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Evaluation of Oxidation of Irradiated Aluminum for Thermal Insulator of a Capsule for HANARO

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1. Introduction

As a research reactor, HANARO, operates well, it is time to develop and fabricate nuclear materials in domestic company.[1,2] There are several materials for a nuclear reactor. In this study, aluminum used for thermal insulator of a capsule of HANARO was prepared and irradiated. Oxidation was determined after irradiation to obtain basic data of the materials.

2. Experimental Method

Aluminum ingot with 1002 grade was prepared in a domestic company. The ingot was fogged, extruded and drawn to a long cylinder following annealing at 400oC during the final reduction stage. The heavily drawn aluminum block was finally rolled and cut to be thin disk shape with about 0.1mm thick and 3 mm in diameter.

The specimen was irradiated in CT hole of HANARO. The irradiation test condition was for 36 days at 320℃ with the maximum neutron fluence of 4.8x1020 n/cm2 (E>1.0 MeV). The total fluence of the neutron with the energy of (E>0.1 MeV) and (E>1.0 MeV) for 29 days in CT hole were 7.0-9.3x1020 n/cm2 and 3.2-4.3x1020 n/cm2, respectively. The gamma heating rate was in the range of 2.0-6.45 W/gm.

Specimens were kept in hot cell before addition tests. Weight change by oxidation in air was determined with a precise balance (Mettler-Toledo Model AX26 Delta-Range) after heat treated at 300-500oC for 3-24 hours before and after irradiation. Fig. 1 is a stage in a balance for irradiated specimen.

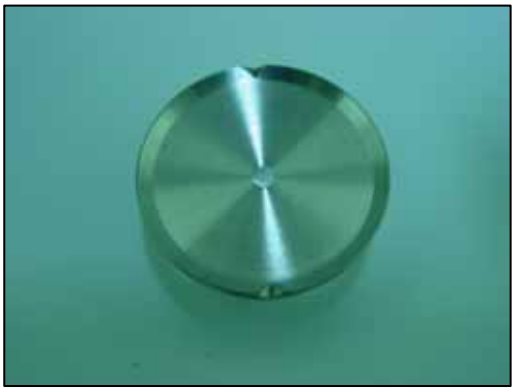

Fig. 1. Irradiated Specimen and Holder

3. Results and Discussion

Table 1 is weight change with annealing time after irradiation and annealing at 300°C. As shown in Table 1, oxidation at 300°C was initially weigh gain, whereas, it showed weight loss after longer time. Table 2 is weight change with annealing time after irradiation and annealing at 500°C. As shown in Table 2, weight loss was initially observed.

Table 1. Weight Change of Aluminum 1002 with Annealing Time after Irradiation and Annealing at 300°C.

Sample #	Annealing Time [hr]	Weight Change[mg]	Dose [mR/h]
S5-1	3	0.109	0.27
S5-2	9	-0.291	0.26
S5-3	24	-0.017	0.21

Table 2. Weight Change of Aluminum 1002 with Annealing Time after Irradiation and Annealing at 500°C.

Sanple #	Annealing Time [hr]	Weight Change[mg]	Dose [mR/h]
S5-4	3	-0.166	0.24
S5-5	9	-0.208	0.22
S5-6	24	-0.169	0.25

It is difficult to why weight loss was observed in this study. Since aluminum is well corroded in air and has thin protective layer on the specimen. Aluminum oxidation in air usually shows weight gain because thin oxide film on the aluminum surface is so protective that additional oxidation does not occur. However, the oxidation of irradiated aluminum shows weight loss. If the weight loss was real value, aluminum oxide on surface should be removed. In order to be detached the protective oxide film, the oxide film should be weak. Considering molar volume change of aluminum oxidation, the protective film should be activated by irradiation. Hence, the relatively thick oxide layers formed on the aluminum surface ere activated by irradiation, broken and detached from the surface, resultantly, reducing weight.

4. Summary

Post irradiated oxidation of 1002 aluminum for a thermal insulator of a capsule of HANARO was evaluated. The specimen was irradiated in a capsule of 01M-05U which was installed in CT hole of HANARO for 36 dyas at 320℃ with total fast neutron flux of 7.0 9.3x10^{20} n/cm^2 and 3.2 4.3x10^{20} n/cm^2, gamma heating rate of 2..0 6.45 W/gm. Residual irradiation flux was 0.25 to 0.27 mR/h after 24 hour-annealing. Annealing temperature increased oxidation of irradiated aluminum, which is related to surface oxide film detachment resulting from activation by irradiation.

Acknowledgements

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References

[1] Y. H. Kang et al., Capsule Development and Utilization for Material Irradiation Tests, KAERI/RR-2038/99.
[2] Y. Choi, KAERI/CM- 404/99, 2000.