The beam extraction of ion source with curved electrodes shape

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1. Introduction

A various ion sources are widely used for many industrial applications such as: space application, neutral beam injection, material surface modification etc. But, in comparison with other surface treatment technology, ion beam technology is a high cost process and consists of more complicated design and devices. Also small beam area make costs for treatment higher than those associated with other methods and this has limited many industrial applications for mass production.

We studied fundamental beam extraction experiments to make broad beam with modification of electrodes grid shape from flat type to curved type in the previously.

In this article, we describe extracted ion beam shape and size adding hole as well as changing hole diameter in the center of electrodes. And, we identified beam profile before and after modification of extraction grid system (cathode, Acceleration and deceleration grid) with measurement of faraday cup.

2. Methods and Results

2.1 DuoPIGatron Ion Source and Performance

The discharge chamber of DuoPIGatron ion source is based on the principle as the Kaufman ion source and ion source is consist of three extraction electrodes such as cathode, acceleration and deceleration electrodes. We modified electrodes shape to make broad beam from flat to curved type as mentioned above. It is explained a difference of beam size and shape between flat type and curved type electrodes in the previous study. 1 And a curved shape electrodes lean at an angle of 10 degree as shown in the Fig. 1.

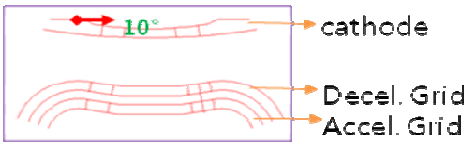


Fig. 1. The angle of curved type electrodes

In this experiments, the source operated over the energy and current ranges from 30~50keV and 20~50mA, respectively, with extraction system and we measured beam profiles at a target location 73cm downstream of the source. And we measured beam profiles by modifying electrodes hole size as well as electrodes shape. The Fig. 2 shows experiment order by changing hole size. At the first step, we fabricated electrodes with 4 hole (8Φ) at the side and we added hole (5Φ) in the center at the 2nd step and we change the hole size (6.5Φ) at the last step.

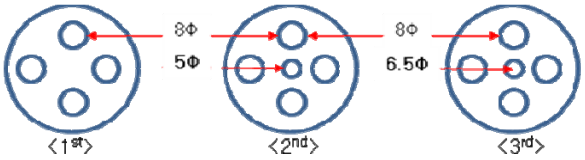


Fig. 2. The concepts of electrodes grid system

2.2 The measurement of beam profile

In the 1st experiment, we measured beam profile of flat electrodes and curved electrodes: 4hole with 8Φ diameter as shown Fig. 3. It is shown that the ion beam was diverged due to electrodes shape and angle compared to flat electrodes. At first, we expected that the extracted beam through the hole will be overlapped each other in the center but the result was not as shown Fig. 3. These problems are anticipated as follows: plasma density was not equal at the center-and-side and electrodes shape and angle.

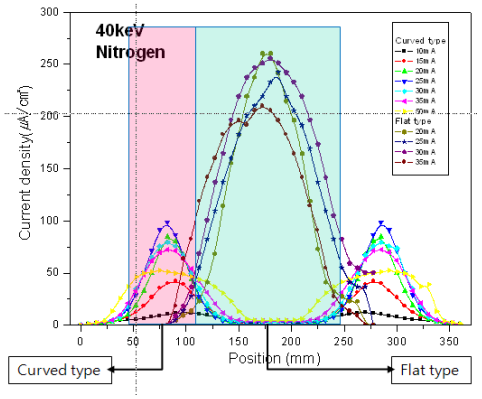


Fig. 3. The Beam profiles for curved and flat type electrodes (1st experiment)

In the 2nd experiment, we added diameter 5Φ hole so that the beam could be extracted at the center. The results measuring with faraday cup are shown Fig. 4. We identified that the beam was extracted at the center and beam current density was increased with increasing extraction current also. The distance gap which is

detected between side parts and center part is anticipated the plasma density and electrodes shape as mentioned above.

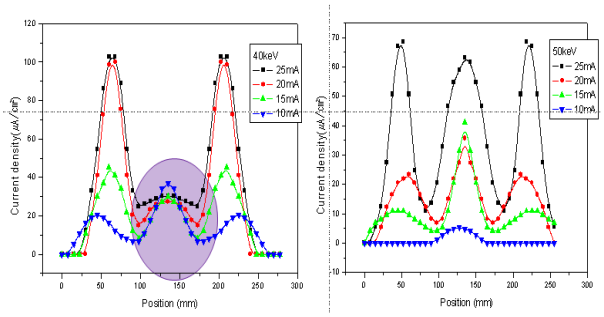


Fig. 4. The Beam profiles for curved type electrodes (2nd experiment)

In the 3rd experiment, we change center hole size from 5Φ to 6Φ diameter to reduce the gap. The results are shown in Fig. 5. The uniformity of ion beam current densities is broad with increasing beam current as well as gap was more reduced than 2nd experiment.

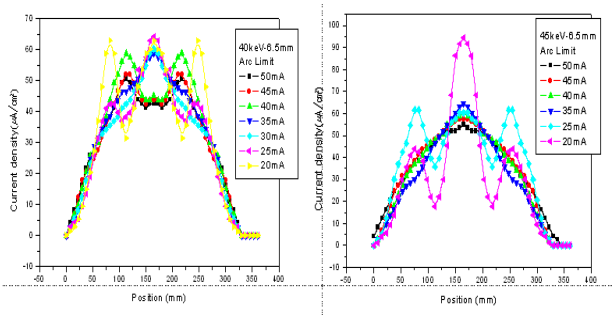
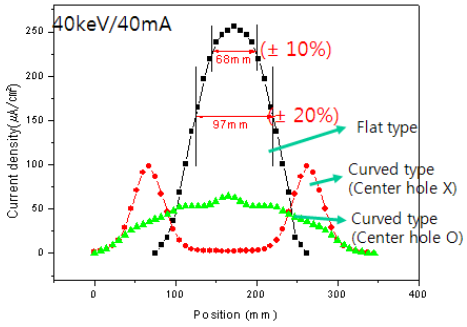


Fig. 5. The Beam profiles for curved type electrodes (3rd experiment)

The Fig. 6 is shown the three beam profiles, one is under flat type, another is under curved type with no center hole and the other is under curved type with center hole. The current density of curved type electrodes is low compared to flat type but beam area is broader. In addition to, from a uniformity perspective, beam profile of curved type has 130mm and 200mm in diameter beam area under ±10% uniformity, respectively. Whereas, beam profile of flat type has 68mm and 97mm beam area.



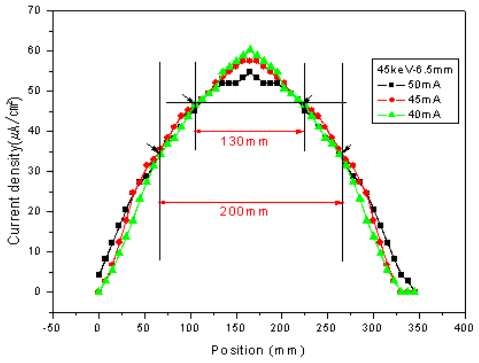


Fig. 6. The beam profile before and after modifying electrodes.

3. Conclusions

We designed and fabricated new type electrodes system which is modified with curved type to meet mass production using broad beam. We measured beam profiles by modifying electrodes hole size as well as electrodes shape through three experiments. From a uniformity perspective, beam profile of curved type has 130mm and 200mm in diameter beam area under ±10% uniformity, respectively. This indicated 206% increase compare to flat type electrodes under 20% uniformity.

4. Acknowledgement

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REFERENCES

[1] C. Y. Lee and J. S. Lee, Transactions of the Korean Nuclear Society Autumn Meeting , 2010