Installation of Test-stand for Conditioning of the Microwave Ion Source at KOMAC

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1. Introduction

The 100-MeV proton accelerator has been providing beams to users since 2013[1]. The ion source of the 100-MeV proton accelerator is a 2.45 GHz microwave ion source. The ion source is a component that accumulates aging of the device. There should be periodic replacement of consumables for the ion source. And, when an unexpected replacement of ion source occurs, there should be spare parts for quick replacement. In addition, the most important part is that the ion source must have the same beam characteristics before and after replacement. In this paper, we present the process of confirming the characteristics of the ion source after replacement of the ion source component and constructing a test bench for conditioning of the microwave ion source.

2. Measurements and Results

2.1 Microwave ion source

The ion source can be largely divided into three parts. The first is a component for generating and transmitting microwaves of 2.45GHz.

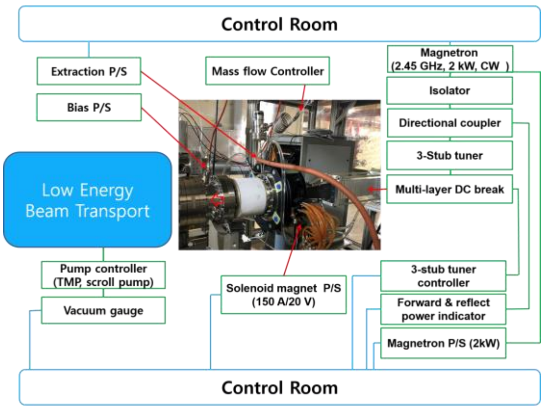

Fig. 1. System block diagram of microwave ion source

The second is the microwave window, plasma chamber, solenoid electromagnet and its power supply for generating plasma. The third is three electrodes (high voltage electrode, bias electrode, ground electrode) for extraction of the proton beam, a high voltage power supply, and a high voltage switch [2]. Fig. 1 shows the system block diagram of microwave ion source.

2.2 Vacuum trace

Most of the consumables of ion sources are associated with plasma. These are two types of physical breakage of the microwave window by back streaming electrons by the plasma and insulation of the plasma chamber by the sputtering effect [3]. Fig. 2 shows the degree of vacuum trace in the plasma discharge after replacing the microwave window and plasma chamber. In Fig. 2, prepare for plasma discharge by purging the initial hydrogen gas. As microwave power is applied, the initial degree of vacuum rises steeply. Controls the steep rise of the vacuum degree by sequentially increasing the microwave power. After rising to a maximum of 2.5E-5 torr (normal operation vacuum degree 1.2E-5 torr), it stabilizes at normal operation vacuum degree after about 2.5 hours. As the plasma ignition is repeated, the stabilization time of degree of vacuum is shortened to about 0.5 hours.

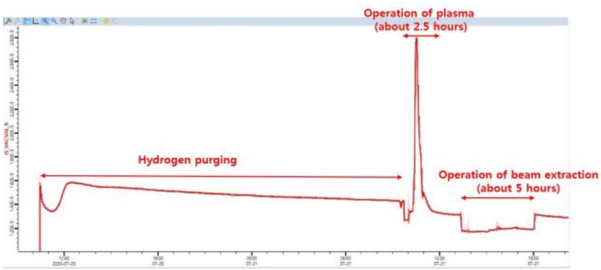

Fig. 2. Vacuum trace of microwave ion source

2.3 Conditioning of beam extraction

Fig. 3 shows the beam current during about 1 hour at LEBT when the beam in normal operation is extracted. This is the beam extraction data after high voltage conditioning including plasma conditioning. The average beam current is 20.8 mA, and the beam stability is ± 3.9 %. One arc occurred.

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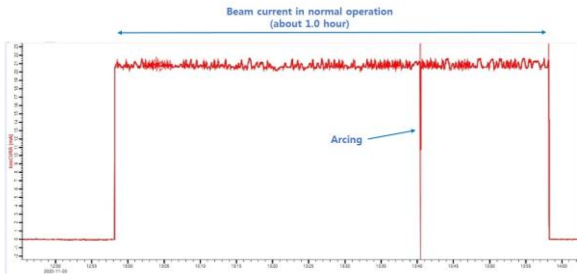

Fig. 3. Beam current in normal operation after conditioning of high voltage of microwave ion source

Fig. 4 shows the beam current not only the plasma chamber including the microwave window, but also plasma conditioning and after replacing three electrodes. Continuous arcing occurred. There was a difference in operation parameter values in normal operation such as degree of vacuum and microwave power. It can be seen that the number of arcing occurs decreases toward the second half of the beam extraction.

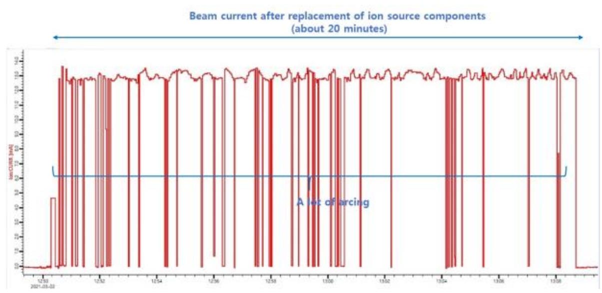

Fig. 4. Beam current in LEBT during conditioning of microwave ion source

3. Test-stand for Microwave Ion Source

The microwave ion source of the test-stand is a spare part and has the same shape as the existing microwave ion source, and it is a concept that changes it to the whole when it is regular or irregular. At the microwave ion source test-stand, plasma conditioning, high voltage conditioning, and beam extraction conditioning are planned. In addition, a cooling channel will be applied by measuring the heat conduction of the plasma chamber according to the microwave power. As such, the test-stand will work to improve the ion source. Fig. 5 shows the installation of test-stand for microwave ion source. In the test-stand, the magnetron was installed vertically by using a waveguide bend to reduce the installation space.

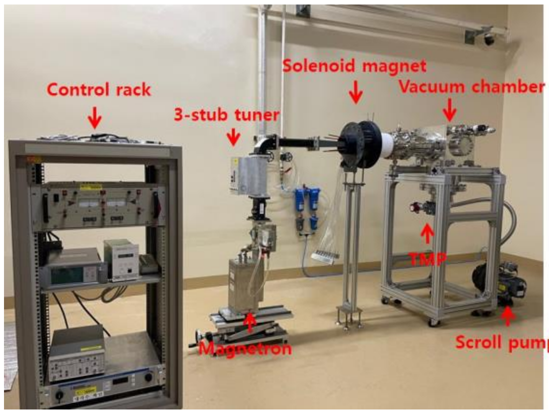

Fig. 5. Test-stand for conditioning of microwave ion source

4. Conclusions

The test-stand for microwave ion source was installed to prepare a spare part of the microwave ion source. By conditioning the ion source in the test-stand, the beam characteristics are to be consistent with before and after its replacement. In addition, experiments in test-stand are also planned to improve the ion source, including conditioning the ion source, thermal analysis of the plasma chamber, and changing the size of the solenoid electromagnet.

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