Characterization of Alpha Track Shapes from Radioactive Particles with Various ^{235}U-Enrichments

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1. Introduction

Radioactive particles originated from nuclear activities can be transported and adsorbed onto a dust or an aerosol particle that can be present around the nuclear facilities [1]. The alpha track method can be used for detecting and mapping the alpha-emitting particles such as U, Pu, Am, Th in dust samples [2, 3]. The present research is to establish the technology discriminating U-containing particles with various ^{235}U contents using the alpha track analysis method. The properties of alpha tracks image recorded on the LR-115 track detector, such as size and dense area, vary with the particle size as well as the ^{235}U enrichment of the particles from the track image. The correlations of various track properties with particle size and ^{235}U enrichment using a U-metal particle were determined in this study. It was also discussed here that the handling techniques of micro-particles under optical microscope using various micro-tools.

2. Methods and Results

2.1 Mapping of the area in U-containing particles

The sample was taken by smearing a swipe on a surface of working table in a facility in KAERI. U distribution was observed by alpha track mapping using the LR-115 contacted for 5 days. The alpha tracks formed on the detector were observed with naked eyes as shown in figure 1.

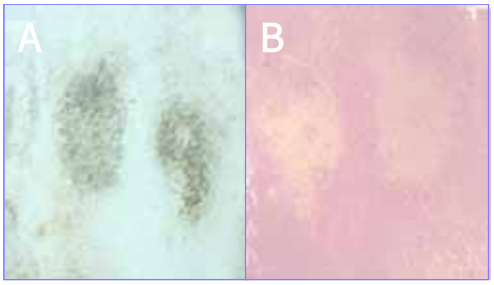

Figure 1. Photo of swipe sample (A) and alpha autoradiograph on LR-115 (B).

2.2 Alpha Track Method

Various sizes of U-metal particles in the range from about 20 to 80μm and ^{235}U enrichment range 0.2, 0.7 and 19.7% were used in this study.

The U-metal particles were dispersed onto a poly carbonate film (Lexan) with a dilute Collodion solution which is used to fix the particles using micro-techniques and dried in air. The prepared plates were then placed in close contact with a piece of LR-115 detector cut to the size of the plate and fixed with tape. The prepared samples were contacted for 5 days. After contacted, the Lexan film was removed and the LR-115 detector sheet was etched in a 2.5M NaOH solution for 160 minutes at 40℃ in a shaking water bath. The alpha tracks formed on the detector were observed with an optical microscope. The size of the alpha track recorded on the detector was measured by a digital image analyzer system as shown in figure 2.

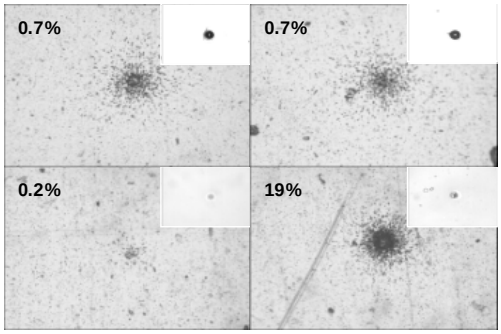

Figure 2. Comparison of alpha autoradiograph and corresponding particle of various particle sizes and ^{235}U enrichments.

2.3 Alpha Track Analysis

It is important to obtain a database of the size and shape of the specific tracks for fissile particles with well-defined size and ^{235}U enrichment. The database will be used to discriminate the U-particle

size and its ^{235}U contents. The cluster of tracks diameters obtained from the alpha tracks analysis was plotted as a function of U-metal particle diameters in Fig. 3. Using the regression analysis, the linear correlation (r = 0.796) between the track diameters and the particle diameter were obtained.

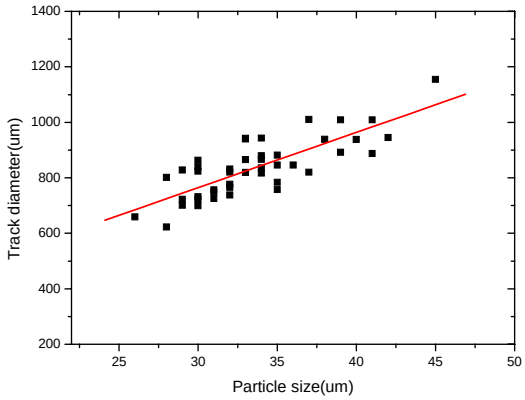

Figure 3. Plot of track diameter of U-metal particle with ^{235}U 19% enrichment versus particle size.

As shown in Fig. 3, the track diameter for the U-metal particle with ^{235}U 19% enrichments recorded on the LR-115 detector showed a linear correlation (slope=19.9) with particle sizes. Consequently, U containing particle size can be estimated from the slope.

The number of alpha tracks observed is proportional to the number of ^{235}U enrichment. The result was obtained from other U-metal particle with ^{235}U enrichments were listed in Table 1. Consequently, ^{235}U enrichments can be estimated from the values.

Table 1. Experimental and calculated alpha tracks from uranium containing particle (alpha track counts/ug /day)

^{235}U enrichments (%)	0.2	0.7	19
Experimental	47±13	57±16	1080±100
Calculated	1050	1090	2050

3. Conclusion

The alpha track technique was used in this study to estimate the ^{235}U enrichment using the U-containing particles with various ^{235}U contents.

This work has shown that alpha track analysis can be used for mapping the U-containing particles in the swipe samples as well as for estimating ^{235}U enrichments of the interesting U-containing particles.

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