§62. Erosion Analyses of the LHD Divertor Tiles

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Due to high reproducibility of the divertor structure with external SC coils system in LHD, divertor footprints on graphite targets have been successfully identified after 10,000 shots of the 3rd campaign [1]. The measured erosion depth has been found to be about a factor 3 less than the estimated one mainly due to redeposition as indicated by numerical simulations.

Using the LP data in Fig.1, the total erosion depth (gross) expected after the 3rd campaign was estimated by summing up $Y_s\ \Gamma_{div}\tau_d/n_c$ of each shot, where we used the sputtering yield Y_s = 0.05 for C by He at the impact energy 200eV (2Ti+3qTe, approximating Te=Ti=24eV) and 0.002 for H at 100eV, the curve fitted formula $\Gamma_{div} = 0.092\langle n_e\rangle^{1.1924}$, discharge duration time τ_d, and carbon density n_c=1.5g/cm^3. The result is shown in Fig.2. The total fluence of He and H are 2x10^{25} m^{-2} and 1.2x10^{25} m^{-2}, respectively for Rax=3.6m.

Numerical simulations of erosion profiles have been performed using the 3 dimensional code EDDY. In this work the code has been modified to simulate such a glancing thin plasma layer as in the LHD divertor leg [2]. Under the condition of n_e=1x10^{18} m^{-2}, Te=24eV and B_{div}=1T, the typical result for the tile (#2) is shown in Fig.3, where the primary plasma includes impurities of 2% of C, 1% of O and 0.1% of Fe estimated from measured Zeff in the 3rd campaign [3]. In this figure the result means that the He plasma causes net erosion but the H plasma causes net deposition of C impurity within the present condition. This is easy to understand, because the impurity concentration in plasma was comparable to the sputtering yield of H. The total net erosion depth, therefore, is about 5μm, which agrees very well with the measured depth (#2) as shown in Fig.2.

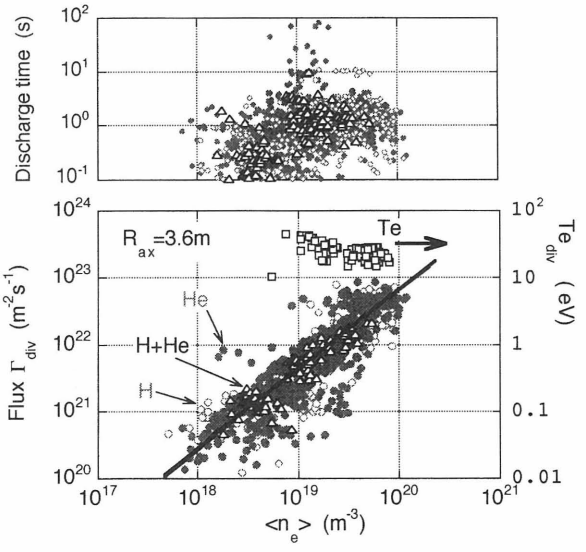

Fig. 1 Particle flux Γ_{div} and electron temperature $T_{e,div}$ measured at the outboard side divertor, and discharge duration time τ_d as a function of the line averaged plasma density $\langle n_e\rangle$ in the 3rd campaign.

References:

[1] A.Sagara, et al., to be submitted to the 15th PSI Conference, Gifu, 2002.
[2] K.Ohya et al., to be submitted to J. Plasma Fusion Res.
[3] S.Morita et al., Physica Scripta, T91 (2001) 48.

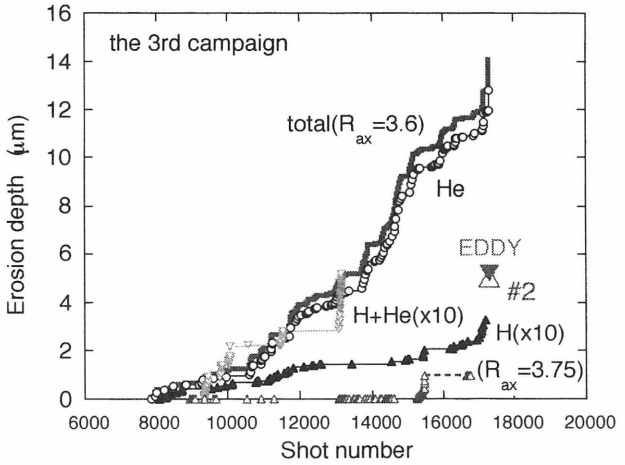

Fig.2 Erosion depth estimated using the measured data of Fig.1, measured depth on the #2 tile and the result of the numerical simulation with EDDY.

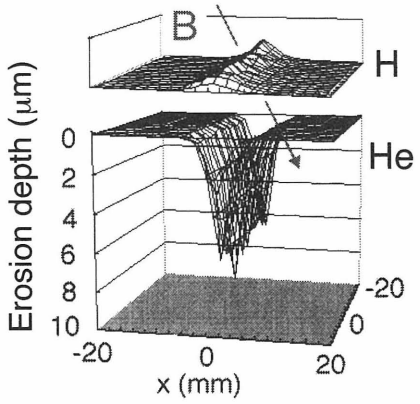

Fig.3 Numerical simulations using EDDY on net erosion of Carbon under the same plasma condition for the tile #2.