Preparation of Gd targets for in-beam fission measurements as a step towards the handling of ^{243}Am targets with ultra-thin backings

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The study of in-beam fission characteristics is of fundamental importance in understanding heavy-ion induced fusion reactions and the shell structure of fissioning nuclei. Characteristic information is extracted from the measured velocities of the fission fragments. Since the fragments lose kinetic energy when passing through the target and/or backing to reach the detectors, thinner targets and backings are favored for studies to decrease the systematic error. Additionally, safe handling and survival of radioactive isotope (RI) targets in beam are important factors. Since thinner targets and backings are fragile, the optimization of the backing material, thickness and preparation procedures are key for studies with RI targets.

In order to find the optimum backing, a variety of backings with different material, thickness, and substrate, were prepared, as indicated in Table 1. As the thin backings are too thin for electrodeposition of the RI target, a substrate such as Cu is used to support the backing during electrodeposition, and is subsequently removed. The Ti and Cr materials were evaporated using an evaporator at ANFF. [a)] The Cu substrates were dissolved by a solution made by combining 4 grams of trichloroacetic acid (TCA), 20-mL 30% NH_3 solution and 20-mL deionized water, resulting in 40-mL of 9.3% TCA solution, similar to that described in Refs. 1–3). The success ratios for dissolving the Cu without breaking the backing materials were more than 80% for Ti backing material and less than 50% for Cr backing material. Attempts to release the Ti-backings from KI-coated glass by dissolving potassium iodide in water were not successful because the backings were broken.

As a backing test, the backings, 200-nm Ti, 300-nm Ti, and 300-nm Cr (once removed from the Cu substrates), were irradiated by a 170 MeV $^{58}Ni^{12+}$ beam of 1 mm diameter, which was provided by the Heavy Ion Accelerator Facility of the Australian National University. The 300-nm Ti backing survived beam irradiation of 1.5 enA for more than one hour.

Table 1. Combinations of backing material, thickness and substrate.

Backing material	Thickness	Substrate
Ti	200 nm	Cu (3.6–4.7 μm)
	300 nm	
	300 nm	KI-coated glass
Cr	300 nm	Cu (3.8–4.4 μm)
Al	740 nm	self-supporting

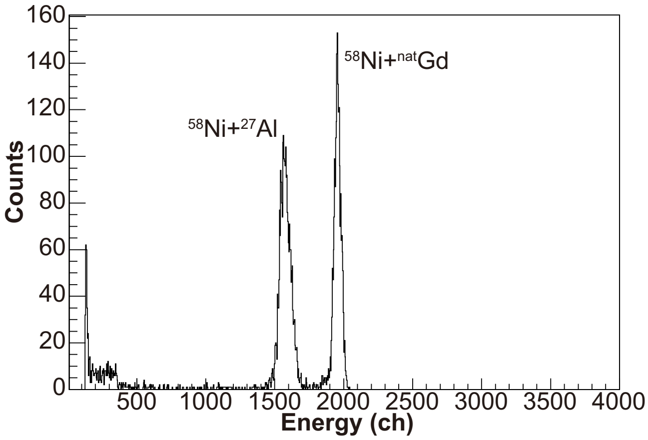

Fig. 1. Energy spectrum measured by a Si detector from the reaction of ^{58}Ni + ^{nat}Gd with Al backing.

Gd target material, instead of RI ^{243}Am, was successfully deposited on Ti-backing and Al-backing by electrodeposition utilizing the Hot-Lab of RIKEN Nishina Center. The detailed procedures are similar to that described in Ref. 4). The thicknesses of 1.6-mm-diameter (5-mm-diameter) Gd targets were between 130 and 190 (40 and 120) $\mu g/cm^2$.

The Gd targets on 300-nm-Ti/740-nm-Al backings were tested with the same conditions as the backing test. An energy spectrum measured by a Si detector, which was mounted 15 cm downstream of the target at 18° with respect to the beam axis, is indicated in Fig. 1. The clear peaks indicate the elastic scattering from the reactions of ^{58}Ni + ^{nat}Gd and ^{58}Ni + ^{27}Al, which demonstrate the uniformity and quality of the target and backing.

The safety of all of procedures for handling the target, as well as the uniformity and quality of the target, have been confirmed. The ^{243}Am target will be prepared using the same procedures as the Gd targets.

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