§6. Wall Plasma Interaction Using Ablated Plasma Plumes Induced with Laser and Ion Beams

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Reactor components such as divertor plate are subject to extreme environments where plasma, liquid, gas, and solid phases exist at the same time. It is thus of critical importance to study these extreme states in order to have a good understanding and design criteria for future reactors with a systematic manner. The systematic means here that we should be able to cover various materials with a broad range of incoming thermal flux assisted with a full scale computer simulation. We have started our collaborative study along this scenario using both laser and plasma devices to create the extreme states relevant to the reactor material studies.[1-4]

We have performed several experiments using both laser and plasma devices. In our double laser beam configuration where two laser beams irradiate orthogonally two solid targets that have a 1.25 cm radius concave curvature. Once the ablated plasma is created on each target, two plasma plumes cross each other. We define one of the plasma plume as an incoming plasma and the other as a shielding plasma plumes. The laser specifications are 1J, 351 nm, 6 nanoseconds as the laser energy, laser wavelength, laser pulse width. The plasma parameters at the plasma cross point are 10^{12}-10^{15} /c.c. and 1-2 eV as electron plasma density and temperature for most of the target materials. The energy of incoming plume flux is absorbed with the shielding plume through the collisions. The degree of absorption is measured by thickness monitors placed in front of the incoming plasma. When the shielding plume has functions, the transmitted plasma flux decreases due to the collisional processes at the cross point. Theoretical studies have been conducted in parallel to understand the collision Processes[5,6] In our parameter regions, the ion-ion collision should be a first dominant process, not the neutral atom collision. In the course of the theoretical approach, direct Monte Carlo method has been conducted to reproduce the collisional effect observed in the experiments.
The collision parameter has been defined as an indicative factor of collision.

$$\text{Collision parameter} = \frac{\sum_i i^4 f_i}{m_{red}^2 u^3} \qquad (i = 1, 2, \dots)$$

This CP has been chosen from the variance of Coulomb ion-ion collision. Here *u, i, m* and *f* are the speed, ionization degree, mass and the fraction of the ions.
The shield rates are measured for various targets: C, Al, Mo, Cu and W and are shown in Fig. 1.

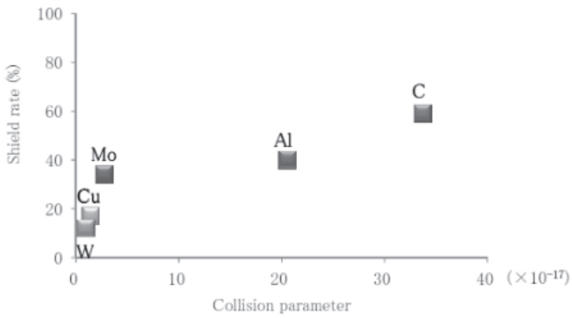

Fig.1 Shield Rate vs. Collision Parameter

As seen in Fig.1, almost 60 % of the incoming plasma plume has been absorbed with the another carbon shielding plume resulting only 40 % of the incoming plasma plume transmits. Our estimate of the incoming plasma plume corresponds to 10^4 W/m^2 in this experiment.
At the upgrade effort of plasma beam device, maximum of 1.5 MJ/m^2 irradiation plasma intensity has been established with the aid of LHD project research. Al and W targets are tested for the irradiation as shown in Fig. 2 and will be reported in forth coming annual report.

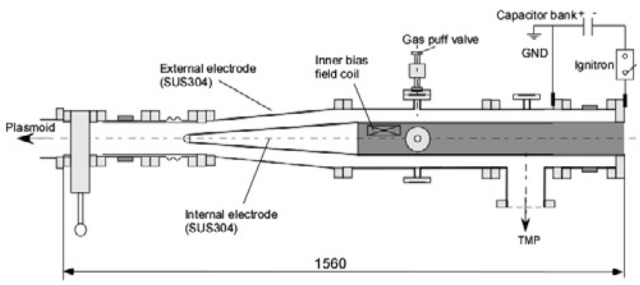

Fig. 2 Plasma Beam Device whose irradiation intensity reaches 1.5 MJ/m^2.

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