Improved-flatness beryllium disk stripper for uranium acceleration at RIKEN RIBF

H. Hasebe,[*1] H. Okuno,[*1] H. Kuboki,[*1] H. Imao,[*1] N. Fukunishi,[*1] M. Kase,[*1] and O. Kamigaito[*1]

We have successfully provided a stable uranium beam during long-term operation in November 2012 (totally 1.18 $\times 10^{18}$ particles in 37 days) using a rotating beryllium disk stripper with a thickness of 0.1 mm as the second stripper. The number of irradiating particles and disk conditions are summarized in Table 1 along with those of other disks described below. This first used Be disk is denoted as Disk 1 in the Table. However, emittance growth due to the nonflatness of the disk exceeded the accepted levels for subsequent cyclotrons (IRC, SRC)[1)].

To realize flatter disks, we prepared a Be disk subjected to diamond polishing (Disk 2) in March 2013[2)]. Also, disk thickness was reduced from 0.1 mm to 0.085 mm, which was suited for the IRC injection energy. Therefore, transmission efficiencies of the IRC and SRC were improved. The Be disk was still usable even after the totally 9.29 $\times 10^{17}$ U-particle irradiation during the 30-day beam time operation[3)].

Disk 2 was used again for the U beam time in March 2014. The lifetime of this disk ended and was determined to be additional 21 days (Fig. 1: Right). The total number of U beam particles was 1.68 $\times 10^{18}$ during 51 days (including 30 days in 2013) as written in Table 1. Many cracks were observed along the beam irradiation traces.

The Be disk was replaced with a new one (Disk 3), which was identical to Disk 2 (0.085-mm-thick, diamond polished), for the remaining beam time. Irradiation with an additional 8.83 $\times 10^{17}$ U particles was carried out in 17 days. Beam transmission efficiency was improved, but since the thermal load to the disk was increased from 90 W to 230 W because of the increased beam intensity, the disk was greatly deformed. The difference in the deformation is shown in Fig. 1 (Right: Disk 2, Left: Disk 3).

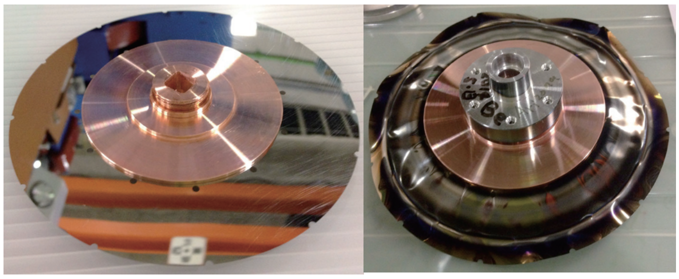
Fig. 1. Polished Be disks after irradiation (Right: Disk 2, Left: Disk 3).

*1 RIKEN Nishina Center

Table 1. Summary of four Be disk used.

	Irradiation current Total beam particle	Days	State
Be Disk 1 Not polish 0.1-mm thick	4 - 5 eμA 1.18×10^{18}	37	Many cracks Still usable Slight beam fluctuation
Be Disk 2 Diamond polish 0.085-mm thick	4 - 12 eμA 1.68×10^{18}	51 (30+21)	Distortion and Many cracks Not usable Slight beam fluctuation
Be Disk 3 Diamond polish 0.085-mm thick	12 eμA 8.83×10^{17}	17	Distortion, Slightly cracked Still usable No beam fluctuation
Be Disk 4 Diamond polish 0.085-mm thick Φ110mm Special processing	8 eμA 9×10^{17}	20	Slightly Distorted No crack Still usable No beam fluctuation

In October 2014, we introduced the Be disk with a special design[2)] (Disk 4) to reduce the thermal deformation. Due to this improvement, this Be disk survived after the U beam time with approximately 9 $\times 10^{17}$ U-particle irradiation·in 20 days. Main changes were as follows: 1) The outer diameter of the disk was 110 mm (from 120 mm), 2) 12 areas with cuts existed around the disk circumference, 3) the disk holder was made of copper (from aluminum) with an outer diameter of 65 mm, and 4) 12 holes with 2-mm diameter existed around the holder. Beam availability was further improved by the suppression of the beam fluctuation. The conditions of U beam irradiation are listed in Table 1 (Disk4). This Be disk is still usable and exhibits no problem. Figure 2 shows the special-design Be disk: (left) new and (right) after usage.



(a) (b)

Fig. 2. (a) New specially designed Be disk and (b) after irradiation. Deformation was moderated.

References

1) H. Hasebe et al., RIKEN Accel. Prog. Rep. **46**, 133 (2013).
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URL: http://www.pascal-co-ltd.co.jp/home.html
3) H. Hasebe et al., RIKEN Accel. Prog. Rep. **47**, 144 (2014).