The Capability of isotopic uranium analysis in nuclear material at KINAC

Jong-Ho Yoon, Jung Youn Choi, Gil Hoon Ahn

Korea Institute of Nuclear Nonproliferation And Control, 1534 Yuseong-daero, Yuseong-gu, Daejeon, 305-348
**Corresponding author: 2bwiths@kinac.re.kr*

1. Introduction

Destructive analysis is used to verify that protracted diversion of safeguard nuclear materials has not occurred[1]. The alpha spectrometry has been mainly used in analyzing Pu material especially ^{238}Pu for isotopic analysis at IAEA. In addition, it is possible to analysis of isotopic composition of uranium and has advantage of cheapness in comparison with Thermal Ionization Mass Spectrometry(TIMS)[2~3].

In this paper, the results of the enrichment for alpha spectrometry will be compared with two results of KOLAS testing lab for uranium isotope analysis by mass spectrometry.

2. Methods and Results

2.1 Sample preparation

18 uranium pellets and 12 bottles of powder in the wide range of uranium enrichment were provided by Korea Electric Power Corporation-Nuclear Fuel(KEPCO-NF) for this study. The schematic diagram of sample preparation for alpha spectrometry is shown in Fig. 1.

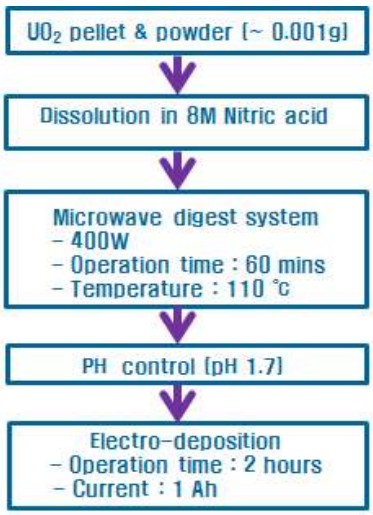

Fig. 1. Schematic diagrams of sample preparation.

The pellet samples which were pulverized physically and the powder samples were weighed out accurately about 1mg and then charged into the teflon vessel with 8M HNO_3. Microwave digestion system(Model START D, Milestone, Inc.) with the Teflon vessels was used to dissolve uranium pellet and powder under 400 W at 110 ℃ for 1 hours individually [4,5]. After digestion procedure, the samples in HNO_3 solution taken from the microwave were collected 1~2 ml then titrated with the litmus paper. The pH was adjusted to 1.7 and controlled with NH_4OH (base) and (1:9) H_2SO_4(acid)[6]. For preparation of SUS disk for alpha spectrometry, the solution was put in the electro-deposition cell which was made of teflon. The anode was a platinum wire. The disk were heat by fire until hot after electro-deposition.

2.2 Measurement

The isotopic uranium analysis were carried out using alpha spectrometry. The disks that uranium was electro-deposited were counted by a Passivated Implanted Planar Silicon (PIPS) detector with active surface area of 450mm^2 (Canberra). The measurement time (live) was 80,000 sec. The samples about 0.1ml were prepared for inter-comparison of analysis respectively as soon as after microwave digest process.

Table. 1. Characteristics of Alpha spectrometry

Sample size (detectable)	Up to 51 mm (in diameter)
Sample-to-detector spacing	1 to 45 mm (in 4 mm increments)
Energy resolution	< 18 keV (FWHM)
Energy range	3 to 15 MeV
Background	< 1 count/hr (above 3 MeV)

2.3 results & discussion

As shown in Fig. 2~3, the results of analysis for alpha spectrometry are not perfectly matched in comparison with the two results for TIMS. Also The average value of the percent difference for pellets and powder are -12.8 % and -22.3 % respectively. The differences of each results are considered many chemical pre-treatment procedures for measuring alpha. Furthermore the reason may be that powder samples were scattered whenever put samples out from the bottle and weighed it.

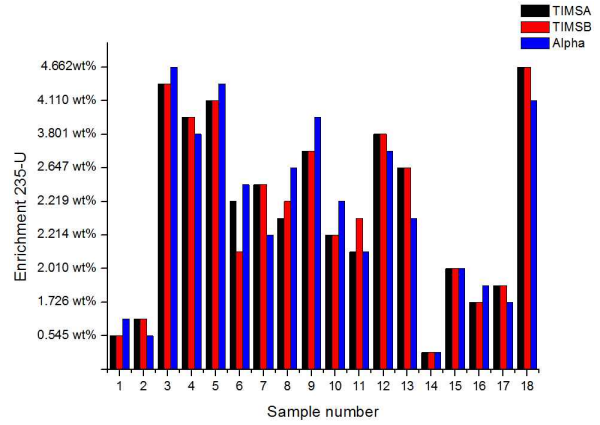

Fig. 2. Plots of the result of enrichment analysis for pellet with alpha vs. analysis with TIMS results.

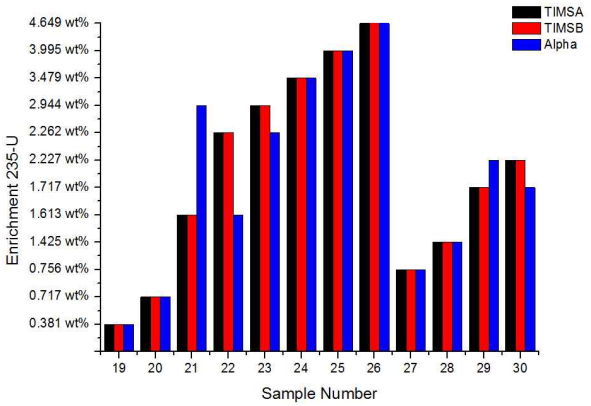

Fig. 3. Plots of the result of enrichment analysis for powder with alpha vs. analysis with TIMS results.

3. Conclusions

To obtain meaningful and sufficiently accurate results for alpha spectrometry, it is necessary to take the sample for every procedures to monitor and check it out.

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