01pC05

ジャイロトロンを用いた大電力ミリ波放電の発振周波数と集光形状による放電構造の変化

Influence of beam frequency and focusing on a millimeter wave discharge generated by a gyrotron

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Introduction

Studies on the millimeter-wave discharge have begun with the development of the high power oscillator, Gyrotron. Although the millimeter-wave discharge has some interesting features such as the self-assembly filamentary structure, there are still only a few experimental studies [1,2].

In this paper, experiments of the discharge using a 170 GHz gyrotron and 28 GHz gyrotron were implemented to investigate effects of the incident beam frequency and beam power density variation on the discharge. This study will contribute to wireless power transfer applications such as beamed energy propulsion launchers [3].

Experimental apparatus

Figure 1 shows an experimental setup using parallel beams. The discharge is ignited at the focal point of the parabolic mirror. The ionization front then propagates absorbing the beam power. In the experiments a high-speed camera was used to observe the discharge in the E plane and H plane of the incident beam, where E plane is parallel to the electric field plane, and H plane is perpendicular to the E plane.

Another experimental setup for focusing beams is shown in Fig. 2. The incident beam diameter is expanded to 240 mm at a transmitter mirror. A receiver mirror focuses the incident beam and the beam power density varies along the beam path.

Experimental results

In the 170 GHz case, small granular plasmoids propagating toward the beam source was observed by the high-speed camera. The distance between the plasmoids are close to the wavelength. The exposure images in E plane and H plane were almost coincident. In contrast, 28 GHz case the exposure images had discrete structures and were completely different in each plane.

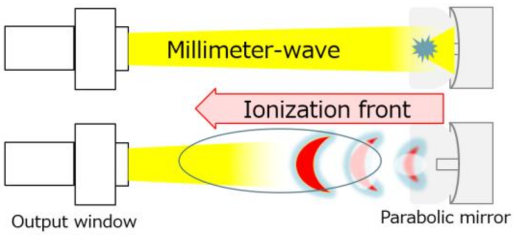

Fig. 1 Experimental setup using parallel millimeter-wave beams. 170 GHz and 28 GHz beams were used.

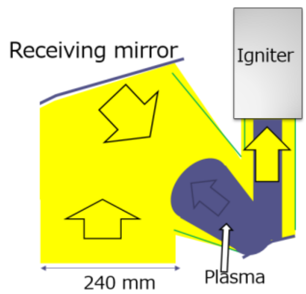

Fig.2 Experimental setup using focusing millimeter-wave beams. Beam frequency was 170 GHz

The propagation velocity of the ionization front decreased accordingly with the beam power density decrease along the beam path. In the low beam power density region, the filamentary structure disappeared and the plasma became a cloud like shape. The cloud like plasma remained long time even after the beam cutoff, which implies the transition of the thermal equilibrium state of the plasma and ambient gas.

In the conference, the author will present more detail.

Reference

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