Topic: EX-D

Modification of Edge Profiles, Edge Transport, and ELM stability with Lithium in NSTX

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The use of lithium in NSTX has enabled access to a high pedestal pressure regime, one in which the core stability limits at high normalized beta are observed with no sign of ELMs. Research in such ELM suppressed or small ELM regimes is of increasing importance for ITER, which requires that the projected fractional stored energy drop per ELM be maintained below 0.3%. Following application of lithium onto graphite plasma-facing components in NSTX, ELMs were eliminated gradually through growing periods of quiescence, with the resulting pressure pedestal widths increasing substantially. The modification of the pressure profile originated mainly from reduced recycling and edge fueling, which relaxed the edge density profile gradients inside the separatrix, effectively shifting the profile inward by up to 2-3 cm. In contrast, the edge electron temperature profile was unaffected in the H-mode pedestal steep gradient region at constant plasma stored energy; however, the region of steep gradients extended radially inward by several cm following lithium coatings. Consequently, the pressure profile width increased substantially, with the peak post-lithium ELM-free discharge gradients comparable to the pre-lithium ELMy discharge gradients. Simulations of the measured edge profile changes with the SOLPS code indicated that both a reduction in recycling *and* a drop in the edge and SOL cross-field transport was required to match the post-lithium profiles.

Calculations with the PEST and ELITE codes have confirmed that the post-lithium discharge pressure profiles were farther from the stability boundary than the reference pre-lithium discharges, which were relatively close to the kink/peeling boundary. Indeed low-n (n=1-5) pre-cursors were observed prior to the ELM crashes in the reference discharges, consistent with the PEST and ELITE predictions. The resulting post-lithium discharges were ELM-free with a 50% increase in normalized energy confinement, up to the global !$_N$ ~ 5.5-6 limit. While these ELM-free discharges ultimately suffer radiative collapse, pulsed 3-d magnetic fields can be used to trigger ELMs on-demand to control density and purge impurities as needed. This research was sponsored in part by U.S. Dept. of Energy under contracts DE-AC05-00OR22725, DE-AC02-09CH11466, DE-FC02-04ER54698, DE-AC52-07NA27344, DE-FG03-99ER54527 and DE-FG02-99ER54524.