VI. 3. Target Preparation by the Precipitation Method for Nuclear Reactions and the Production of Californium Isotopes

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We applied a simple and an unique method to the target preparation by using a membrane filter (Anodisc 25 which is consisted by Al_2O_3, pore size; 0.1 μm , diameter; 20 mm, an effective thickness; 25 μm) distributed commercially by Whatman Co Ltd[1)]. It can be useful for the method with a precipitation after filtrating the target material. We found that the deposition efficiency is almost 100 % for obtainable thickness. The ^{238}U deposited on the Anodisc disk was irradiated with ^{12}C ions in order to produce the ^{245}Cf and ^{244}Cf with ^{238}U(^{12}C,xn) reactions.

An amount of 1g ^{238}U (^{nat}U) in 6 N 100 m*l* of nitric acid (HNO_3) solution was diluted by pure water to concentrate ^{238}U as 9.6 mg(^{238}U)/6.2 m*l*. The diluted HNO_3 solution was collected and a few drops of phenolphthalein were added to the solution in order to check its pH afterwards. Ammonia water in concentration of 25% (pH~10) was added to the solution with being checked the alkalinity indicated by phenolphthalein. Then, water was added to be its total volume of 9.6 m*l*. (1 mg ^{238}U/ m*l*). The solution was permitted to stand for at least 30 min due to the growth of uranium crystals (uranium hydroxide) in the solution. The solution of 9 m*l* exactly containing the ^{238}U of 900 μg as a hydroxide was partially collected in a separate beaker, and diluted by 2-3 m*l* of water. Finally, the solution was filtrated to deposit ^{238}U hydroxide on the Anodisc. Therefore, the chemical yield of the filtration was estimated to be approximately 100 %.

Recently, a He-gas jet transport system was installed for producing heavy elements

around Z=100 at the CYRIC. The target was mounted in an aluminum holder and placed in a He-jet reaction-chamber placed on the end of a beam course. The reaction-chamber was connected to the He-gas (containing KCl clusters) jet transporting system. He-gas (a flow rate of 5 *l* /min) was applied through a KCl-cluster generator with heating at 660 degree C. The transport efficiency of the system was estimated to be 30-40 %.

The Anodisc deposited ^{238}U (300 $\mu g/cm^2$) was mounted in a target holder and irradiated with 120 MeV ^{12}C ions in order to produce heavy isotopes such as ^{245}Cf and ^{244}Cf by the $^{238}U(^{12}C,xn)$ reactions[2-3]. The beam current was typically 150 particle-nA. The reaction products adsorbed on the cluster were transported with He-gas through a capillary tube (15 m long) to an automated rotating–wheel-chamber placed at the room in the next door. Four α-ray detectors consisted of a PIN-photodiode were installed in the rotating-wheel-chamber in order to measure the α-rays emitted from the nuclides transported. The products transported by He-gas were blown on a polyethylene terephtalate films. The accumulation of the transported products and the measurements of the α-rays from ^{245}Cf and ^{244}Cf was repeated by each 20 min. The data were stored with a PC-CAMAC system.

After the irradiation, the surface of the Anodisc was examined with a SEM image in order to confirm the damage. Typical SEM images are shown in Fig. 1(a)-1(d). The Anodisc before use is shown in Fig. 1(a) with an unit magnification ratio of 10 μm, and here, the ^{238}U hydroxide was seen on the surface though observing the local cracks. The Anodisc irradiated by ^{12}C ions are shown in Fig. 1(b)-1(d) by the different magnification ratios, 1(b) for 100 μm, 1(c) for 10 μm and 1(d) for 1 μm (the reverse side). It was found that no damage was seen though some faintly brown-colored at the area irradiated. The SEM image is almost similar to that of the Anodisc before use.

The α-ray spectrum of ^{245}Cf and ^{244}Cf produced by the ^{238}U (^{12}C,5n) and $^{238}U(^{12}C,6n)$ reaction is shown in Fig. 2. It was found that clear peaks of the α-rays of ^{245}Cf and ^{244}Cf were observed at 7.13 and 7.21 MeV with the $^{245}Cm(\alpha,5n)$ and $^{244}Cm(\alpha,6n)$ reactions. Therefore, it seems that the Anodisc is useful for the target-backing irradiated by several ion beams. The α (γ)-ray spectra and/or the excitation functions for producing such heavy elements, not only ^{245}Cf, ^{244}Cf but also heavier nuclides, can be obtained by means of the Anodisc target. This utilization may lead a new method for target preparations, simple procedures and high yields for depositing source materials.

References

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3) Sikkeland T., Maly J., Lebeck D., Phys. Rev. **169** (1968)1000.

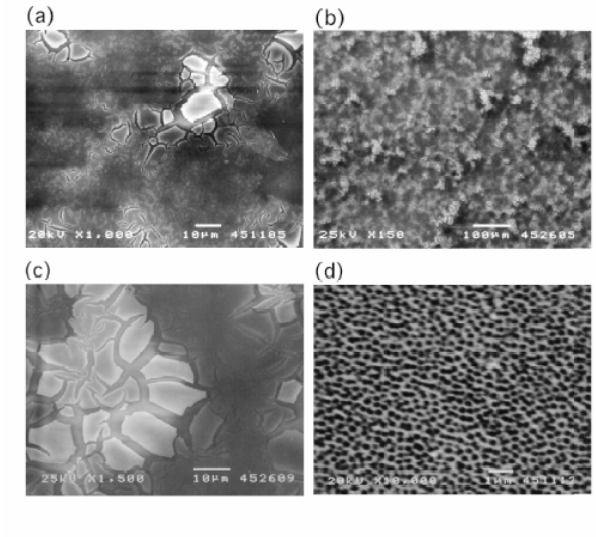

Fig. 1. SEM images; (a) for the Anodisc deposited ^{238}U before use, (b)-1(d) for the different magnification ratios, 100 μm for 1(b), 10 μm for 1(c) and 1 μm for 1(d) (the reverse side).

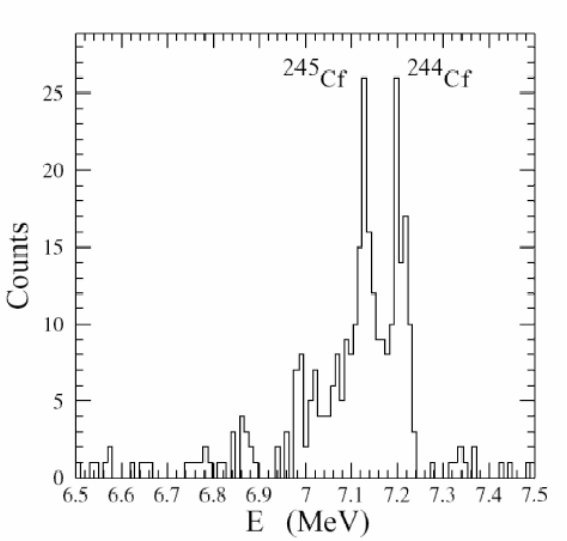

Fig. 2. The α-ray spectrum of ^{245}Cf and ^{244}Cf produced by the ^{238}U(^{12}C,5n) and ^{238}U(^{12}C,6n) reactions.