Development of a 100 MHz RF ion source test stand at KOMAC

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1. Introduction

Korea Multi-purpose Accelerator Complex (KOMAC) has several ion accelerators to provide various ion beams to users. A test stand of ion source is being developed to satisfy the needs from the users for the applications with kV range ion beam implantation. A commercial RF ion source with 100 MHz (NEC Cor.) is selected for its reliability, robustness and long-time operation without maintenance. The ion beam currents are tested and measured to check its characteristics depending on high voltage such as deck bias voltage, probe bias voltage and focusing bias voltage. In this paper, the ion source and test stand developments are described in section 2; measurement of the ion beam currents with several bias voltages in section 3, and the conclusion will be given in section 4.

2. Test stand

A quartz tube for ion source is installed in an ion source housing where is applied a high voltage up to 20 kV (ISEG Cor. EPP) as shown in figure 1, 2 and 3. A permanent magnet is installed to confine the plasma at the end of the tube. An RF power with 100 MHz is launched by RF coupler shown in figure 2 and 3. To apply bias voltages (ISEG Cor. SHQ: 2 Ch.) such as probe (0-2 kV) and focus (0-1 kV), input power (220 V, 60 Hz) is supplied through an insulation transformer as shown in figure 2. Base pressure is 8.9 x 10^{-8} Torr. Hydrogen gas is controlled by a metering valve through gas inlet as shown in figure 3, and operating pressure is 1.5 x 10^{-6} Torr. The ion source is allowed to warm-up for several hours under NEC's standard operating procedure. Various parts of the system, including a canal in the ion source canal and high power supplies is operated for long duration.

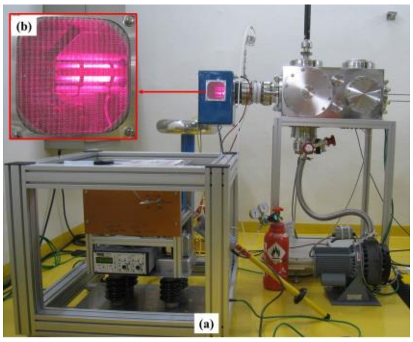


Fig. 1. (a) Test stand for RF ion source, (b) Hydrogen plasma is produced by an RF power with 100 MHz.

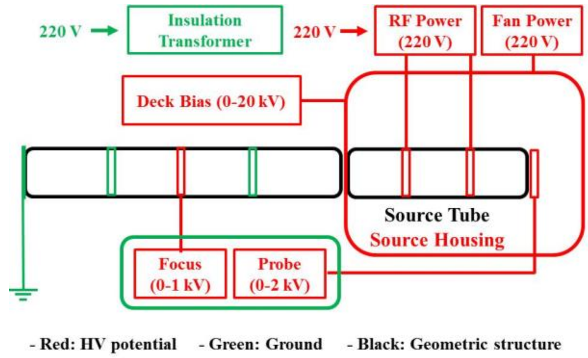


Fig. 2. Block diagram of the test stand system.

The plasma is compressed by magnetic fields at the entrance to an aluminum canal with 1 mm diameter where it is electro-statically extracted and focused to a downstream. Figure 3 shows geometric schematic with bias voltages such as deck, probe, and focus. The probe bias voltage is to drive ions out of the source by maintaining a potential difference between the extractor and probe electrode. Ion beam is focused by the Einzel lens, it is controlled by the focus bias voltage.

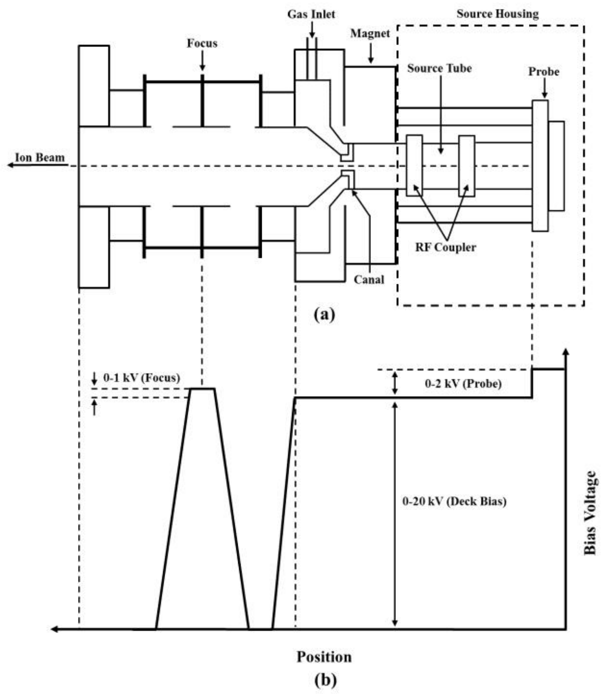


Fig. 3. (a) Schematic of the ion positive ion source, including the probe, focusing lens assembly. (b) Shown below the source is a range bias profile. The allowable ranges of values for each of the bias supplies are adjusted independently.

The ion beam conditions depend on the electrostatic optics of the entire system. For this system, bias voltages are floated on deck bias voltage (up to 20 kV); the probe bias voltage is 0-2 kV, focus bias voltage is 0-1 kV as shown in figure 3.

3. Measurement of ion beam current

In order to initially test ion beam current with bias voltages, a Faraday cup with 30 mm diameter is installed in the front side of the chamber. The ion beam currents are acquired through a low noise current amplifier (SRS: SR 570).

Figure 4 shows ion beam current with probe bias voltages depending on the deck bias voltages. The ion beam currents are increased with increasing both bias voltages. These are lead that effects of the probe bias voltage are more than deck bias voltage for extracting and/or driving ions.

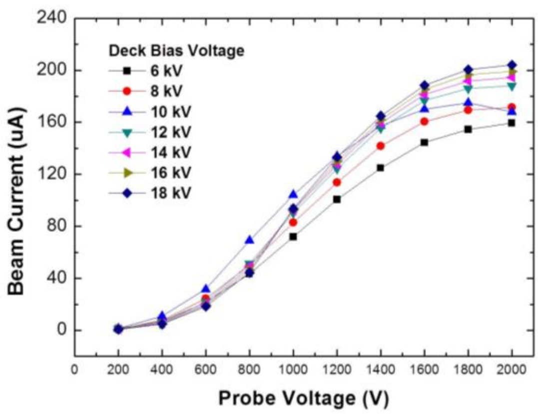
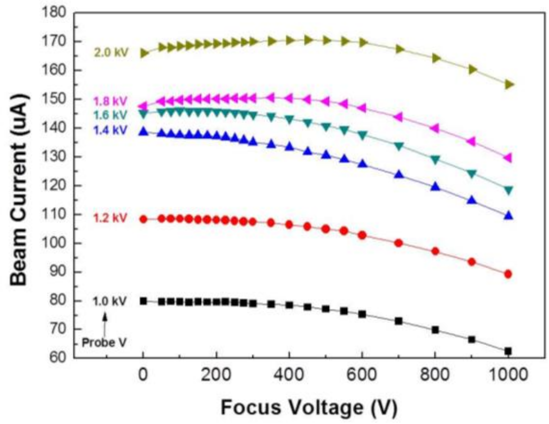


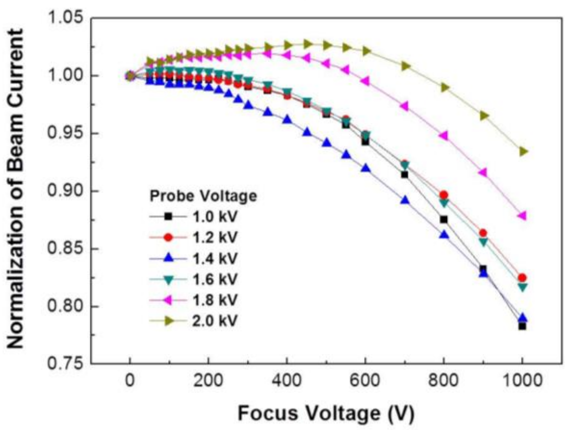
Fig. 4. shows ion beam current with increasing probe voltage depending on deck bias voltage.

Figure 5 (a) shows ion beam current with focus bias voltages depending on the probe bias voltages, when deck bias voltage is fixed at 10 kV. Starting points of the ion beam current are different due to effects of the probe bias voltage. The ion beam currents are increased up to 200 to 500 V of the focus bias voltage. And, they are decreased.

In order to simply compare and analyze, the beam currents are normalized by V_{fx}/V_{f0}; V_{fx} is ion beam current at an applied focus bias voltage, V_{f0} is ion beam current at focus bias voltage= 0 V. These results are shown in figure 5 (b). The normalization value of the ion beam current can be checked conditions of the maximum ion beam current by ratio (R) the focus bias voltage to the probe bias voltage with the deck bias voltage. The R values are range from 0.89 to 0.93 to extract and/or drive the maximum ion beam current. The R value is one when focus bias voltage is equal to probe bias voltage, and the R values are increased with increasing focus bias voltage. The extracted ion beam currents are larger than ion beam current at V_{f0} (without focus bias), when the R values are below the one. However, the R value are low such as lower than 0.9, the ion beam currents are decreased. The ions are basically extracted by the difference of the potentials in entire system. The bias effects are $V_p \gg V_d > V_f$ for extracting ion; where V_p is the probe bias voltage, V_d is the deck bias voltage, V_f is the focus bias voltage.



(a)



(b)

Fig. 5. (a) shows ion beam current with increasing focus voltage depending on probe voltage. (b) shows normalization of the ion beam current.

4. Conclusions

A 100 MHz RF ion source has being installed and tested with bias voltages to check its characteristics. The ions are basically extracted by the potential differences in the entire system. Therefore, ion beam extraction conditions are affected by probe, deck and focus bias voltage. We check the bias effects for extracting ions: $V_p \gg V_d > V_f$.

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