§53. Integration of PWI Experiments, Diagnostics, Simulation and Modeling in Steady State Plasma

Sakamoto, M. (RIAM, Kyushu Univ.)

Issues of plasma wall interaction (PWI) are strongly related to the steady state operation (SSO) of fusion plasma. PWI characteristic length scales extend from order of nm (microstructure of deposits and radiation damage) to order of μm (dust) and order of cm (hot spot) up to m (global particle balance). It is necessary to investigate PWI phenomena comprehensively from multiscale viewpoints. In this study, we had utilized the superconducting tokamak TRIAM-1M, in which a long pulse operation could be carried out, as a platform of the study under Interactive Coordinated Researches of NIFS.

As the macroscopic approach, the following studies have been carried out; the recycling structure of the long duration discharges with profile measurements of H_α intensity, DEGAS simulation, spectroscopic measurement of the boundary plasma, Langmuir probe measurement of the scrape of layer (SOL), heat load profile on the plasma-facing components, global particle balance and plasma flow measurement. As the microscopic approach, the following studies have been carried out; analysis of the radiation damage process using the surface probe system, analysis of the structure of the deposition layer, quantitative estimation of the retention inside the deposits, quantitative analysis of the growth of the deposition layer using the optical method, and dust collection and analysis. Many fruitful analyses and results have been produced[1-11].

In order to investigate differences of PWI phenomena between a single long duration discharge and a repetition of discharges, we have focused on behaviour of oxygen impurity. Figure 1 shows the time evolution of OII line intensity divided by the line averaged electron density (I_{OII}/n_e). The value of I_{OII}/n_e is considered as a monitor of oxygen concentration on the plasma-facing wall surface. As shown in Fig.1, the oxygen decreases with plasma duration. The characteristic time τ of the decrease in I_{OII}/n_e is ~48 s. In the case of a repetition of discharges, the data of I_{OII}/n_e of eight discharges are connected in the order of the discharge number from #84512 to #84519. The signal has a large spike at the beginning (i.e. ohmic heating phase) of each discharge that is indicated by the arrow in Fig.2. In this case, τ is ~141 s, which is about three times longer than that of a single long duration discharge. From the analysis using Langmuir adsorption equation, the oxygen concentration is found to increase during the interval time between discharges with the time constant of 5500 s. This increase may result from adsorption of H_2O on plasma facing wall surface. The source of H_2O seems to be surface area which does not face the plasma, e.g. extension pipes. Noted that such increase of oxygen concentration during the interval time was observed in the early phase of the experimental campaign.

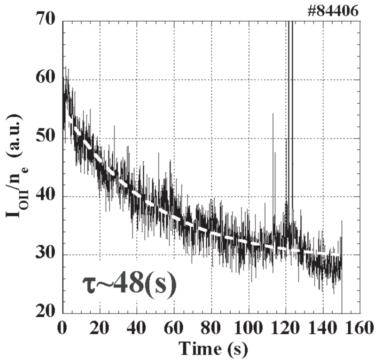

Fig.1 Time evolution of OII line intensity divided by the line averaged electron density in a single long duration discharge.

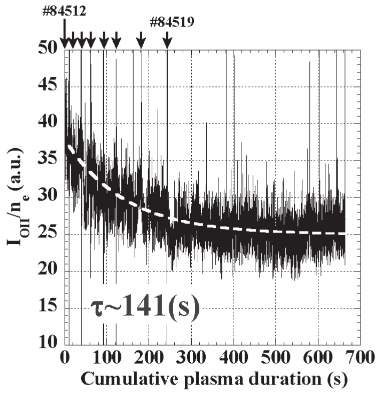

Fig.2 Time evolution of OII line intensity divided by the line averaged electron density in a repetition of discharges.

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