Present status of ERIS at the SCRIT electron scattering facility

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The electron-beam-driven RI separator for SCRIT (ERIS)[1)] at the SCRIT electron scattering facility[2)] is an online isotope separator system used to produce low-energy RI beams for electron scattering experiments of unstable nuclei. Recently, we developed ion-stacking and pulse-extraction systems to improve the DC-to-pulse conversion efficiency using an RFQ cooler buncher named FRAC (fringing-RF-field activated DC-to-pulse converter).[3)] The results were reported in Ref. 4). In the present year, we have adopted the ion-stacking and pulse-extraction systems to the surface-ionization ion source to extend the variety of ion beams. In this paper, we report the results and present the status of ERIS.

Figure 1 shows the schematic of the surface-ionization ion source at ERIS and its electrical potential. The ionization chamber is made of tantalum, which is 25 mm long, contains a hole with a diameter of 1.5 mm, and has inner and outer diameters of 7 and 9 mm, respectively. The exit grid contains a hole with a diameter of 3 mm which is attached to a meshed electrode, and it is 3 mm away from the exit hole of the ionization chamber to avoid thermal deformation. Most of the neutral atoms remain inside the ionization chamber and transfer tube, except those that escape through the small exit hole. The neutral atoms are ionized at the inner wall of the ionization chamber. A large electric current is applied to the ionization chamber through the transfer tube and the inner wall is heated to 1000–2000°C.

The commissioning test was performed using a ^{133}Cs ion beam of 10 keV. The voltage of the exit grid at the stacking and extraction were 10 and −60 V, respectively. An electric current of 120 A was applied to the ionization chamber. The extracted ions were transported to FRAC and measured by the monitoring system.[5)] Figure 2(a) shows the pulse shape with a stacking time of 10 ms. The extraction period was set to 2 ms to measure the pulse shape. With a stacking time of 10 ms, the pulse height was roughly 34 times of that with a continuous beam. The stacking time dependence of stacking ratio is shown Fig. 2(b). The stacking ratio is the ratio of the charge calculated by subtracting the contribution of the continuous beam from the total charge within a extracted pulse width to the total charge obtained by integrating the continuous beam over the stacking time. A stacking ratio of almost 0.9 was obtained at a stacking of 10 ms. In comparison to previous results[4)] (approximately 0.2 with a 10 ms stacking), the obtained stacking ratio is much larger. We reason that the number of neutral atoms escaped from the ionizaiton chamber during the staking time is small owing to the high ionization efficiency.

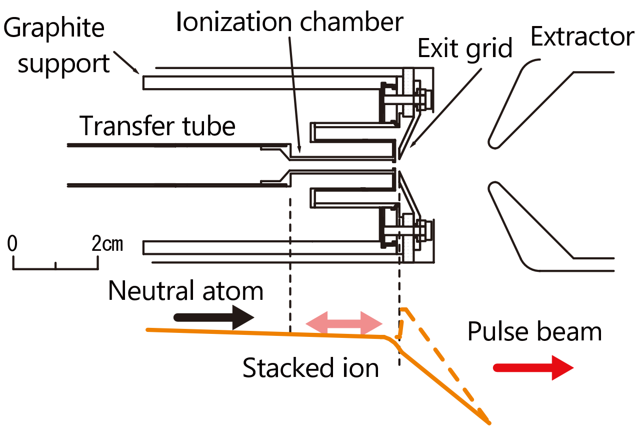

Fig. 1. Schematic of the surface-ionization ion source at ERIS and the electrical potential.

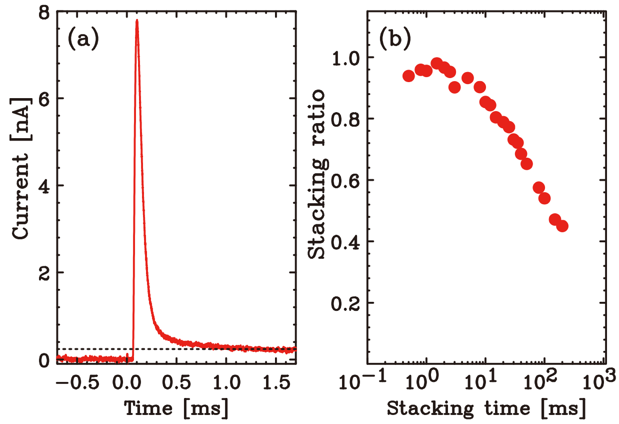

Fig. 2. (a) Pulse shape after 10-ms of stacking; the dotted line shows the current of the continuous beam. (b) Stacking-time dependence of stacking ratio.

The DC-to-pulse conversion efficiency of FRAC was measured and it exceeded 50% with a longer stacking time of approximately 50 ms. This longer stacking time was enough to cool the ions with a relatively small amount of buffer gas ($\sim 10^{-3}$ Pa)inside FRAC. This operation condition is needed to connect with the SCRIT device installed inside the electron storage ring. The results at FRAC were reported in Ref. 6).

More detailed study and improvement of the ion stacking inside ERIS is in progress.

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