

Uranium Isotopic Ratio Analysis of U-Bearing Particulates By SIMS in CIAE

Zhao Yonggang
China Institute of Atomic Energy
P.O.Box 275-8, 102413, Beijing, China
Email: zhaoyg@iris.ciae.ac.cn

ABSTRACT

In this paper measurement method of uranium isotope ratio of uranium-bearing particles in swipe samples was introduced; Swipe sample screening program was proposed on the basis of studying various destructive assay and non-destructive assays. Scanning electron microscope(SEM) equipped with an energy dispersive X-ray fluorescence(XRF) system was applied to locate the deposited uranium-containing particles on the graphite support, particle's composition and size can be identified. Some isotope ratio results were compared with those of other bulk analytical methods;By measuring the same prepared sample, we got the U-particle isotopic ratio data similar to those from IAEA NWAL, indicating that our operation parameters and experimental conditions are viable and can be used for measurement of U-particle isotopic ratio from swipe samples.

1 BACKGROUND

After the adoption of U.N. Resolution 687, International Atomic Energy Agency (IAEA) began to use particle analysis technology in determining the nature of activities at the inspected sites in Iraq. Isotopic ratio measurement of single particle has been recognized to be very effective in revealing clandestine nuclear activities such as uranium enrichment. Afterwards hundreds of samples were collected from the inspected areas and sent to IAEA's safeguards analytical laboratory for particle analysis, in fact, many of the parallel samples were distributed to the network analytical laboratories. The IAEA needs assistance in improving particle analysis methods applied to environmental sampling for safeguards, As a member state of the IAEA, we want do something in supporting IAEA's strengthen safeguards.

In March 2001, a secondary ion mass spectrometry (SIMS) from Cameca Ltd. was installed in China Institute of Atomic Energy for the purpose of studying particle analysis in nuclear facility environmental monitoring.

2 SAMPLES ANALYSIS

The samples from IAEA should be kept anonymous. Analysts are not allowed to know about their origin, for the sake of staff safety and compatible samples management, a sample screening program is needed.

2.1 Samples preparation

Sample preparation is very important for isotopic ratio measurement of single particles by SIMS. Normally, the particles to be determined must be put on an even electrical conductor material, such as metal plate, graphite support etc. One can embed the sample grains to gold slice, or deposit the grains suspended in inert solvent solution to the support. The latter is applied in our laboratory.

2.2 Composition analysis and location of particles by SEM

By using the scanning electron microscope (SEM) equipped with XRF system, composition and size of a U-bearing particle can be determined; As to the sample with spare U-grains, locating of U grains by SEM is necessary. We are trying to do the location of a U grain by SEM and re-locate it by SIMS.

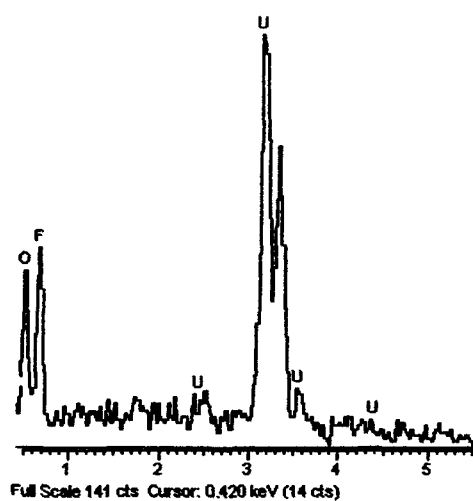


Figure 1. Composition of a U-bearing



Figure 2. Size of a U-bearing particle

2.3 Uranium isotopic ratio analysis by SIMS

We use the ims6f to measure the uranium isotopic ratio of simulated samples or swipes from enrichment plant. The normal operation parameter of the instrument is: Primary beam: O₂⁺, Voltage of Pb: 10–12.5kV, Current Intensity: 10–40μA, Secondary ion voltage: 5kV, Mass resolution: 300–500.

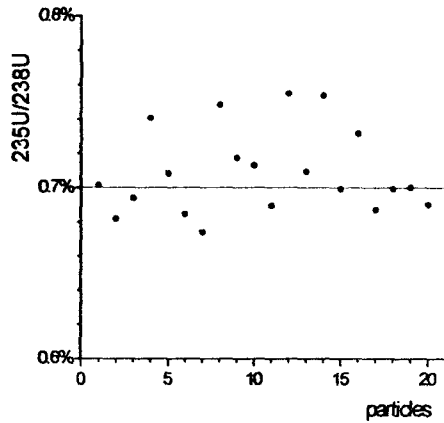


Figure 3. Isotopic ratio of a simulated

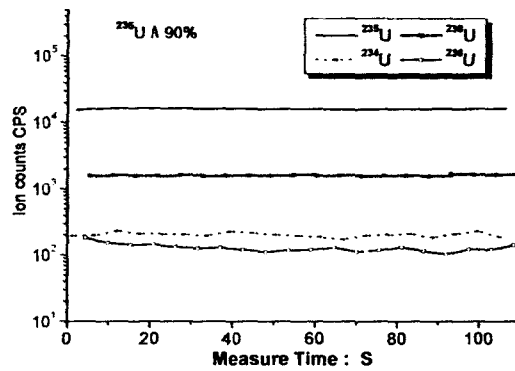


Figure 4. Stability of the secondary ions at mass 234,235,236,238 during a sputtering time

3.SUMMARY

- With nearly three years working, our group has mastered some skill in uranium particle isotopic ratio analysis by SIMS.
- Quality control and quality assurance must be done to value every step of the whole analytical process.
- Low yield of secondary ion of U particle related to sample preparation is a problem to be resolved.