§10. Effect of Radiation Power Loss due to Impurity Gas Puff to Divertor Plasma

Murakami, I., Suzuki, C., Kato, D., Masuzaki, S.

Divertor plates would be seriously damaged by high heat load in a fusion device such as the ITER, a DEMO and a helical reactor FFHR[1], and we need to prevent such damage. One of feasible ideas to reduce the heat load is impurity gas injection into a divertor plasma, since radiation power loss caused by impurity gas decreases electron temperature, which would result in plasma detachment. Nitrogen, neon, argon, and other noble gases are the candidates for impurity gas injection.

In the 17^{th} and 18^{th} LHD experimental campaigns we injected impurity gas to the divertor region and measured extreme ultraviolet (EUV) spectra to examine how the impurity gas contributes to reduce electron temperature[1]. Fig. 1 shows EUV spectrum when Ne gas was injected. Ne VIII and Ne VII lines were observed. Fig. 2 shows temporal distribution of various quantities for discharges #125899 and #125900 with different Ne gas amount in the 18^{th} campaign. Increase of radiation power is slower for smaller amount of Ne gas in #125900. Partial detachment occurred in both discharges. Time duration between detachment occuring and radiation collapse is longer for #125900 than #125899. Intensities of Ne VIII and Ne VII lines increase with time, but intensity ratios of Ne VIII are kept nearly constant except appearing and disappearing time of these lines as shown in Fig. 3. On the other hand intensity ratios of Ne VII increased slightly for both discharges as shown in Fig. 4. For comparison, we calculated the intensity ratios of these lines using ADAS[2] as functions of electron temperature as shown in Figs. 3 and 4. The constant intensity ratios of Ne VIII imply these lines were emitted at the same temperature region. The electron temperature is estimated as 20-25eV with ion density ratio n(Ne IX)/n(Ne VIII) as about 4-6. Increasing ratio of Ne VII lines indicates increasing ion density ratio and/or decreasing electron temperature for Ne VII. We need more detailed analysis to confirm their emitting region in order to estimate the effect of radiation power loss.

1) C. Suzuki et al.: J. Nucl. Materials **463**, 561 (2014).

2) H. P. Summers: The ADAS User Manual, version 2.6, http://www.adas.ac.uk (2004).

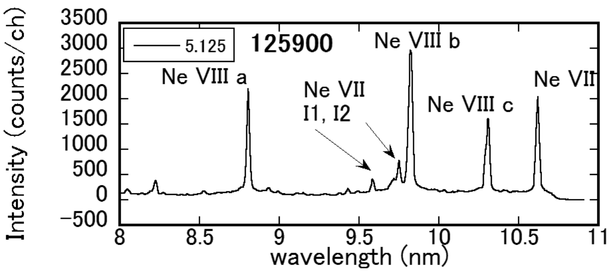

Fig. 1 EUV spectra measured with SOXMOS for the discharge #125900. N_e gas was injected at t =3.6-3.7 s.

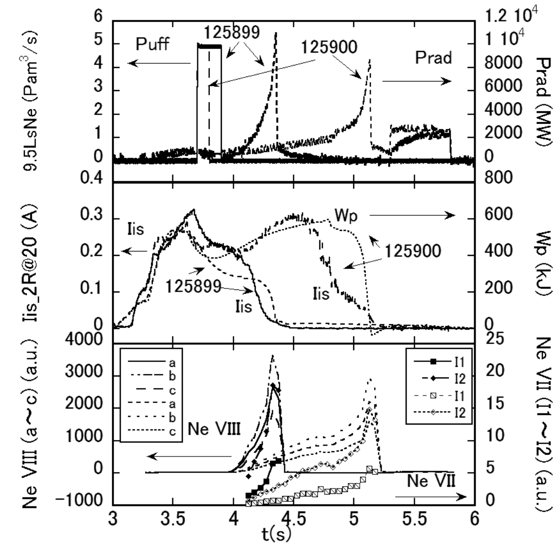

Fig. 2 Temporal distribution of amount of (top) Ne Gas puff and radiation power P_{rad},, (middle) ion saturation current at divertor plate I_{is}, and stored energy W_p, and (bottom) intensities of Ne VIII and Ne VII lines for discharge #125899 and #125900.

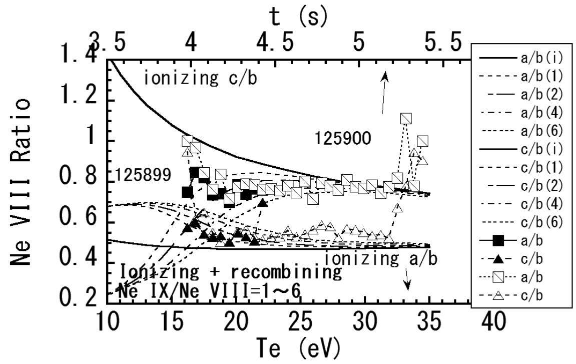

Fig.3 Calculated intensity ratios of Ne VIII lines a-c in Fig.1 as functions of electron temperature with. ion density ratios n(Ne IX)/n(Ne VIII)=0 (ionizing plasma) ,1, 2, 4, and 6. Measured intensity ratios are also plotted as a function of time.

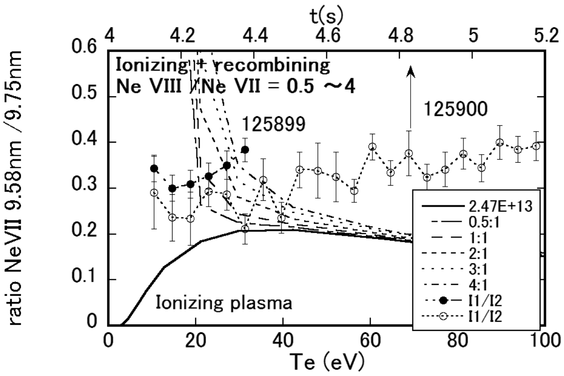

Fig.4 Calculated intensity ratios of Ne VII lines I1 and I2 in Fig.1 as functions of electron temperature with. ion density ratios n(Ne IX)/n(Ne VIII)=0 (ionizing plasma), 0.5, 1, 2, 3, and 4. Measured intensity ratios are also plotted as a function of time.