Interpretive modellings of tungsten sourcing and leakage in the EAST divertor with a mixed material environment

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Tungsten erosion processes under a mixed-material environment for EAST L- and H-mode discharges are analyzed and interpretively reproduced by a Li-C-W mixed-material model. During EAST type-I H-mode discharges, a unique double-peaked intra-ELM tungsten erosion phenomenon was observed. The ELM transport in the SOL and the corresponding W erosion process are sequentially simulated by using an ELM free expansion model together with a SDTRIM.SP mixed material model. Simulation results reveal that during ELM bursts, the energetic streaming C^{6+} arrives the divertor target about 0.5-1.5 ms latter than the main ions due to the lower initial thermal speed. As shown in figure 1, the time delay between the streaming D^+ and C^{6+} derived from the modeling agrees well with the time delay between the experimental double W erosion peaks for a wide range of pedestal conditions [1]. A Li-C overlayer on the tungsten surface makes the heavier impurity (C) comparatively more efficient than the main ions on causing tungsten erosion. With different thickness of the Li-C overlayer, three kinds of experimental intra-ELM tungsten erosion profiles are explicated, which are D^+ dominated single-peaked, C^{6+} dominated single-peaked and double-peaked erosion profiles. Besides, the tungsten erosion of type-I H-mode discharges are quantitively compared with the grassy-ELM H-mode discharges. Although the tungsten erosion caused by a single grassy ELM can be more than 10 times lower than the typical type-I ELM, the total tungsten erosion is not reduced due to the high grassy ELM frequency. For L-mode discharges, the tungsten erosion and transport are investigated by using the DIVIMP code combined with the SDTRIM.SP mixed material model. The W leakage from the divertor and the accumulation at the main SOL for discharges with different degrees of detachment are analyzed and benchmarked with the newly developed 1DImpFM [2]. Simulation results reveal that the divertor screening effect firstly decrease then increase with the enhancement of the divertor detachment, which indicates that a fully detached divertor is favorable for both the divertor protection and the tungsten impurity screening. The key physics governing the tungsten sourceing and leakage will be presented in this talk.

References

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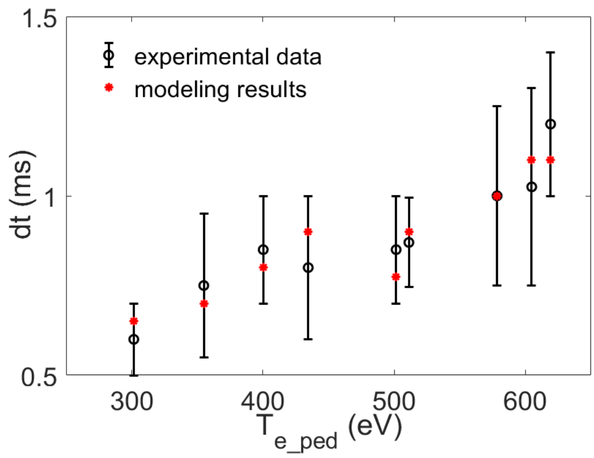

Figure 1, The time delay between the intra-ELM double W erosion peaks for different discharges with pedestal top electron temperature varying from 300 eV to 620 eV. Red stars are the time delay between the peak particle flux density of the intra-ELM D^+ and C^{6+} derived from the modeling.