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ELMパルス熱負荷時の蒸気遮蔽効果の解明に向けた ダブルプラズマガン装置の初期実験

Preliminary experiment of a double plasma gun device for clarification of a vapor shielding effect at ELM pulse heat load bombardment

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1.Introduction

Thermal transient events such as type I edge-localized modes (ELMs) and disruptions remain a major concern to the lifetime of divertor materials in ITER. It is predicted that the heat load on the divertor during type-I ELMs in ITER is 0.2-2 MJ m^{-2} with pulse length of ~0.1-1 ms [1]. We have started to investigate surface damage of tungsten materials under pulsed heat loads produced by a magnetized coaxial plasma gun (MCPG) device at University of Hyogo [2, 3]. The capacitor bank energy for the plasma production was 50 kJ at the gun voltage of 6 kV. The pulse duration was ~0.2 ms, close to the typical pulse length of a type I ELM predicted in ITER. It is known that surface melting and evaporation during a transient heat load could generate a vapor cloud layer in front of the target material [4]. Then, the subsequent erosion could be reduced by the vapor shielding effect.

2.Experimental setting and result

Recently, we introduced a new experiment using two MCPG devices of so-called "double plasma gun" to perform the following experiments. The first one is to understand vapor shielding effects of a tungsten (W) surface under ELM-like pulsed plasma bombardment. The second plasma is applied with a variable delay time after the first plasma. A vapor cloud layer in front of the W surface produced by the first plasma irradiation could shield the second plasma load on the W surface. The second one is to generate high-energy density plasma using plasma merging processes [5, 6]. Figure 1 shows the ion temperature of each single plasma and merged plasma. In the preliminary experiment, the initial ion temperature of the two pulse plasmas was ~25 eV, where the capacitor bank energy was relatively low. The ion temperature increased significantly during the oblique pulsed plasma merging and reached ~100 eV, where the plasma merging angle was 90 degree. It could be considered that the ion heating originated from converting the plasma kinetic energy into the ion thermal energy. Sophisticated measurements of the merged plasma will be performed in order to clarify the mechanism of the ion heating during the plasma merging process.

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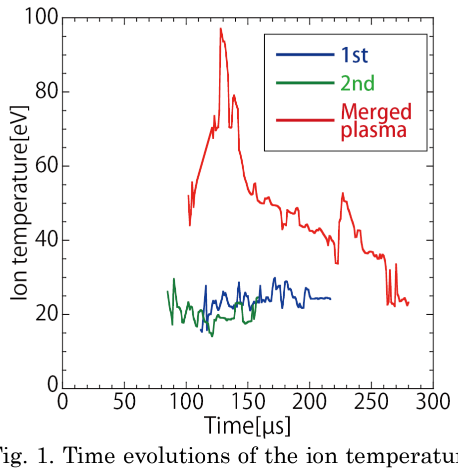

Fig. 1. Time evolutions of the ion temperature of each single plasma and merged plasma.