), which are classified as high-level wastes in the current nuclear fuel cycle, and by transmuting long-lived nuclides including MA into stable or short-lived ones. Transmutation of the long-lived nuclides is proposed to be achieved using commercial fast reactors or dedicated transmuters such as accelerator-driven systems (ADS) wherein fuels or targets containing long-lived nuclides are used.

To develop the fuels for MA transmutation, it is necessary to evaluate their behavior based on the thermochemical and mechanical properties of MA compounds. Our studies on MA compounds had been limited to those on Np and Am because of the difficulty of preparing Cm samples at mg scale with the high purity necessary for the abovementioned studies and of handling such samples. The most widely available isotope ^{244}Cm is highly radioactive and decays to plutonium-240 (^{240}Pu) almost immediately because the half-life of ^{244}Cm is 18.1 years.

We developed a method for preparing high-purity Cm samples from aged ^{244}Cm oxide samples. Removal of Pu and Am is necessary to obtain high-purity Cm samples from the starting material, a typical composition of which is 20% ^{244}Cm–80% ^{240}Pu oxide and which contains ^{243}Am impurities (about 1%) (Fig.4-12). This method comprises four steps: dissolving the starting material in a mixture of nitric acid and H_2O_2 (oxidizing agent) with heating; removal of Pu by an anion exchange method; removal of Am by chromatographic separation using tertiary pyridine resin and a nitric acid/methanol mixed solution (Fig.4-13); and precipitation of Cm oxalate from the high-purity Cm solution (Fig.4-14).

We have prepared the oxide and nitride samples using the obtained high-purity Cm oxalates and have successfully measured their thermochemical properties. The method for preparing high-purity Cm samples, which will be used for the evaluation of MA transmutation fuel behavior, was established.

This study contains the results of “Basic actinide chemistry and physics research in close cooperation with hot laboratories” conducted under the Strategic Promotion Program for Basic Nuclear Research by the Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT).

Reference

Hayashi, H. et al., Separation and Recovery of Cm from Cm–Pu Mixed Oxide Samples Containing Am Impurity, Journal of Radioanalytical and Nuclear Chemistry, vol.296, issue 3, 2013, p.1275–1286.