ELM suppression through modification of Edge Profiles with Lithium Wall Coatings in NSTX

R. Maingi[a], T.H. Osborne[b], J.M. Canik[a], and the NSTX research team

[a]*Oak Ridge National Laboratory, Oak Ridge TN, 37831 USA*

[b]*General Atomics, San Diego, CA, 92121 USA*

Lithium coatings have been shown to improve energy confinement mainly through reduction of electron transport [1] in the National Spherical Torus Experiment (NSTX). When 'thick' coatings are applied between discharges, edge localized modes (ELMs) are completely suppressed [2,3]. The resulting post-lithium discharges are ELM-free with a 50% increase in normalized energy confinement, up to the global $\beta_N \sim 5.5\text{-}6$ limit [4]. Stability calculations have shown that the ELM suppression is caused by broadening of the pressure profile and the corresponding edge bootstrap current, owing mainly to a modification of the density profile [4].

The pressure profile broadening 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. The measured edge profiles in both the pre-lithium and post-lithium discharges were simulated with the SOLPS code package, which 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. While these ELM-free discharges otherwise suffer radiative collapse, pulsed 3-d magnetic fields were used to trigger ELMs for impurity control [5].

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