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Characteristics of pulsed plasmas in the magnetized plasma gun device
磁化プラズマガン装置におけるパルスプラズマの特性評価

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The plasma parameters of surface absorbed energy density, velocity and line-averaged electron density of pulsed H, D and He plasmas produced by the magnetized coaxial plasma gun (MCPG) device at University of Hyogo were measured. Dependencies of the plasma parameters on the gas species were observed. The high energy density of > 1 MJ/m^2 was successfully produced for all the gas species at the gun voltage of 6 kV.

1. Introduction

A pulsed (~0.1-1 ms) plasmoid is produced by a magnetized coaxial plasma gun (MCPG) device at Univ. of Hyogo [1, 2] in order to simulate thermal transient events such as type I edge-localized modes (ELMs) and disruptions. It is important to know detail characteristics of the pulsed plasmoid for understandings of interactions between the pulsed plasma and candidate materials of divertor in ITER. In this study, surface absorbed energy density, plasmoid velocity and line-averaged electron density of pulsed H, D and He plasmas were measured in the MCPG device.

2. Experimental setup

A calorimeter is applied to measure the surface absorbed energy density of the pulsed plasma produced by the MCPG. The detail of the MCPG device is shown in [3]. The calorimeter consists of cylindrical graphite (IG-430U) of 8 mm in diameter and 10 mm in height, in which a thermocouple is inserted. The plasmoid velocity is estimated by a time-of-flight measurement of the magnetic field signals. The line-averaged electron density is measured by a He-Ne laser interferometer.

3. Experimental results

Figure 2 shows the velocity of the pulsed H plasma as a function of the gun voltage. The gun current reaches at ~90 kA, which is two times larger than that of the previous MCPG [1]. The plasma duration is about 0.2 ms. The resultant ion energy of the pulsed H plasma with the gun voltage of 6 kV is about 40 eV. The line-averaged electron density of the pulsed H plasma at z = 175 mm measured by the He-Ne laser interferometer is shown in Fig. 2. Here, z is the distance from the tip of the inner electrode.

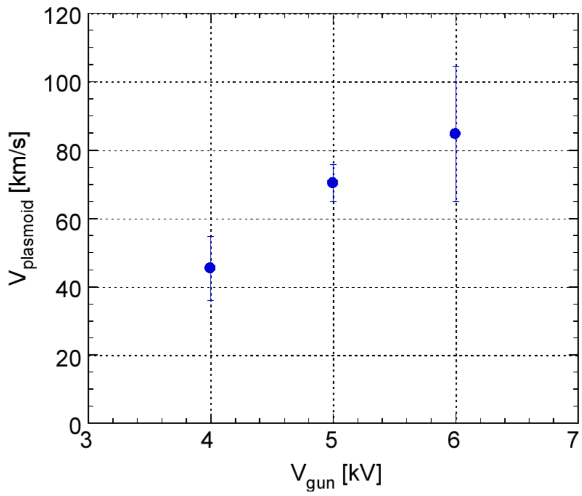

Fig. 1 The velocity of the pulsed H plasma as a fuction of the gun voltage.

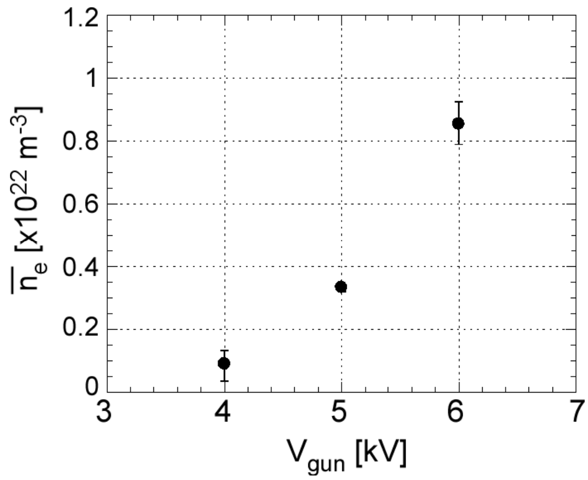

Fig. 2 The line-averaged electron density of the pulsed H plasma as a fuction of the gun voltage.

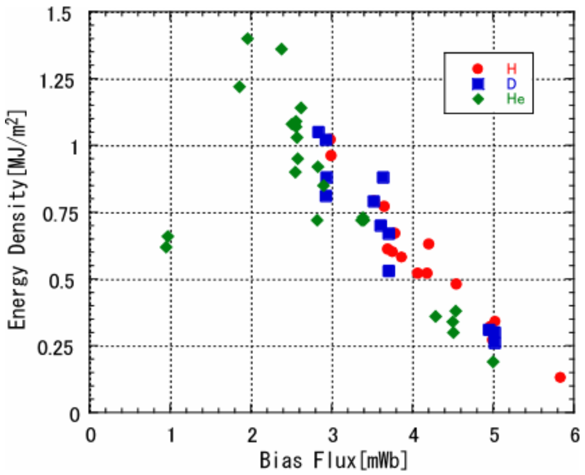

Fig. 3 The surface absorbed energy density of the pulsed H, D and He plasmas as a function of the bias magnetic flux.

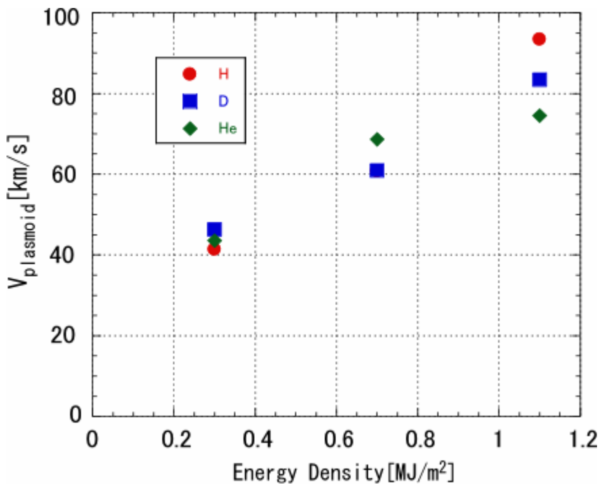

Fig. 4 The velocity of the pulsed H, D and He plasmas as a fuction of the bias flux.

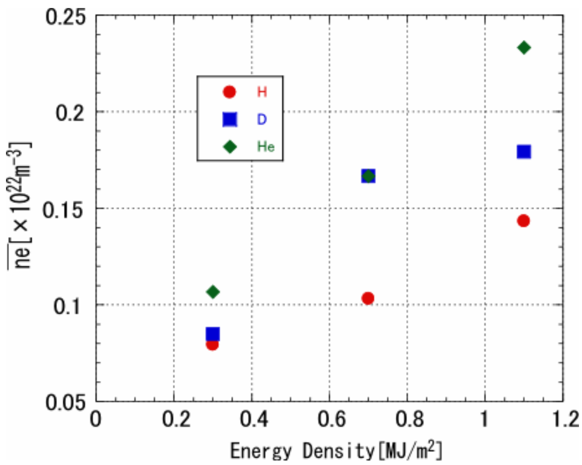

Fig. 5 The velocity of the pulsed H, D and He plasmas as a fuction of the bias flux.

The surface absorbed energy of the pulsed H, D and He plasmas at z = 340 mm was measured with the calorimeter by changing the bias magnetic flux, as shown in Fig. 3. Here, the gun voltage was 6 kV. Figure 4 shows the velocity of the pulsed H, D and He plasmas as a function of the measured energy density (Fig. 3). The velocity of the pulsed He plasma at the energy density of 1.1 MJ/m^2 is also smaller than the others. On the other hand, the line averaged electron density of the pulsed He plasma at the energy density of 1.1 MJ/m^2 is higher than the others, as shown in Fig. 5. Thus, the differences of the plasma parameters should be considered in the pulsed plasma irradiation experiments [4], even though the energy density is the same.

4. Summary

The surface absorbed energy density, the velocity and the line-averaged electron density of the pulsed H, D and He plasmas were measured in the MCPG device. The high energy density plasmoid with the different gas species was successfully generated. A calorimeter made of W should be performed in future, because a particle reflectivity between graphite and W is different.

References

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