A Comparison Between Alpha-emitting Calibration Source and Electro-deposited Plate of KINAC

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1. Introduction

Alpha Spectrometry is used for isotopic composition measurement of radioactive elements that decay by the emission of an alpha particle [1]. The detector energy, efficiency and resolution has to be calibrated by a calibration source (CS) in prior to analysis by alpha spectrometry [2]. After calibration, the element of interest is chemically separated from the sample matrix (pure uranium samples may not be required any additional purification prior to mounting) and then deposited on a metal plate (typically stainless steel) by electro-deposition [3]. Consequentially, the shape of the electrodeposited sample depends on the pretreatment process (ex. dilution, valence control, deposition condition and so on).

The CS was manufactured to the highest standards and fully complied with applicable international standards. therefore, it is necessary to analyze the surface of CS with the actual sample KINAC made. By comparing the surface condition of two samples, our pretreatment process is needed to constantly evolve.

In this paper, alpha-emitting calibration source was morphologically analyzed using optical microscope and scanning electron microscope (SEM) - Energy Dispersed Spectrometry (EDS) in comparison with electro-deposited plate of KINAC.

2. Experimental

2.1 CS sample

The alpha-emitting CS used in this study was standard radionuclide source (24.1 mm Diameter x 0.65 mm Thick Stainless Steel Disk) by Eckert & Ziegler. The source is shown in Fig. 1.

Fig. 1. Alpha-emitting calibration source (SRS 94370).

2.2 Electro-deposited plate of KINAC

^{232}U tracer solution taken from NIST standard solution (SRM 4324B) was used for raw material of KINAC's sample. The pH was adjusted to 1.7 and controlled with NH_4OH (base) and (1:9) H_2SO_4 (acid) using the litmus paper. For preparation of stainless steel plate for alpha spectrometry, the solution was put in the electro-deposition cell which was made of Teflon, as shown in Fig. 2. The anode was a platinum wire. After electro-deposition process, the plate was heated by fire torch [4].

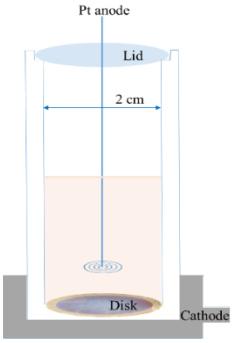

Fig. 2. Electro-deposition module.

3. Results

3.1 Microscope analysis

The two samples were analyzed using optical microscope (OLYMPUS, BX53TRF) and the image of samples was as shown Fig. 3, respectively. According to the images, the particles in CS were

remarkably observed as shown Fig. 3-b in comparison with electro-deposited plate of KINAC (Fig. 3-d).

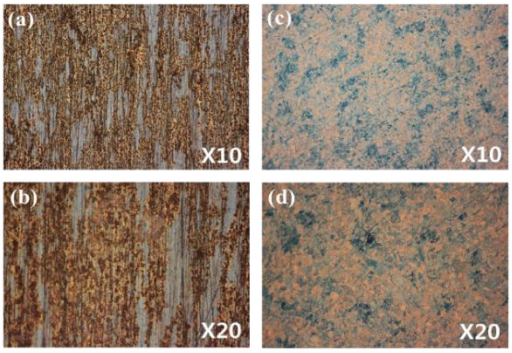

Fig. 3. Microscope image of the CS (a) X10, (b) X20 and electrodeposited plate of KINAC (c) X10, (d) X20.

In CS sample, the suspicious depositions were observed patterns like a scratch not similar to electro-deposited plate of KINAC.

3.2 SEM analysis

In order to analyze particle size in detail, the samples were analyzed using a SEM(JEOL JSM-6610LV) coupled with an EDS microanalysis.

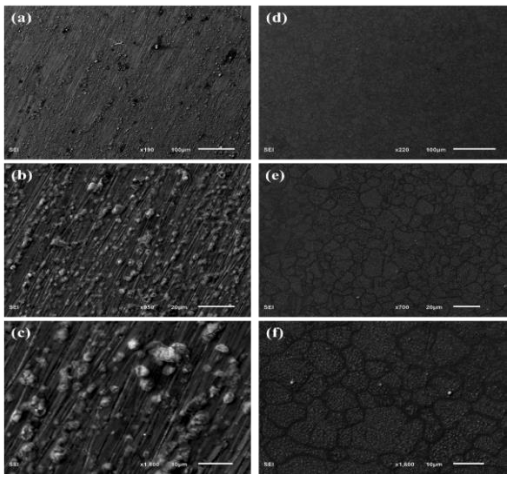

Fig. 4. SEM image of the surface of CS (a) 100 ㎛, (b) 20 ㎛, (c) 10 ㎛ and electro-deposited plate of KINAC (d) 100 ㎛, (e) 20 ㎛, (f) 10 ㎛.

In the case of the CS, the particle size ranges from 3 to 10 ㎛ approximately (Fig. 3-c) and electro-deposited plate of KINAC was less than 1 ㎛ (Fig. 3-f).

3.3 EDS analysis

As shown Fig. 4-a, the uranium particles were found several spot in the CS by EDS results. The particles were usually verified as U, Mn, Fe and Cr. However, the particles size of sample that KINAC made was too small to detect the EDS equipment and most of the particles was usually verified as Cr, Zr and Fe in shown Fig. 4-b.

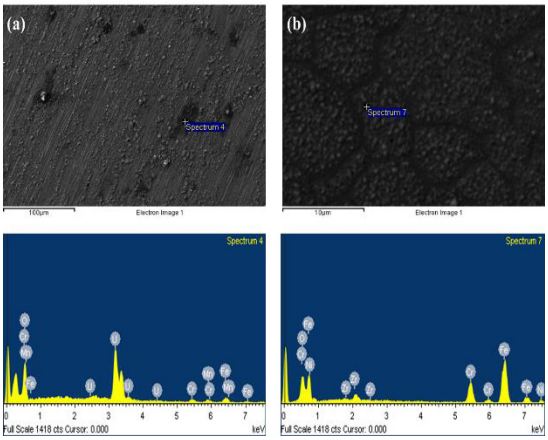

Fig. 5. EDS element results of the particle in CS (a) 100 ㎛ and electrodeposited plate of KINAC (b) 1 ㎛.

4. Conclusion

Through the surface analysis of the two samples, the difference of pretreatment process between the CS and the sample that KINAC made were verified morphologically. The particles in CS was easily observed using SEM and the elements were confirmed by EDS unlike electro-deposited plate of KINAC. Further work is necessary to research particle size changes depending on the pre-treatment condition in electro-deposition plate.

REFERENCES

[1] Donna Beals, “INFL GUIDELINE FOR ALPHA SPECTROMETRY”, ITWG-INFL-ALPH, ver. 1, (2012).

[2] Nora Vajda, Paul Martin, Chang-Kyu Kim, “Handbook of Radioactivity Analysis”, chapter 6, 363-422 (2012).

[3] Talvitie, N.A., “Electro-deposition of Actinides for Alpha Spectrometry Determination,” Analytical Chemistry, 44, 280-283 (1972).

[4] Jong-Ho Yoon, “The Capability of isotopic uranium analysis in nuclear material at KINAC”, Transactions of the Korean Nuclear Society Spring Meeting, Jeju, Korea, May 7-8, 2015.