On-demand triggering of ELMs using impurity pellet injection into ELM-absent H-mode plasma on EAST

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Edge Localized Modes (ELM) are generally undesirable because of the strong divertor heat loads. However, ELM-free or low-frequency ELMy H-modes often suffer from impurity and radiation buildup. ELMs play a crucial role in particle and impurity transport in H-mode plasmas. Optimal ELM control can be achieved by suppressing naturally occurring ELMs and reintroducing them as needed for impurity control. This study demonstrates a method for on-demand ELM triggering in ELM-suppressed H-mode plasmas on the EAST tokamak using submillimeter lithium and carbon granule injection from the low field side midplane and X-point.

ELM suppression was achieved with a low-recycling wall by Li coating or active boron powder injection. Robust ELM triggering was obtained with 0.9±0.1mm diameter lithium granules, achieving a triggering efficiency of ~100%. The triggered ELM frequency ranged from 5-200Hz, depending on the pellet injection frequency and plasma conditions. Core radiation from heavy impurities, dominated by W, decreased by up to 50%, and the H98 factor increased from 0.87 to 1.12 after lithium granule injection.

Initially, substantially reduced-size ELMs were triggered, followed by a transition to a mixed ELM phase with intermittent large ELMs comparable to spontaneous ELMs. The particle flux from the triggered large ELMs impacted a wide spatial region of the outer target. The W flushing efficiency for the smaller, irregular pellet-induced ELMs can be evaluated from fast bolometry and SXR measurements. No statistically significant difference in the W flushing efficiency between pellet-triggered and natural ELMs has emerged. ELM-sputtered impurity influxes, determined from visible divertor spectroscopy, can be compared among ELM types.

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