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# The flow rates threshold for actively conditioning the walls through boron injection in EAST

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Wall condition is a crucial factor for plasma performance in magnetic confined fusion devices due to the uncontrolled impurities and fuel recycling, especially for future devices with great increases in heating power and pulse duration. As part of ITER's consideration to change its first wall material from beryllium to tungsten, it is proposed to inject solid boron into the plasma to coat the walls and divertor, in addition to glow discharge boronization, which has been widely employed in fusion devices.

EAST is a full metal wall machine with tungsten divertor and molybdenum armour which is similar to the entire tungsten wall in ITER. In the last campaign, EAST conducted boronization through pre-discharge coating using carborane and real-time injection of boron powder. At the initial stage of operation, boron powder was injected into L-mode discharges to try to enhance the plasma performance. It was found that the low-Z impurities, such as oxygen and carbon, and recycling both reduced obviously during injection. Unfortunately, the core tungsten and other high-Z impurity emissions increased with the increase of flow rate, which is enormously different from the previous results in H-mode discharges. It is possibly due to different transport mechanisms and electron temperatures on targets between L-mode and H-mode discharges. Besides, there was an obvious mass threshold for this wall conditioning effect. Only the injected boron mass over 2.0 mg/s, this wall conditioning effect started showing. And this effect was gradually enhanced with the increase of boron flowrate. Also, there was a maximum mass threshold. When the injected boron flowrate over than 3.5mg/s, the plasma density increased, showing a fueling effect. And this fueling effect was gradually enhanced with an increase of boron flowrate, finally leading to plasma disruption. The possible mechanism for the recycling decrease is due to the mitigation of plasma and wall interaction by reducing the electron temperature in the SOL and divertor region. Furthermore, a new experiment of recycling feedback control was carried out using boron powder real-time injection. In this experiment, a lower divertor Dalpha signal is the target of recycling behaviour in the initial stage of the feedback experiment. It was found that boron powder was instigated when the Dalpha emission was over the pre-set target value, and then the Dalpha reduced below the target value with boron entered into plasmas.

These investigations provide a very valuable reference for evaluating boron powder real-time wall conditioning effects in ITER and future fusion reactor devices.

References
[1] W. Xu et al., 2021 Phys. Scr. 96 124034
[2] W. Xu et al., 2023 Nuclear Materials and Energy, 34 101359

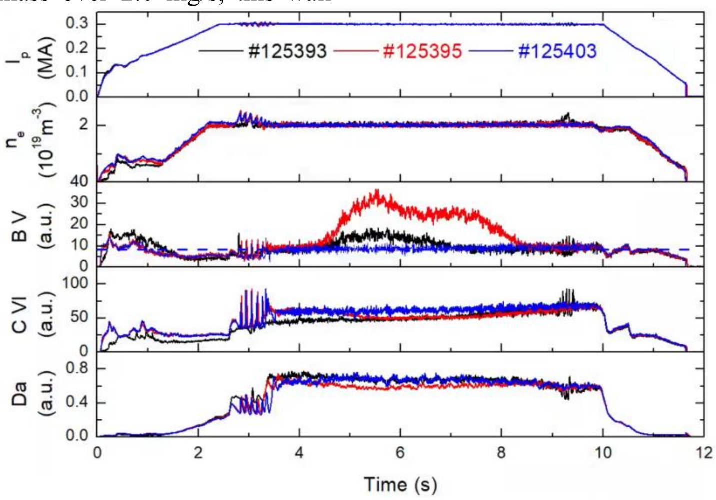


Figure 1. The minimum flow rates for boron powder actively conditioning first wall in EAST (#125403 without boron, #125393 with 1.0 mg/s and #125395 with 2.0 mg/s)