Improved beryllium disk stripper for uranium acceleration at RIKEN RIBF

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In 2012, we first attempted to use a rotating beryllium (Be) disk with 0.1 mm thick as the second charge stripper for uranium (U) acceleration[1]. The Be stripper was successfully provided stable high-intensity U beam (several electric μA on average) during a beam time of 37 days using a single disk with no exchange. The lifetime of the stripper was extended drastically compared to before. The total number of U particles irradiated on one foil/disk increased from 7.12×10^{15} (carbon foil in 2011) to 1.18×10^{18} (Be disk in 2012). A remaining problem was improvement of the thickness uniformity for improving the transmission efficiencies of the subsequent cyclotron IRC and SRC. In addition, the Be disk with a slightly thinner thickness of 0.085 mm was found to be better to match the injection energy of the IRC.

A thinner Be disk, with a thickness of 0.085 mm, was fabricated by Pascal Co., Ltd.[2], who proposed a special machining method. They reduced the Be disk thickness of 0.15 mm to the desired thickness of 0.085 mm by only diamond-polishing both sides of the disk; diamond polishing was used because in the previous study, we had found that the standard buff finish process made thickness uniformity worse.

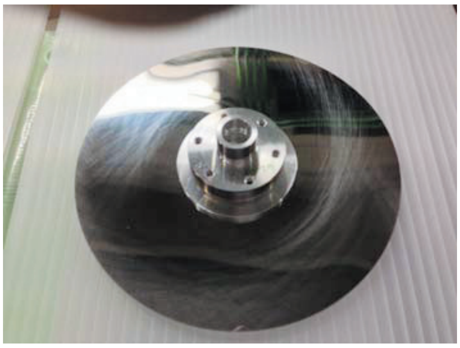

Fig. 1. Polished new Be disk.

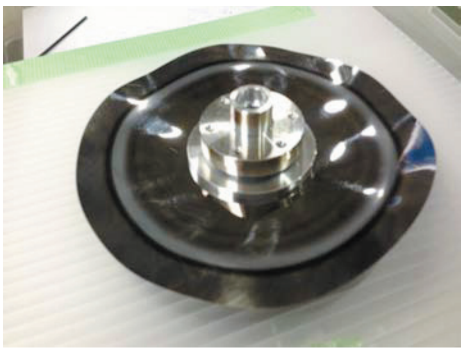

Fig.2. Slightly deformed Be disk after irradiation.

The polished new Be disk was used for a beam time from April to May 2013. The outer diameter of the disk was 120 mm, and the thickness was 0.085 mm, with a tolerance of ± 0.005 mm. The arithmetic average roughness (Ra) was less than 0.01 μm. A U^{64+} beam at 50 MeV/nucleon was irradiated on the Be disk, which rotated at 1000 rpm. Figure 1 shows the polished new Be disk before installation. Figure 2 shows a photograph of the disk after the beam time. As in the previous beam time, the outer circumference of the beam-irradiated part (black band in Fig. 2) was deformed when the irradiated U beam intensity was increased to several electric μA. However, unlike the last beam time, no cracks were observed.

The improvement in the thickness uniformity is shown in figure 3[3]. The figure shows the beam intensity trends as monitored by Phase Probe (PP)-G01 (G01: downstream of SRC). The vertical and horizontal axes indicate the beam intensity and scan time, respectively. Signals stay at "beam-on level" in the figure if beams are provided from the SRC, whereas signals drop to the bottom "beam-off level" if no beam is available. The upper and lower parts are the trends measured in November 2012 and May 2013, respectively. The red square parts denote a single rotation period of the Be disk (60 ms). Availability of the U beams was improved from 90.7% to 98.8%. A total of 9.29×10^{17} U particles were irradiated on the Be disk over 30 days. It has been shown that the polished new Be disk is now ready for practical use.

Fig. 3. Signals of phase probe monitor (PP-G01). Vertical axis: beam intensity. Horizontal: scan time.

References

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