Second report on offline tests for RF carpet transportation in RF ion guide gas cell at the SLOWRI facility

S. Iimura,[*1,*2,*3] A. Takamine,[*1] M. Rosenbusch,[*3] M. Wada,[*3] S. Chen,[*4] J. Liu,[*4] P. Schury,[*3] T. Sonoda,[*1] T. M. Kojima,[*1] Y. X. Watanabe,[*3] A. Odahara,[*2] and H. Ishiyama[*1]

We are developing a radio frequency carpet (RFCP) -type ion guide[1)] gas catcher cell (RFGC) at the SLOWRI facility. In the previous version,[2)] we could achieve a transport efficiency of ∼60% only in 133 mbar helium gas on the first carpet from offline measurements. In these developments, to improve the transport efficiency, we changed the carpet pitch (the distance between the center of neighboring RF electrodes) from 0.32 mm to 0.25 mm.

In our offline measurements, we evaluated the transport efficiency of the RFGC using a surface ionization Cs ion source placed at the inner wall of the gas cell. Firstly, we measured the ion reaching onto the 1st RFCP by using it as a Faraday cup. Subsequently, we used the 2nd RFCP as a Faraday cup to measure ions transported by the 1st RFCP after applying appropriate RF and DC fields. The efficiency was defined by the current measured at the 2nd RFCP divided by that measured at the 1st RFCP.

Figure 1 shows the result of the obtained transport efficiency as a function of the RF voltages applied to the 1st RFCP in three different helium gas pressures. The transport efficiency reached ∼80% at each pressure, which is ∼1.3 times greater than in the previous measurements.[2)]

In an online experiment, the total extraction efficiency is determined by the product of stopping, ion survival,

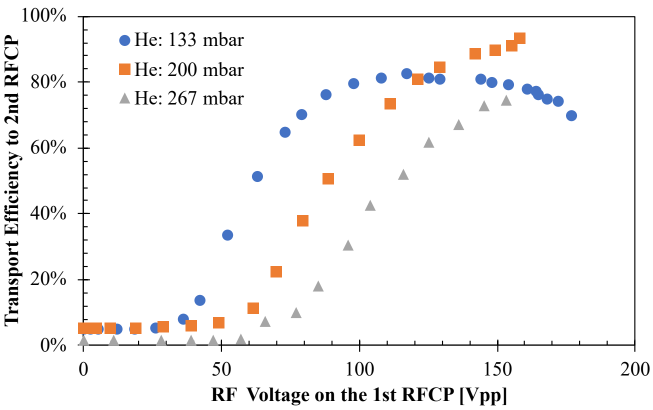

Fig. 1. 1st RFCP transportation test results in three different helium gas pressures: 133 mbar, 200 mbar, and 267 mbar. In this test, the drag dc field on the 1st RFCP, the extraction DC field between the 1st and 2nd RFCPs, and each RF frequency were 4 V/cm, 20 V/cm, and ∼5 MHz, respectively.

*1 RIKEN Nishina Center
*2 Department of Physics, Osaka University
*3 Wako Nuclear Science Center (WNSC), IPNS, KEK
*4 Department of Physics, The University of Hong Kong

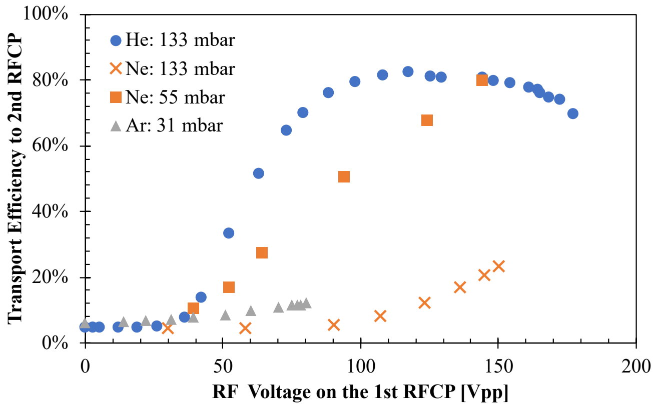

Fig. 2. 1st RFCP transportation test results for three kinds of gases: helium, neon, and argon. The DC fields condition and RF frequency were the same as in the previous tests.

and transport efficiencies. In order to enable more efficient stopping, heavier species of buffer gas have been investigated. Figure 2 shows the result of the measured transport efficiency for three kinds of buffer gases. The gas pressures of neon (55 mbar) and argon (31 mbar) were adjusted so that the beam would be stopped with the same efficiency as that achieved for 133 mbar of helium. It was found that helium (133 mbar) and neon (55 mbar) gases gave comparable transport efficiencies. On the other hand, with a higher pressure for neon, *i.e.*, equal to the helium pressure, the transport in neon gas was observed to be four times less efficient. In addition to these results, considering that the ion survival probability in helium is 1.3 times higher than that in neon, as shown previously,[3)] the total efficiency in helium gas may be the best performance.

We will keep testing the RFCP to search for the optimum conditions, especially for the parameters of the 2nd RFCP. Furthermore, the ion-guide system to be placed behind the 2nd RFCP is under assembly; it consists of a quadrupole ion beam guide and an ion trapping system. After that, we can provide a low-energy RI beam to a multi-reflection time-of-flight mass spectrograph (MRTOF-MS), which is under preparation. We plan to start online commissioning of the RFGC and the MRTOF-MS in spring FY2020 at the downstream of the ZeroDegree Spectrometer.

References

1) M. Wada *et al.*, Nucl. Instrum. Methods Phys. Res. B **204**, 570 (2003).
2) A. Takamine *et al.*, RIKEN Accel. Prog. Rep. **52**, 139 (2019).
3) P. Dendooven *et al.*, Nucl. Instrum. Methods Phys. Res. A **558**, 580 (2006).