§55. Plasma-wall Interaction and Divertor Particle Control in Steady State Plasma

Sakamoto, M., Hasegawa, M. (RIAM, Kyushu Univ.)

The achievement of the stable steady state operation (SSO) is one of the most important issues for the future fusion reactor. The issues contain not only subjects related to the core plasma such as confinement, heating and current drive but also those related to the plasma-wall interaction (PWI) such as hydrogen recycling and wall pumping. In this study, PWI phenomena and divertor particle control have been investigated comprehensively from the viewpoint of SSO.

A previous study on hydrogen recycling has clearly demonstrated that the hydrogen recycling coefficient increases with two different time constants: a few seconds and ~30s in the initial phase of a long duration discharge.[1] In this period, the recycling coefficient changed significantly. Figure 1(a) shows the time evolution of the wall pumping rate in the initial phase of a long duration discharge in TRIAM-1M. The decreased wall pumping rate means that the recycling coefficient increased. It was found that the wall pumping rate decreased shot-by-shot. The OII line intensity implies the same tendency as the wall pumping rate shown in Fig.1(b). Figure 1(c) shows the wall pumping rate as a function of the OII line intensity. The global wall pumping rate seems to correlate with the oxygen behavior. Oxygen impurities affected the physicochemical properties of the deposits, and then the capability of hydrogen retention of the deposits increased significantly.[2] The result of Fig.2 may suggest the impact of co-deposition of hydrogen with oxygen and molybdenum on global wall pumping.

On the other hand, divertor particle control in the spherical tokamak QUEST has been studied using the divertor simulation code SOLDOR[3]. Figure 2(a) shows a mesh model, which simulates the closed divertor configuration in QUEST. The input parameters for the simulation are as follows: the input power is 3 MW (1MW for the ion, 2MW for the electron), the plasma density is 5 x 10^{19} m^{-3}, the ion temperature is 3 keV, the electron temperature is 3 keV and the gas supply is 1 x 10^{21} s^{-1}. It is found that the peak positions of electron density and temperature on the divertor plate locate on the upper side of the strike point, and the density increases with a SOL width although the electron temperature change little with the SOL width. The electron density on the inner divertor is four times higher than that of the outer divertor. Figure 2 (b) shows the pump rate as a function of the ratio of outer pump speed to inner pump speed, where the total pump speed is constant (25 m^3/s). It is found that the inner pump is more effective than the outer one.

1) M. Sakamoto, et al.: Nucl. Fusion **42** (2002) 165.
2) M. Miyamoto et al., J. Nucl. Mater. 337-339 (2005) 436.
3) K. Shimizu et al., J. Nucl. Mater. 313-316 (2003) 1266.

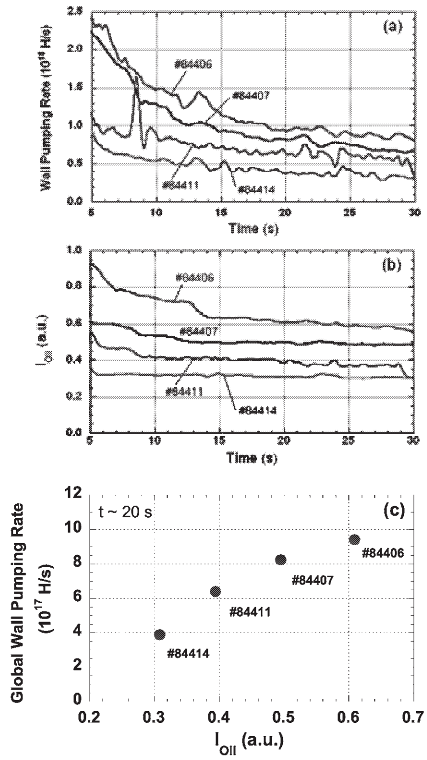

Fig. 1. Time evolution of (a) wall pumping rate and (b) OII intensity in the initial discharge phase. (c) Wall pumping rate at t~20 s as a function of OII line intensity.

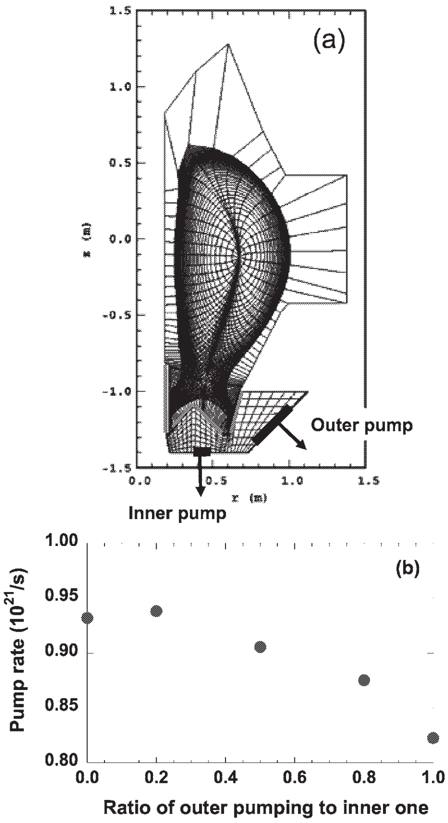

Fig. 2. (a) mesh model for the divertor simulation code SOLDOR. (b) dependence of pump speed on the ratio of outer pump speed and inner pump speed.