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Comparison of Tungsten Transport Among Original, RMP-Induced and RF-Induced ELM-Free H-Mode Plasmas on EAST Tokamak

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Tungsten (W) accumulation is one of indispensable concerns in ELM-free high-performance discharge operation scenarios in tokamak devices with tungsten plasma-facing components (PFCs). In order to study compatibility of plasma performance, and operation window of auxiliary heating systems with respect to the tungsten accumulation, a variety of ELM-free operation scenarios have been considered in addition to the original ELM-free discharge, e.g. ELM-free discharges by n=2 RMP field application and by superimposing low hybrid wave (LHW) and ion cyclotron resonance frequency (ICRF) heating. These scenarios can be also referred as ELM suppression. In this work, line emissions from low-Z impurity ions of C^{4+}-C^{5+} and O^{5+}-O^{7+} and high-Z impurity ions of Fe^{17+}-Fe^{22+}, Cu^{19+}-Cu^{26+}, Mo^{24+}-Mo^{31+} and W^{24+}-W^{45+} located at different radial positions, which are measured with sets of high-performance extreme ultraviolet (EUV) spectrometers [1-3], are analyzed and results are compared for such different scenarios. It is found that the tungsten accumulation continued during the original ELM-free phase which leads to a continuous reduction of plasma store energy (W_{MHD}), as seen in Fig. 1(a). A similar tungsten accumulation was also observed during the ICRF-induced ELM-free phase (see Fig. 1(b)), and ELM-free phases during ICRF heating repeated with short pulse of 0.2s, while the W_{MHD} was kept constant in both phases. During the ELM-free phase induced by n=2 RMP field, on the other hand, the tungsten accumulation started to decrease, when the RMP field strength exceeds a threshold, i.e., RMP coil current $I_{RMP} \geq$ 1.45kA (see Fig. 1(d)). This result corroborates our recent study on the ELM-suppression by n=1 RMP application [4, 5]. Behaviors of other impurity species are also reported in the workshop. Tungsten transport simulation is now being developed based on TGYRO and STRAHL codes.

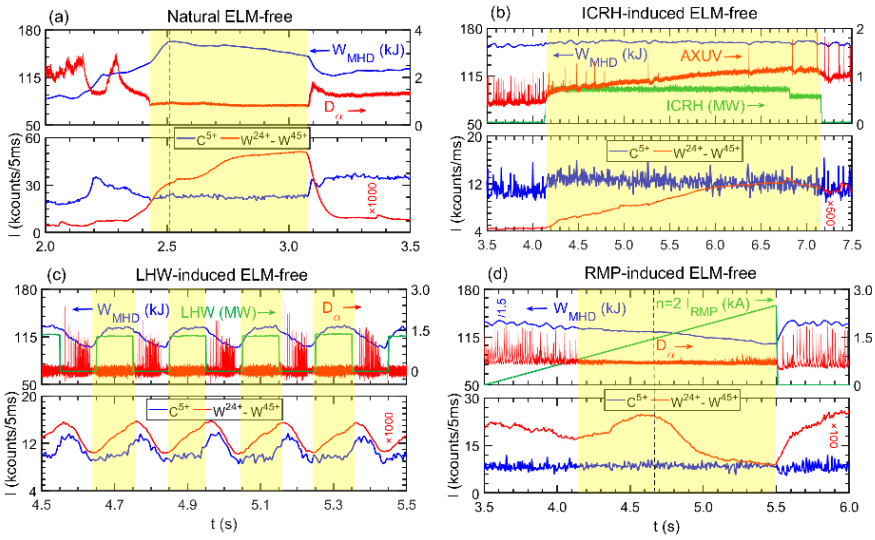

Fig. 1 Time evolutions of W_{MHD} and line emissions of D_α, C^{5+} and W^{24+}-W^{45+} band in discharges with (a) original, (b) RMP-induced, (c) LHW-induced and (d) ICRH- induced ELM-free phases.

References

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