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

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Reducing high heat load on divertor plates is one of issues to prevent serious damage of divertor plates in future fusion devices such as the ITER, a DEMO and a helical reactor FFHR[1]. Impurity gas injection into a divertor plasma is one feasible idea to reduce the heat load on divertor plates, since impurity gas causes radiation power loss and decreases electron temperature, which would result in plasma detachment. There are several works considering the effect of impurity gas puff for scrape-off layer and divertor region for ITER[2,3] and JT-60SA[4] by using transport codes. Nitrogen, neon, argon, and other noble gases are the candidates for impurity gas injection.

We carried out theoretical calculations to examine the effect of impurity gas puff for peripheral plasmas using one-zone plasma modeling[5]. We found that Ne and N gas puff can reduce electron temperature down to a few eV within 1s if gas puff rate is high enough with 1% contamination rate. Dominant ionic states for radiation loss are different when electron temperature is different.

In the 17th LHD experimental campaign 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. Fig. 1 shows EUV spectra when Ne gas was injected and Ne VIII – Ne VI lines were observed. Those intensities decrease during 4.0 – 5.4s, but the intensity ratios keep almost constant as shown in Fig. 2. Electron density distribution does not change during this period, but the temperature distribution changes after 5.3s (Fig. 3). From the model calculation using ADAS[6] the line intensity ratios depend on electron temperature. This implies these lines were emitted at the same temperature region even if the temperature distribution changes. These ions are supposed to exist at T_e ~ 30 - 40eV region under the ionization equilibrium condition. We need more detailed analysis to confirm their emitting region in order to estimate the effect of radiation power loss.

1) A. Sagara, A. et al.: Fusion Engineering and Design **83** (2008) 1690.

2) M. E. Rensink & T. D. Rognlien: LLNL Report, UCRL-ID-124702 (1996).

3) M. E. Rensink, T. D. Rognlien, D. D. Hua: LLNL Report, UCRL-ID-124702-1 (1997).

4) Y. Suzuki et al. : Contrib. Plasma Phys. **48** (2008) 169.

5) I. Murakami et al.: Plasma and Fusion Res., **6** (2011) 2403029.

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

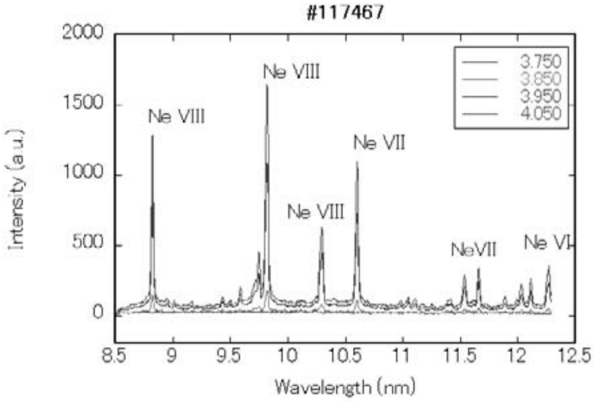

Fig. 1 EUV spectra measured with SOXMOS for the discharge #117467. N_e gas was injected at t=3.8 – 3.9s.

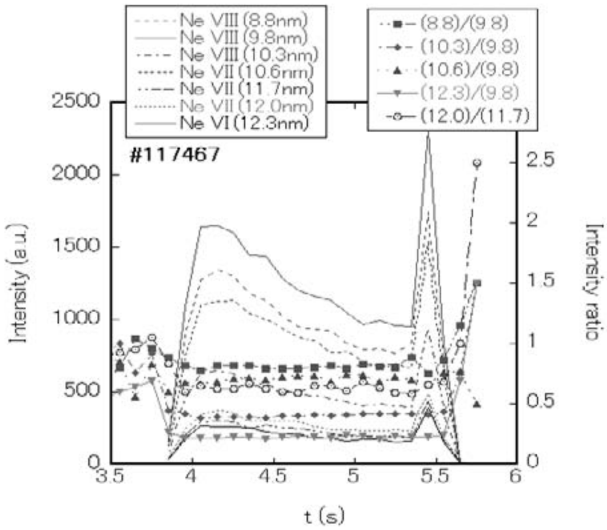

Fig.2 Temporal distribution of spectral intensities and intensity ratios for Ne VIII – Ne VI lines.

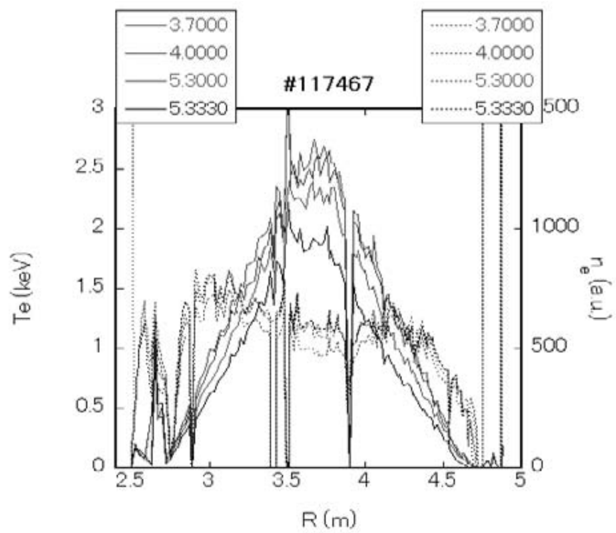

Fig.3 Electron temperature and density distribution measured by a Thomson scattering.