An Effort to Improve Uranium Foil Target Fabrication Technology by Single Roll Method

Moonsoo SIM [a*], Chang-Kyu KIM[b], Jong-Hyeon LEE[a]
[a] *Chungnam National University, Green Energy Technology, Goongdong 220, Yuseong, Daejeon*
[b]*Korea Atomic Energy Research Institute, Research reactor Fuel Development Division, Dukjin 150, Yuseong, Deajeon*

Corresponding author: jonglee@cnu.ac.kr, ckkim2@kaeri.re.kr

1. Introduction

Technetium-99(^{99m}Tc) is the most commonly used radioisotope in nuclear medicine for diagnostic procedures[1]. It is produced from the decay of its parent Mo-99, which is sent to the hospital or clinic in the form of a generator[2,3]. Recently, all of the major providers of Mo-99 have used high-enrichment uranium (HEU) as a target material in a research and test reactor[4].

As a part of a nonproliferation effort, the RERTR program has investigated the production of the fission isotope Mo-99 using low-enrichment uranium(LEU) instead of HEU since 1993, a parent nuclide of ^{99m}Tc , which is a major isotope for a medical diagnosis[5,6].

As uranium foils have been produced by the conventional method on a laboratory scale by a repetitive hot-rolling method with significant problems in foil quality, productivity and economic efficiency, attention has shifted to the planar flow casting(PFC) method. In KAERI, many experiments are performed using depleted uranium(DU).

2. Methods and Results

1. development of a uranium foil fabrication

Fig. 1 is the equipment developed by KAERI for making uranium foil. The equipment is based on a rapid solidification method for thin foil using roll casting. The melt feeding system with a long slot of about 70mm is installed on the rotating Cu wheel. The gap homogeneity of the slot should be precisely controlled and the clearance between the tip of the melt feeding system and the surface of the cooling should be maintained with a suitable gap. Because uranium metal has a strong reactivity with air all equipment are mounted in the vacuum and inert atmosphere controlling chamber.

The conventional crucible and tundish were made of quartz tube. But, it had several draw backs such as melt leakage and waste generation due to single use. In this study, crucible and tundish are made of graphite. A thin gap with ~0.5mm width and ~70 mm long was machined at the bottom of the graphite tundish for inducing planar flow of uranium melt. A charged uranium ingot in the crucible was heated by induction method. When the uranium metal was completely melted and the predefined temperature was leached, the pouring plug in the crucible was removed by hand as shown in Fig. 2. The rapidly solidified uranium foil was collected by a winding system.

The dimension of uranium foils was examined at several positions along each foil. The surface morphology of uranium foils was examined with an optical microscope. X-ray diffractometer was used to determine the phase as shown Fig. 3.

Fig. 1 Vacuum planar flow caster

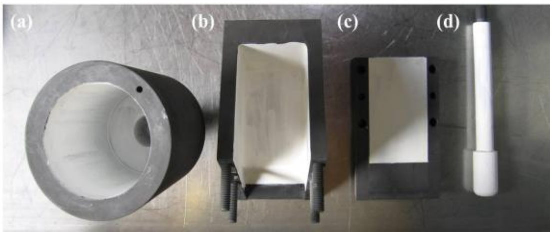

Fig. 2 The components of uranium foil fabrication equipment

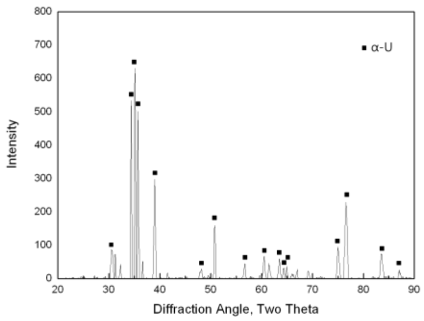

Fig. 3 X-ray diffraction pattern of the obtained uranium foil

Fig. 4 Whole shape of fabricated uranium foil

3. Conclusions

Through modifications for the equipment DU foils were successfully fabricated as shown Fig. 4. The length of the preliminarily fabricated DU foils was longer than 10 m. The thicknesses of DU foils were measured to be 140-300 ㎛, which meets to the specification requested by ANL in USA. The DU foils were very smooth without rumpling because of collected by auto-collection system of winding. It is considered that the yield of foil increased because the possibility of melt loss by leaking could be excluded. The fabrication cost would be very much decreased from repeatedly use of graphite crucible.

4.Summary

KAERI launched a R&D project for improving the homogeneity quality of foil as well as the uranium yield in foil production. The concepts on improving the quality were a stabilization of the melt with eddy-flowing in the feeding stage from changing melt-pouring under pressure to melt-pouring by gravity force. In addition, the previous process using the highly-costed quartz crucible was replaced with the conventional process using repeatedly usable graphite crucible. When U foil is formed and maintains at high temperature a rolling work using the side roll was done to eliminate the irregularity of the open side surface of the foil. In order to collect the quickly forming-out foil without any damage on foils automatic winding system for foil was designed and adopted to this new system. .

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