Pre-liminary test for Metal Ion Beam Extraction using Metal Vapour Vacuum Arc Ion Source

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1. Introduction

Recently, Acceleration development and operation division of the Korea Multi-purpose Accelerator Complex (KOMAC) is constructed the metal Vacuum Vapour Arc (MEVVA) ion source for extraction of new metal species. The MEVVA ion source can make plasma through vacuum arc discharge. The characteristic of the MEVVA ion source is its production of high-current metal ion beam. In addition, it is can make plasma over 50 of the solid metal species of the Periodic Table as well as semi-metal (Graphite) and semi-conductors (Si. Ge) because it uses vacuum arc discharge [1]. The MEEVA ion source have advantage with more various metal ion beam extraction. In this study, the MEVVA ion beam facility is studied and operating parameter was also examined.

2. Experimental and Results

2.1 Vacuum Arc Discharge

In this chapter, the phenomenon of the vacuum arc ion source and the composition of the MEVVA ion source have studied. The vacuum arc discharge is high current discharge occurring between two electrodes. When arc discharge occurs, the current is concentrated at the very small spot, which is called cathode spot. Individual spots move around on the cathode surface, and the spot lifetime of a particular spot may be only microseconds or less, and it has a diameter of the order of a micrometer. Also, the spot has a tendency to frequently occur more from a small surface such as the edge protuberances. At the cathode spot the cathode material is heated, vaporized, and into the plasma state. Some of the metal ions are accelerated to the cathode to occur arc discharge, and some of the metal ions are led out to the ion beam through the hole of the anode. The current density of the cathode spot is extremely high level about 10^6~10^8A/cm^2. And beam current is typically about few to a ten of ampere carried by a cathode spot and it is depending on the material [2, 3].

2.2 Metal Vapour Vacuum Arc Ion Source at KOMAC

Fig. 1 shows the MEVVA ion source at the KOMAC.

On the left side of Fig. 1, there are MEVVA ion source and ion beam irradiation chamber, and on the right site, it is a high voltage power supply of the MEVVA ion source. The MEVVA ion source is installed on the top of the chamber and it can be extracted to vertical ion beam. The vacuum system of the MEVVA ion source and irradiation chamber consists of turbo molecular pump (TMP) and scroll pump.

Fig. 1 The MEVVA ion beam facility

On the right side of Fig. 1, there are high voltage power supply of MEVVA ion source. It has arc discharge power supply and ion beam acceleration power supply. The arc discharge power supply is applied to 23 kV and it is typically operated repetitive pulse mode. And ion beam acceleration power supply is can make high voltage up to 80 kV for metal ion beam acceleration. The grids are uses for beam extraction, and conventional multi-aperture, accel-decel configuration is simple and effective. The first grid is plasma grid, and it is located near the plasma. The middle grid is suppressor grid typically several kilovolts negative with respect to ground so as to suppress the back flow of low energy electron. And the third grid at ground potential [1].

Fig. 2 (a) and (b) shows inside of the MEVVA ion source and Fig. 2 (c) shows the schematic of the MEVVA ion source. The MEVVA ion source consists of the cathode, insulator, trigger electrode and anode. And it is installed the cathode push motor. The MEVVA ion source consists of cathode, insulator, trigger electrode, anode and grids. The cathode of the vacuum arc is metallic element to be extracted and it is cylindrical rod type. The insulator, coaxially with the cathode, surrounds the cathode and insulates the trigger electrode from the cathode. The trigger electrode is

applied a high voltage of few tens of kilovolt to occur a trigger on the cathode surface. A high voltage is applied at trigger electrode, and repetition rate and pulse width also can be control. Each value can be adjusted follow as repetition rate 1-20 Hz, pulse width 200-1500 usec, arc voltage 40-100 V, acceleration voltage 35-80 kV.

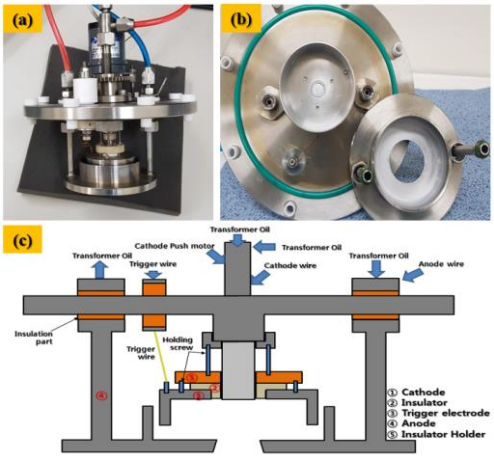

Fig. 2 MEVVA ion source image (a) side and (b) inside (c) shcematic of MEVVA ion souorce

3. Conclusions

In this study, we have studied the MEVVA ion source. And we also have investigated the component and characteristics of the MEVVA ion source. In the future, we will study the extraction of various metal ion elements, beam uniformity and continuous MEVVA ion source operation.

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