Simulation study of density dynamics effect on the ELM behavior with TOPICS-IB

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Edge localized modes (ELMs) induce sometimes very large heat load to divertor plates and cause the reduction of plate lifetime. Analyses from multi-machine experiments showed that the ELM energy loss increases with decreasing the collisionality and becomes larger than 15% of the pedestal energy [1]. Experimental analyses also suggested that the collisionality dependence of the ELM energy loss is caused by the collapse of the temperature profile during an ELM crash and not by the collapse of the density one [1]. Although effects of the bootstrap current and the scrape-off-layer (SOL) transport on the ELM energy loss have been discussed, the physical understanding and quantitative evaluation are not fully accomplished so far. In order to study the ELM mechanism, we have developed an integrated code TOPICS-IB [2] with a dynamic five-point model for SOL-divertor plasmas [3] and a stability code for peeling-ballooning modes, MARG2D. TOPICS-IB is based on the 1.5D core transport code TOPICS extended to the integrated simulation for burning plasmas. The five-point model can reproduce fairly well static and dynamic features obtained by particle and fluid simulations [3]. TOPICS-IB successfully simulates a series of transient behaviors of an H-mode plasma; the pedestal growth, an ELM crash and the recovery of the pedestal. At the ELM crash, the increase of SOL temperature mitigates the radial edge gradient and lowers the ELM energy loss. The collisionality dependence of the ELM energy loss was found to be caused by both the edge bootstrap current and the SOL transport. The steep pressure gradient inside the pedestal top broadens the region of the ELM enhanced transport through the broadening of eigenfunctions and enhances the ELM energy loss above 15 % of the pedestal energy [4]. In the previous simulation, the density profile is fixed for simplicity, the divertor plasma is assumed to be under the high recycling condition and the divertor plasma density is fixed high. The dynamics of the pedestal density strongly connects with the neutral recycling. In the present paper, we integrate neutral models in both the TOPICS and the five-point model. Effects of the density dynamics on the ELM behavior and the resultant energy loss will be studied. The simulation results will be compared with experiments.

[1] A. Loarte, et al., Plasma Phys. Control. Fusion **45** (2003) 1549.

[2] N. Hayashi, et al., Proc. 21th IAEA FEC 2006 (Chengdu), to be published in Nucl. Fusion.

[3] N. Hayashi, et al., J. Nucl. Mater. **363-365** (2007) 1044.

[4] N. Hayashi, et al., 11th International Workshop on Plasma Edge Theory in Fusion Devices, submitted to Contrib. Plasma Phys.