Experiment of steady-state/pulse combined plasma irradiation to fusion reactor wall materials on Pilot-PSI

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1.Introduction

It is considered that thermal transient event such as type I edge localized modes (ELMs) could limit the lifetime of plasma-facing components (PFCs) in ITER. The predicted heat load during type I ELM in ITER is 0.2-2 MJm^{-2}, 0.1-1 ms [1]. On the other hand, surface melting and evaporation during the transient events could generate a vapor cloud in front of the divertor materials. Then, the subsequent heat flux could be reduced by the interaction between incident plasma particles and the vapor layer because of radiation cooling [2]. Experimental evaluations are required to validate the prediction by the numerical simulation [3]. We have carried out the simulation experiment of the vapor shielding effect by using magnetized plasma gun device [4].

For simulating realistic situation of the divertor, this steady-state/pulse combined plasma irradiation experiment has been carried out on Pilot-PSI at DIFFER.

2.Experimental setup and results

Figure 1 shows the Pilot-PSI linear plasma generator. The plasma is generated by a so-called cascaded arc source. An axial magnetic field (1.6 T) is used to generate an intense magnetized cylindrical plasma beam. In addition, the device could combine the continuous plasma with a transient heat and particle pulse (up to 1.2 GWm^{-2} for 1 ms) allowing the study of ELM effects on plasma-exposed surfaces [5].

To generate the vapor layer, not only bulk material samples but also film deposited samples were used in this study. The thin film with a thickness of 1-3 μm was prepared on a substrate by using a magnetron sputtering device in Osaka University. The generation of vapor during the plasma pulse irradiation was measured by using a high-speed visible camera, as shown in figure 2. The details will be presented at the workshop.

References

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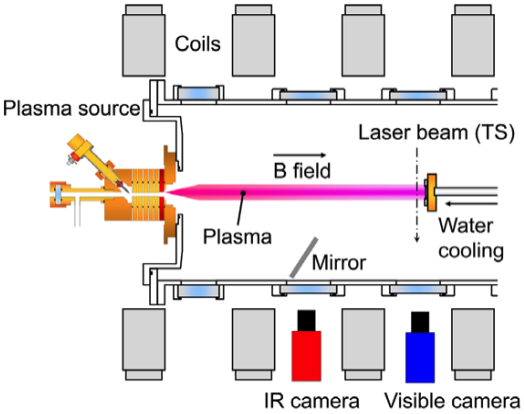

Fig. 1. Schematic view of Pilot–PSI

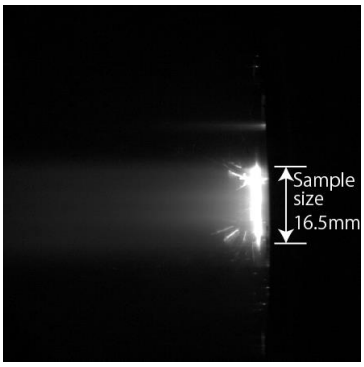

Fig. 2. Photo image through an interference filter of Al_I (394.4nm) during 1st pulse plasma irradiation to an aluminum deposited tungsten sample