§25. Optimization of RF Coupling to Produce High-Density Homogenous Plasma for Negative Ion Sources

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INTRODUCTION

In the experiment in FY 1998, we found a wide-spreading plasma with low floating potential can be produced by a grill-like antenna in which magnets to reduce electron influx into the antenna are buried. By testing three types of the circuit to feed 13.56-MHz rf power to the antenna, we optimized the power-feed system this year.

TESTED POWER-FEED CURCUITS

Figure 1 shows three types of the power-feed circuits tested in the experiment. In all cases, six straight bars, in wihch magnets were buried, were aligned in the source as the rf antenna. These are grouped into two types, namely an electrostatic type and two electromagnetic types. In the electrostatic type, each bar was alternately connected to the opposite polarity of the output from the rf power supply. Capacitively coupled plasma would be produced in this case. Two electromagnetic types composed of a spiral type and a alternating type and would produce a plasma inductively. In the spiral type, the antenna bars were connected so that the rf current in the bars flows like a square spiral as a whole. In the alternating type, each current in the bar flow in the opposite direction one by one.

EXPERIMENTAL RESULT

Figure 2 shows the CCD camera image of the discharge plasmas. For all types of the power-feed system, the spread plasmas were obtained. Higher power couplings were observed for the electromagnetic types than for the electrostatic type. In the electromagnetic types, more spread plasma was obtained for the alternating type than for the spiral type.

In conclusion, the alternating type is the best configuration to produce the intense, homogenous plasma for ion sources. Since the antenna impedance can be adjustable by changing the gap of the bars and the total electrical connections, the alternating type can be adopted to larger ion sources, which is another superior point of this type.

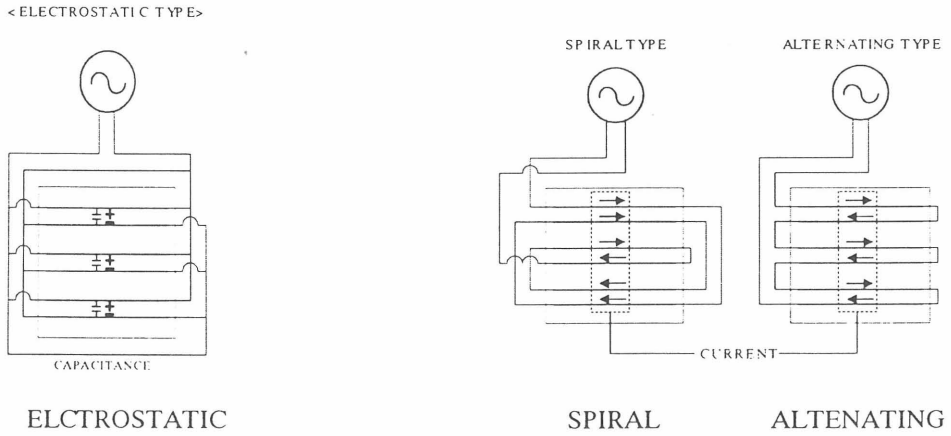

Fig. 1 Tested power-feed circuits.

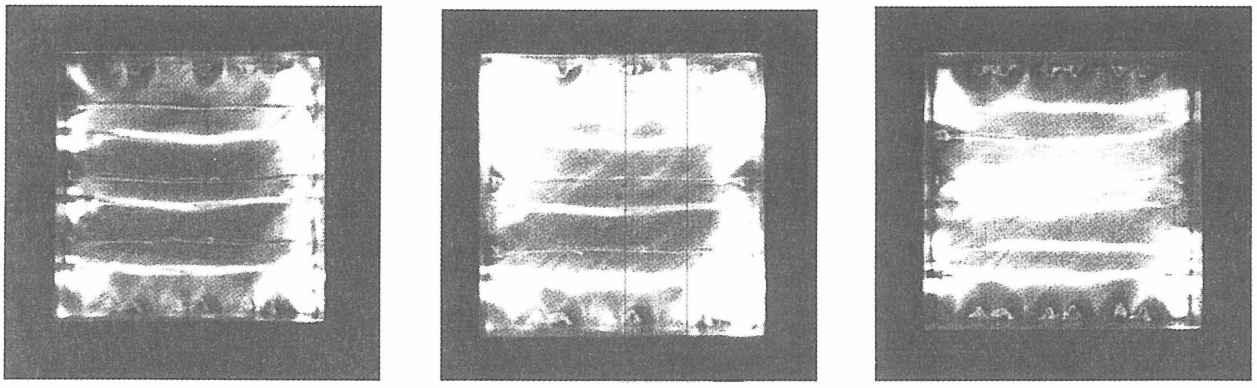

Fig. 2 CCD camera image of the discharge plasmas.