A New Large RF Carpet Electrode System for RFIGISOL

著者	Miyashita Y., Hoshino S., Ishida T., Nagano T., Ouchi H., Ohguma M., Suzuki T., Sato N., Shimada K., Tateoka M., Ukai M., Wakui T., Yamashita W., Yamazaki A., Shinozuka T.
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Miyashita Y.[1], Hoshino S.[1], Ishida T.[2], Nagano T.[1], Ouchi H.[1], Ohguma M.[1], Suzuki T.[1], Sato N.[1], Shimada K.[2], Tateoka M.[1],Ukai M.[2], Wakui T.[2], Yamashita W.[1], Yamazaki A.[2] and Shinozuka T.[2]

[1]Department of Physics, Tohoku University
[2]Cyclotron and Radioisotope center, Tohoku University

The astrophysical r-process plays an important role for explaining the mechanism of the nuclear synthesis. The systematic studies of masses, lifetimes and neutron emission rates of neutron rich nuclei are necessary for astrophysical calculations concerning the r-process scenario. It is difficult to obtain fundamental properties of neutron rich nuclei around the r-process scenario because of shorter half-lives and smaller production cross sections. One of the techniques to obtain such neutron rich nuclei is radio frequency ion guide isotope separator on-line (RFIGISOL) technique.

The neutron rich nuclei are produced by proton induced fission reactions in an RFIGISOL chamber. The produced nuclei are thermalized with He buffer gas in the large volume gas cell of the chamber. Then the thermalized nuclei are speedily guided to the mass separator by the DC and RF electric fields.

The key point of this system is sophisticate electrode configurations for electric field guiding in the gas cell[1,2]. The DC and RF electrodes comprise the 80 ring electrodes on the cylindrical wall of gas cell (cylindrical electrode) and the 364 concentric ring electrodes around the exit hole of the gas cell (RF carpet electrode). Both are made of the flexible printed circuit boards of 50 μm Kapton, shown in Fig. 1 and Fig. 2. The cylindrical electrode is 320 mm long and 220 mm in diameter. A diameter of the RF carpet electrode is 220 mm and an exit hole of 1.2 mm diameter for extraction is bored at the center of the RF carpet electrode.

Using the RFIGISOL system, $^{112}Rh^{1+}$ ions ($T_{1/2}$ = 6.8 sec. for the high spin state and $T_{1/2}$ = 3.8 sec. for the 1+ state) are extracted and mass-separated as test ions of

short-lived nuclei. Figure 3 shows the mass-separated yield of ^{112}Rh as function of applied RF voltage. It is pointed that no RF electric field makes any yield. The mass-separated yield is increasing in accordance with the applied RF voltage. Higher RF voltages are required to obtain higher mass-separated yields. As test experiments, we have obtained mass-separated $^{112}Rh^{1+}$ ions of ~ 4000 /sec at 1 μA incident proton beam. Neutron rich nuclei for the systematic studies of masses, lifetimes and neutron emission rates are now available using RFIGISOL system.

References

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2) Miyashita Y., et al., Proceedings of the 15th International Conference on Electromagnetic Isotope Separators and Techniques Related to their Applications, Deauville, 2007.

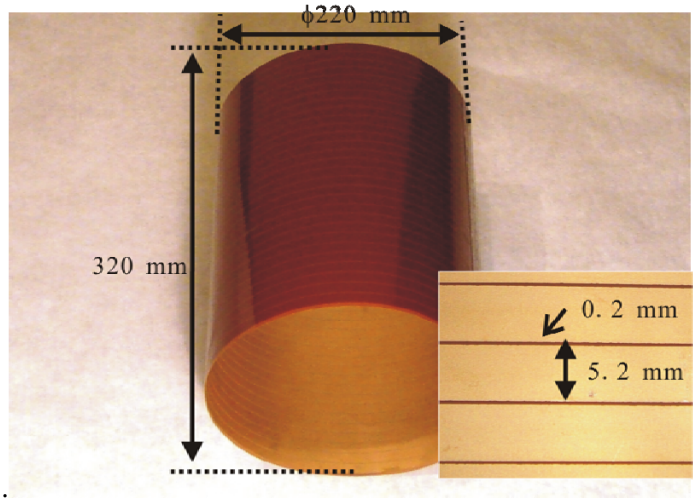

Figure 1. Cylindrical electrodes made of a flexible printed circuit board.

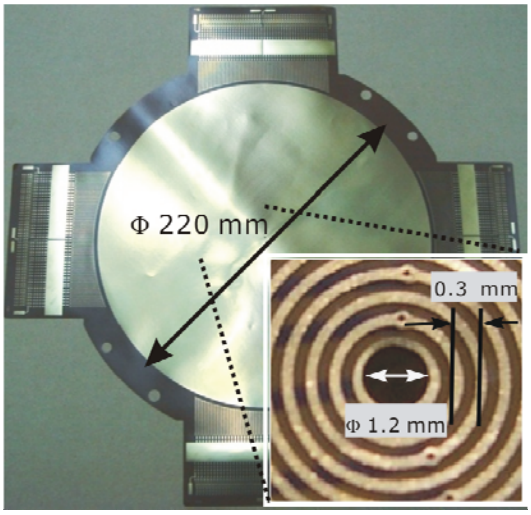

Figure 2. RF carpet electrodes made of a flexible printed circuit board.

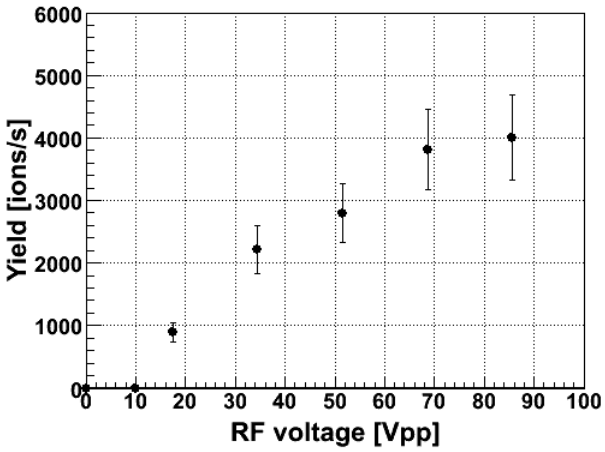

Figure 3. Mass-separated yields of 112Rh as function of applied RF voltage.