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Development of a Duoplasmatron Type Plasma Cathode for Sheet Plasma Production

シートプラズマ生成用デュオプラズマトロン型プラズマカソードの開発

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1. Introduction

A sheet plasma device sustains a thin sheet shaped plasma in a linear magnetic field. A plasma device of this kind can produce a steady-state high density plasma with large density and temperature gradients. Concentrated plasma flow in a magnetic field realizes rapid sputtering of target materials, and produced flux of sputtered atoms can form thin functional films. The homogeneity of the sheet plasma makes the plasma process with the device advantageous to prepare surface treatment over wide area.

A sheet plasma device is often operated with a plasma cathode. A plasma cathode takes a role as an electron source that extracts electrons as discharge current from plasma. The electron emission characteristics of a plasma cathode depend upon the gas pressure, magnetic field, accelerating voltage and discharge current. The present study deals with the problems associated with reliable operation of high density plasma produced by a plasma cathode.

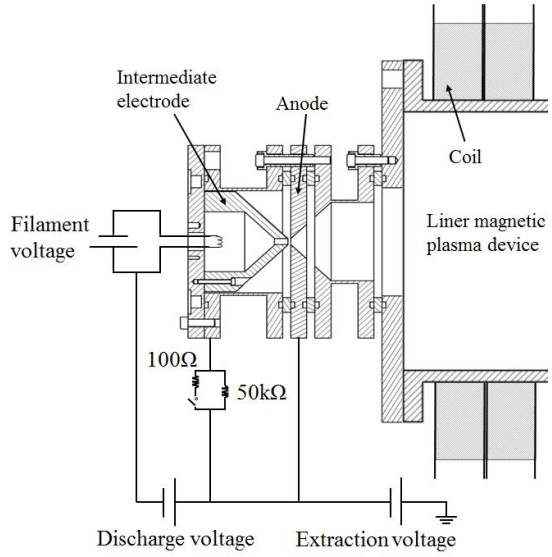

Fig. 1. Schematic diagram of duoplasmatron type plasma cathode.

2. Experimental apparatus

Figure 1 shows the schematic diagram illustrating the structure of duoplasmatron type plasma cathode. Tungsten filament is used to excite a primary discharge for the cathode plasma. The cathode contains nozzle shaped intermediate electrode and anode. Generated plasma is compressed by electric field of intermediate electrode and mirror magnetic field excited between the intermediate electrode and the anode to enhance ionization. The plasma cathode produces a flow of electrons to a liner magnetic plasma device attached downstream of the plasma.

Figure 2 shows the discharge current that runs between the cathode and the anode as function of discharge voltage. Discharge current tends to saturate against increasing discharge voltage. Figure 3 shows the extraction current characteristics for discharge current. The extraction current, which runs between anode and reflector placed at end of liner magnetic field, increased above about 50 V discharge voltage. Plasma parameters such as electron density, electron temperature, and plasma potential are currently being measured by a Langmuir probe to determine accurate spatial distributions of these parameters in the generated sheet plasma.

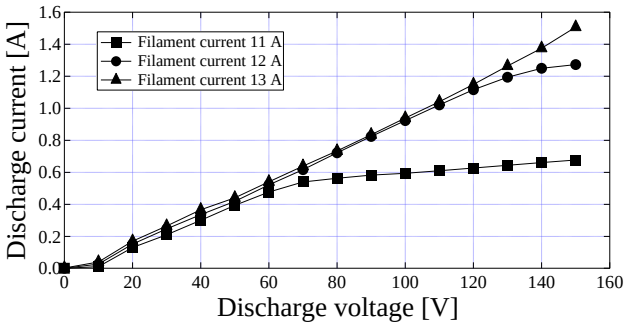

Fig. 2. Discharge current characteristic.

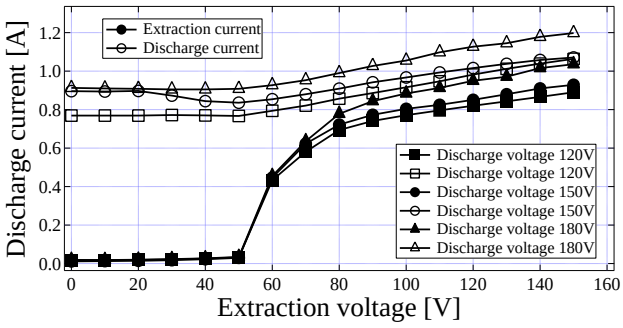

Fig. 3. Extraction characteristic.