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凹型電極によって引き出された低エネルギー高電流密度イオンビームにおける自己集束前後の電子温度・密度分布計測

Profile Measurements of Electron Temperature and Density at a Self-Focusing State in High-Current-Density and Low-Energy Ion Beam

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Ion beam technologies have been used for various fields. As a next technology, a low energy and high current density ion beam is expected to produce novel materials. However, it is very difficult to make a strong focusing ion beam with the range of around 100 eV, due to the coulombic interaction of the extracted ion charges. Eventually, the low energy and high current density ion beam system was developed by using the concave shape of electrode[1], and by the secondary electrons induced by an electron beam[2]. To suppress the ion beam divergence, the most important factor is the existence of sufficient amount of electrons compared with the positive charges of ion beam. However, under some conditions, a new phenomenon has been found that the divergence of ion beam is naturally suppressed without supplying the secondary electron by the electron beam injection[3]. This phenomenon is called as a self-focusing state. It is very important for the effective uses of the ion beam technology, to understand its mechanism. Therefore, it is necessary to measure electron density and electron current density profiles in the vacuum chamber where the ion beam is injected (the ion beam propagation chamber). To compensate the influence of a strong dose of the ion beam flux flowing onto a probe, a double probe is introduced, which has specific structures[4]. Details (the probe drawing and structure) of the double probe are described in Ref. 4. To improve measurement precision and sensitivity, the circuit of a voltage sweeping power supply is modified. Accordingly, it becomes possible to measure small amount of currents which correspond to the low electron density before the transition to the self-focusing state. In this paper, experimental results of probe measurement in the ion beam propagation chamber using the double probe before and after the self-focusing state will be presented.

References

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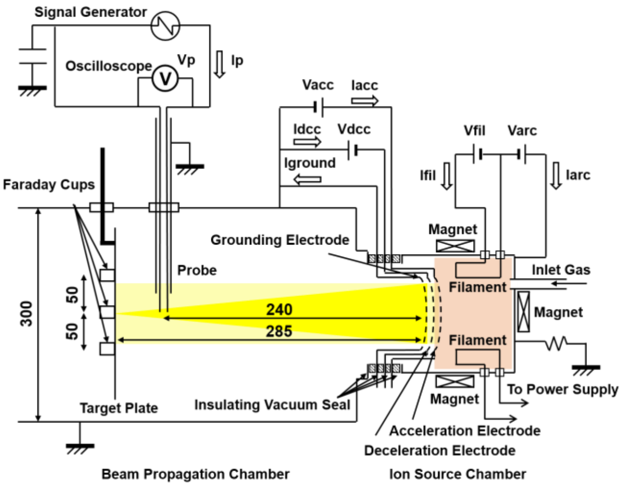

Fig. 1. A schematic drawing of experimental apparatus. Ion source, electrical circuits with power supplies and measuring system are illustrated.

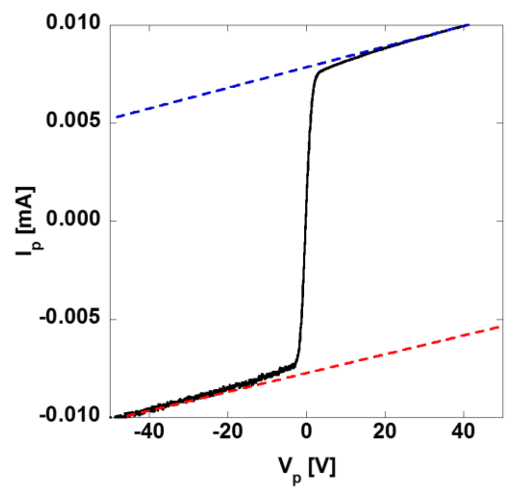

FIG. 2. Dependence of probe current I_p on probe voltage V_p which is measured by the double probe at approximately the center of the ion beam, z = 1 cm, with V_{acc} = 100 V, I_{acc} = 33.06 mA, V_{dec} = -500 V, V_{arc} = 200 V, I_{fil} = 84.17A.