Current status of RI beam production at electron-beam-driven RI separator for SCRIT (ERIS)

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ERIS (electron-beam-driven RI separator for SCRIT [1)]) consists of an RI generator, a FEBIAD-type ion source, and an RI separator. The photofission of uranium driven by an electron beam is used for RI production in ERIS. Details of ERIS were reported in Ref. 2. During the present year, we improved the release efficiency including the efficiency of release from the production target and that of transport from the target to the ionization chamber. In this paper, we report improvements and the present status of ERIS.

One of the improvements is the stable supply of a 1-mm uranium carbide target disk. Using a 1-mm target disk, the efficiency of release from the production target is expected to increase, because the total surface area of target disks becomes larger than in the case of 2-mm target disks used in the previous test[3)]. Uranium carbide is obtained by the carbothermal reduction of uranium oxide in presence of carbon. Details of constructing the target were presented in Ref. 3. In order to construct a thin disk, the careful selection of the graphite grain size is required for the process of constructing a disk from graphite powder. Furthermore, the uranium-oxide-coated graphite powder is also needed to construct a disk without a binder. These requirements are aimed at reducing the vacancy inside the disk and the crack at the edge of the disk. The obtained disk was approximately 1 mm in a thickness and 18 mm in a diameter. In total, 23 disks were prepared. The total amount of uranium was about 15 g, and the average mass concentration of uranium in the disk was estimated as 3.4 g/cm^3.

Another improvement involved strengthening the heat shield. In particluar, the heat shield of the transfer tube located between the target and the ionization chamber was increased in order to ensure no cold spots were present.

After these improvements, the uranium-carbide disks were irradiated with an electron beam accelerated to 150 MeV. The electron beam power was nearly 10 W. Tantalum disks with a thickness of 5 mm and a diameter of 20 mm were inserted in front of the production target to increase the production of γ rays. The temperature of the target and the transfer tube was approximately 2000 °C. The produced RIs were accelerated to 20 kV and mass-separated by the analyzing magnet. They were identified by the measurement of γ rays corresponding to the decay of the RIs using a Ge detector.

Figure 1 shows the rate of Sn and Xe isotopes at the Ge detector. These rates are estimated from the observed γ-ray yield using the efficiency of the Ge detector and the half-life of each isotope. The overall efficiency is the ratio of the observed rate to the expected production rate inside the target. This efficiency includes the efficiency of release from the target, ionization in the ion source, and efficiency of transport from the ion source to the detector. The overall efficiency of stable xenon with a calibrated gas flow was also measured during the experiment. Because stable xenon was introduced into the ionization chamber through a gas inlet, the measured overall efficiency of stable xenon includes only ionization and transport efficiencies. In the case of tin isotopes, the same ionization and transport efficiency as those of xenon can be used, which is supported by the results at ALTO[4)]. As a result, the release efficiency of xenon and tin isotopes can be estimated. Table 1 shows the summary of rate and efficiency in the case of ^{137}Xe and ^{132}Sn. Compared with the previous results[3)], the release efficiencies of ^{137}Xe and ^{132}Sn become almost nine and six times larger, respectively. Furthermore, the overall efficiency of ^{132}Sn at ERIS is achieved at same level as ALTO[4)]. Further studies are in progress in order to realize the electron elastic scattering experiment with RI.

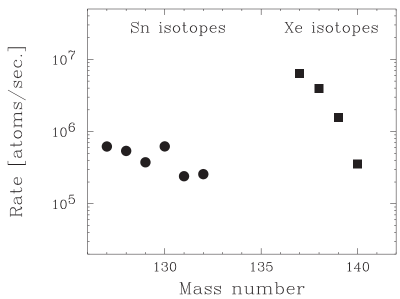

Fig. 1. Rate of Sn and Xe isotopes at the particle identification detector at ERIS. The electron beam power was almost 10 W. Total amount of uranium is 15g.

Table 1. Summary of rate and efficiency with 10-W beam

	^{137}Xe	^{132}Sn
Observed rate (atoms/s)	6.4×10^6	2.6×10^5
Expected rate (atoms/s)	7.5×10^7	1.3×10^7
Overall efficiency	8.4%	2.1%
Overall efficiency of stable xenon	14%	15%
Release efficiency	61%	14%

References
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