The improvement of ion beam uniformity of 300mm bucket type ion source for in-line etching process

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1. Introduction

Ion beam etching process is possible to remove oxide layer of steel surface for improvement of adhesion. To apply to in-line etching process of the steel industry, it is required high etching rate and over 1000 mm of extraction ion beam size. So we developed prototype bucket ion sources for the high rate etching and the increase in ion source life time for in-line type mass production. And we are developed the bucket type Ion source of 300mm ion beam width for large area etching. For large-area ion source, the control of the uniformity of the ion beam is very important. Detailed experimental results will be presented.

2. Methods and Results

2.1 High Current Bucket Type Ion Source for 300mm Ion Beam Width

We are already developed proto type Bucket ion source and Bucket type ion Source for 300mm ion beam width in Fig. 1 [1]. The specification of the developing bucket ion source are designed which amount of hole is 102ea, beam current per extraction hole is 2.74mA, maximum current is 637.5mA at 20kV (theoretically).

Fig. 1 is the schematic diagram and extraction ion beam shape of the prototype ion source and 300mm Bucket type ion source. The beam size of prototype ion source is about 125mm at the maximum and FWHM (full width at half maximum) is about 85mm. The beam size of 300mm Bucket type ion source is about 400mm maximum and about 255mm approximately FWHM.

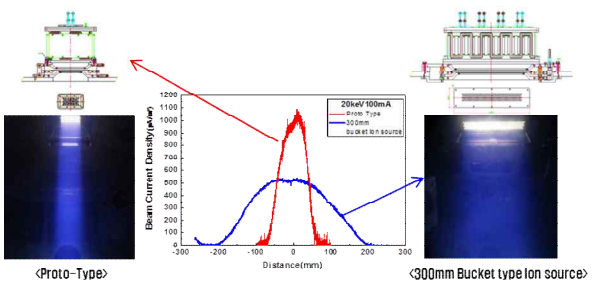

Fig. 1. Proto-type and High Current Bucket Type Ion Source for 300mm ion beam width

2.2 Ion Beam Extraction Control

The prototype ion source was composed of the one filament for ion beam width direction and two filaments for steel plates moving direction. But in the case of 300mm bucket type ion source, it was composed of four filaments for the direction of the ion beam width and two filaments for steel plates moving direction. (Fig. 2) Therefore, it was tested by configuring with 4set filaments as shown in Fig. 2 in order to evaluate the uniformity of the beam width direction and control.

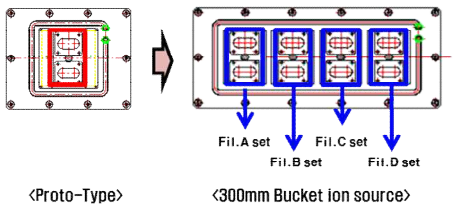

Fig. 2. Filament arrangements of 300mm Bucket Type Ion Source

Generally, we have to control the beam current of the filament. Fil. B set and Fil. C set for each power supply is connected to the same electric current was applied to the extraction was 20keV 120mA. A result of measuring the ion beam profile, as shown in Figure 3, the blue line beam profile biased to one side. In the case of the 300mm Bucket type ion source, a filament which is composed of 8 ea. Because wear behavior of 8 filaments are different, the filament electric resistance is different each other. Therefore, a uniform power supply to the filament to the power supply capacity is constant, as a result of the red line beam profile as shown in Fig 3, uniform beam could be obtained. Table 1 is the power information of the beam that is actually applied. In the case of a large-area ion source of 1000mm or more, the filaments are expected to more than 30ea, and whether the power supply of the filaments uniform for uniform beam extraction is one of the most important factors.

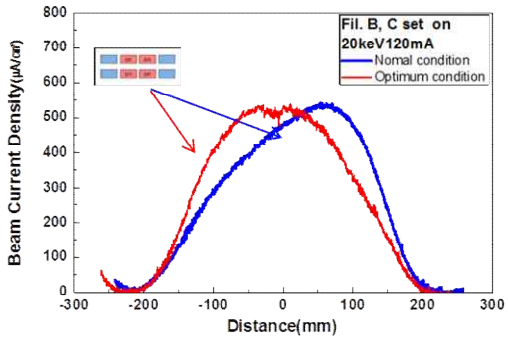

Fig. 3. Ion beam profile by filament power control

Table I: Filament power condition for optimum condition

	Filament Set	Voltage (V)	Current (A)	Power (W)
Normal Condition	Fil. B	8.3	118	979
	Fil. C	9.3	118	1097
Optimum Condition	Fil. B	8.7	121	1052
	Fil. C	9.1	115	1046

2.3 Optimum Wide Ion Beam Extraction

Connect the power supply, which is prepared (B, C set) the two sets of filaments 4set for uniform beam extraction of 300mm Bucket type ion source, when connected to a different power source (A, D set) two sets both ends, I was carried out extraction beam of 20keV 150mA. (Figure 4) The blue line graph is the result of applying the power supply (B, C set) only two pairs of. As a result of optimized by controlling two power supply of filaments 4set, it was possible central portion obtain a flat uniform beam profile as a red line graph. For 300mm bucket type ion source was produced, the uniformity of the beam width of 300mm is about 55%, and uniform beam width of 90% or more is a beam width 200mm about the 300mm bucket type ion source. Thus, if a uniform beam 300mm (90% or more) is required, it is necessary electrode design over 400mm.

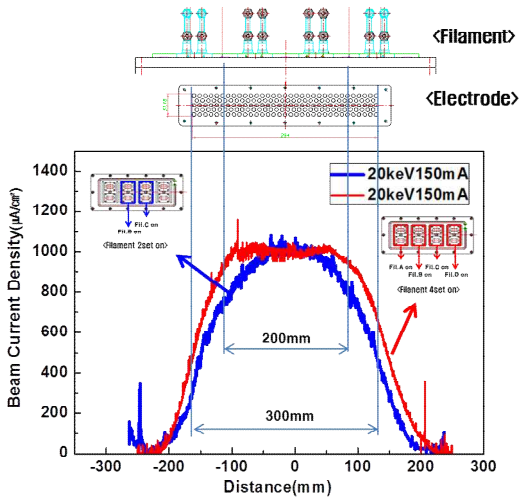

Fig. 4. Beam extraction shape

Fig. 5 is shown the result of the extraction beam to 20keV 200mA to confirm the beam profile according to the current at the optimum process conditions. Extraction beam current increases to 200mA from 100mA, beam current density is increased, but there was little change in the order of 200mm section of a uniform beam width. We are currently studying the wide uniform ion beam extraction condition of high-current beam of 300mA or more

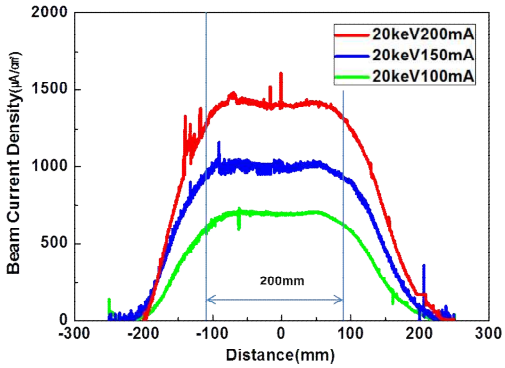

Fig. 5. Optimum ion beam profiles as extraction beam current

3. Conclusions

We successfully extracted max 400mm ion beam width using the 300mm bucket type ion source. We are studied the optimum process condition for wide beam extraction and wide rage uniformity over 200mm. 90% uniformity, it was confirmed that it is a beam width of about 200mm by evaluating the uniformity test of the beam width 300mm Bucket type ion source. Further, via the power adjustment of the filament was significantly improved uniformity of large-area beam.

ACKNOWLEDGMENTS

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