Transport of Li and W impurities and their influence on discharge parameters of the T-10 tokamak

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In 2016, a W-limiter made of ITER-grade WMP "POLEMA" tungsten and the moveable Li-limiter has been installed on the T-10 tokamak [1]. The transport of Li and W impurities and their influence on the parameters of T-10 OH and ECRH-discharges are studied in this paper.

Experiments in OH-discharges were performed with two positions of the Li-limiter: outside and inside of the W-limiter radius. In the first case, short lifetime of Li^{1+} in scrape-off layer is severely limiting lithium flux in the plasma that results in low concentration of Li nuclei in the plasma center ($n_{Li^{3+}} < 0.3\%$ of n_e, which is insufficient to perform CXRS-measurements). In the second case, the flow of lithium is significantly increased and high concentration of Li nuclei in the plasma center is achieved (up to 26% of n_e, according to CXRS-measurements). Reliable data on $n_{Li^{3+}}$ made it possible to establish that the transport of lithium ions and nuclei follows the same dependences as all impurities in T-10 plasma and can be described by the transport model worked out for Ar, K, C, O, W impurities [2, 3]. The main influence of Li on the parameters of OH discharges is a strong reduction of light impurities level. This leads to a decrease of the effective charge Z_{eff} and opens the possibility for a strong peaking for both the $Z_{eff}(r)$ profile and the $P_W(r)$ radiation loss profile on W ions.

Study of the influx, transport, and radiation of W impurity in a plasma cord with a tungsten limiter at high ($Z_{eff} \geq 4$) and low ($Z_{eff} \approx 1$) levels of light impurities is carried out. The following recurring scenario is observed in the experiments: first, $Z_{eff}(r)$ peaks, then W accumulates at the plasma center, $P_W(r)$ peaks and suppresses the sawtooth oscillations (SO). Further the peaking of $P_W(r)$ causes flattening and broadening of $T_e(r)$, which ends with the evolution of the MHD mode m = 2 and the occurrence of a "small" disruption with the impurities removal and loss of 30 ... 50% of the plasma stored energy. This scenario (W-cycle) can repeate many times during the discharge, often resulting in a disruption. The conditions for development of the W-cycle in T-10 plasma are determined in this work. It was found that off-axis ECRH leads to the acceleration of the W-cycle due to the mitigation of SO suppression and the enhanced accumulation and peaking of W. The on-axis ECRH prevents the development of W-cycle at any stage due to the effective removal of tungsten from the plasma center [4].

References

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