Dispersion Target Fabrication for Fission Mo-99 Using Centrifugal Atomization Uranium Powder

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1. Introduction

Among the radioisotopes for medical diagnosis, Tc-99m is most widely used. Mo-99 produced from the nuclear fission of uranium in research reactors is the key radioisotope for Tc-99m generators. Generally, major producers of Mo-99 still use targets containing highly enriched uranium(HEU). However, the international non-proliferation policy currently emphasizes the minimization of the use of HEU in medical radioisotope production[1]. Therefore, low enriched uranium (LEU) targets have been developed by casting and crushing of UAl_2compounds. The UAl_2particle dispersed target has a lower U-235 density when compared to HEU targets. The uranium density of the conventional UAl_2 dispersion targets is known to be lower than 2.7g-U/cm^2[2]. To improve the low production efficiency of LEU targets, target designers try to develop high uranium density targets with LEU. KAERI has fabricated spherical uranium powder by using centrifugal atomization method and tried to fabricate Mo-99 target[3,4].

Mini-size targets with 2.7 g-U/cm^3 were fabricated in this study. The microstructural changes after thermal treatments were observed by scanning electron microscopy (SEM) to analyze the interaction behavior of uranium particles and an aluminum matrix.

2. Methods and Results

Atomized spherical uranium powder and pure aluminum powder were mixed and compacted to form dispersion targets 2.7g/cm^3-U. The mixed powder compacts were sandwiched between 6061Al plates and hot rolled into target plates with a thickness of 1.5 mm at 500℃. Blister tests were conducted at 485℃ for 1 hour to check the bonding integrity of the dispersion targets. Cross-sectional microstructures of the fabricated targets were observed by scanning electron microscopy(SEM). Additional heat treatments were applied to the targets for further reaction of the uranium particles and the aluminum matrix at 540℃, 560℃ for 1 hour respectively.

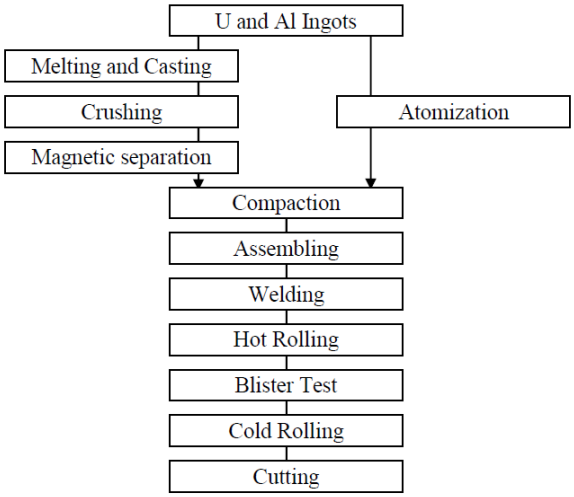

Fig. 1. A flow chart for fabrication of dispersion target plates: (left) the conventional route, (right) new route using atomized powder.

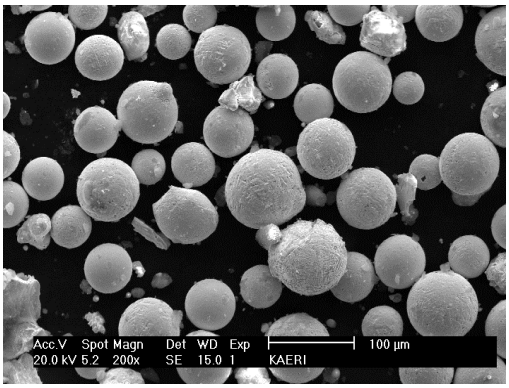

Fig. 2. Spherical morphologies and cross-section SEM images of atomized particles : (a) U-1wt%Al, (b) U-10wt%Al, (c) U-20wt%Al

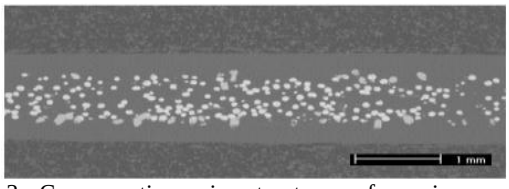

Fig. 3. Cross section microstructures of uranium particle dispersion target plates. (2.7 g /cm^3-U)

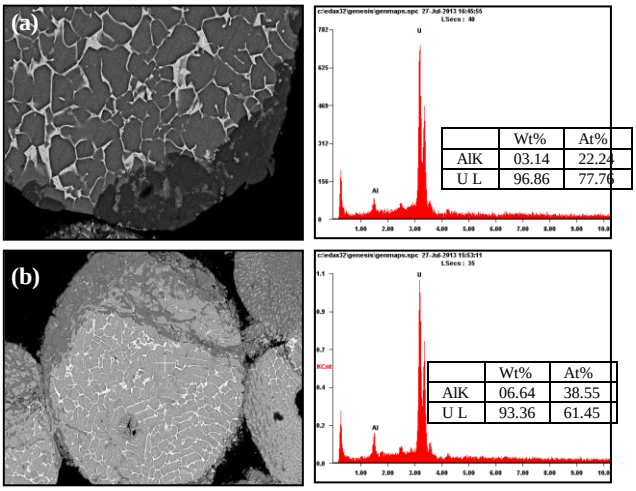

Fig. 4. Cross-section SEM images and EDX spectra of atomized particles : (a) 520℃ 1h, (b) 560℃ 1h

The particles of metallic uranium powder fabricated by centrifugal atomization are spherical (Fig. 2). The average diameter of the powder particles was about 80 μm.

The transverse cross-section image of a 2.7g/cm^3-U mini -size target is shown in Fig. 3. The mini-size target was fabricated successfully using a hot rolling method, and had 1.5mm thickness of the included UAl_x powders. Also, annealing was performed after hot rolling at 500°C. The agglomeration of UAl_x could not be found.

Fig. 4 shows EDS patterns obtained after the heat treatment at 520°C and 520°C for 1hour respectively. The growth of UAl_3 and UAl_4 was observed at 520°C and 560°C 1h heat treated samples.

It was confirmed that uranium particles reacted with the aluminum matrix. The variation of UAl_x composition is not much among the heat treated samples, because uranium particles and aluminum were reacted thoroughly in 1hour.

3. Conclusions

●An mini-size dispersion target with atomized uranium particles were fabricated by hot rolling at 500°C.

●Atomized uranium particles react with the aluminum matrix to form UAl_x phases during the fabrication processes.

●Most of the uranium particles in the dispersion targets were partially converted into UAl_x after annealing at 520 and 560°C .

ACKNOWLEDGMENTS

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