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低エネルギーイオンビーム源の電子密度および温度計測
Measurement of the electron density and temperature in a low energy ion beam source

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1. Introduction

Low energy ion beams have been used in many fields, for example, material processing, etc. However, a low energy (here, less than ~200 V) ion beam with high current density diverges soon after the extraction from a grounded electrode, due to the self electric field of extracted ions. Therefore, it is necessary to prevent the divergence of the ion beam by neutralizing the ion charge with electrons. To neutralize the ion charge, an electron beam is irradiated to the grounded electrode, and secondary electrons are emitted from this electrode to supply slow electrons. Using this method, it was realized to control the beam divergence, and to obtain the focused high current density ion beam [1]. While, a spontaneous self-focusing phenomena of the low energy ion beam around 150 eV was observed even without active electron supply [2].

To understand above described self focusing phenomenon, the electron density and temperature profiles in an ion beam propagation chamber using an electrostatic probe have been measured [3]. In this study, the spatial distribution of the electron density and temperature in the ion source chamber has been measured using an electrostatic probe. Especially, those profiles before and after the transition to a self focusing state are measured.

2. Experimental setup

Fig. 1 shows the low energy ion beam system and a probe configuration. It consists of an ion source, ion beam propagation chamber and measurement apparatuses. The ion source is a bucket type with cusped magnetic fields. Extraction electrodes consist of an acceleration electrode, a deceleration electrode and a grounded electrode. These electrodes have many aperture (1.5 mmφ) and 1mm thickness. Transparency of each electrode is 50 %. In addition, these electrodes have a concave shape [4].

A double probe is prepared to measure an electron density and temperature in the ion source chamber. It composes an alumina tube (4 mmφ), four tungsten wires (0.6 mmφ each) and a corner part. The alumina tube has four holes, and tungsten wires are installed through each hole, and the length between alumina and tungsten tip is approximately 2 mm. Due to the limitation of port configuration, the probe is inserted from off axis position. Then, it is required to modify the probe shape toward the center of the ion source chamber. As shown in Fig. 1, to measure the center part of the chamber and profile, the probe shape is designed to L type. To measure three dimensional distributions of the electron density and temperature using this probe, a guiding instrument which can drive a liner motion and a rotational motion is connected to this probe. However, there are four filaments and the acceleration electrode in the ion source chamber. These prevent the movement of the probe. Therefore, it can be measured that the electron density and temperature at the cross section area indicated in Fig. 2. Along the axis direction, the probe is swept 150 mm.

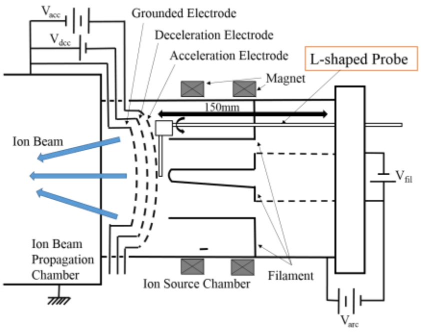

Fig. 1. A schematic drawing of an ion source chamber, electrodes, the ion beam propagation chamber, L-shaped probe and the circuit of power supplies.

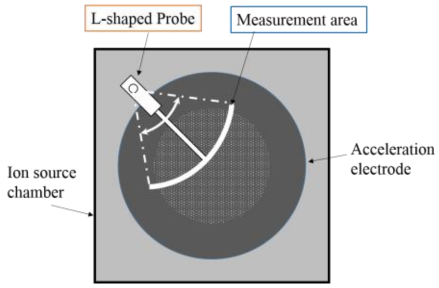

Fig. 2. A schematic drawing of the back view of the ion source chamber. The measurement area is indicated by a white line on the figure.

3. Summary

The "L-shaped" double probe was designed. Electron density and temperature profiles in the ion source chamber are measured. At the conference, initial results will be presented.

References

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