# Measurements and 2-D Modeling of Particle Balance, Recycling, and Core Fueling in Discharges with Lithium-coated PFCs in NSTX*

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The application of lithium coatings on the plasma facing components (PFCs) has been shown to profoundly affect plasma performance in the National Spherical Torus Experiment (NSTX) [1]. In particular, edge-localized modes (ELMs) are completely suppressed [2], which is attributed to an inward shift in the pedestal density caused by a reduction in recycling [3]. Here we present the detailed edge particle balance in both lithium-enhanced ELM-free discharges, and in discharges in which lithium coatings are combined with ELM pacing performed using n=3 magnetic perturbations in order to control the density evolution. Starting from boronized carbon PFCs, as the amount of lithium deposited increases, the density profile measured by reflectometry shows reduced density in the SOL, and an inward shift of the profile near the separatrix. This shift increases as the amount of deposited lithium is increased either by taking several shots with a fixed deposition rate, or by increasing the rate prior to a single discharge, and can reach as large as ~2-3 cm when sufficient lithium is deposited to fully suppress ELMs.

The edge particle balance during these ELM-free discharges has been studied through 2D plasma-neutrals modeling with the SOLPS code, constrained by measurements of the upstream plasma density and temperature profiles combined with measurements of the divertor heat flux and $D_\alpha$ emission. The calculations indicate that the reduction in divertor $D_\alpha$ emission as the lithium layer is applied is consistent with a drop in recycling coefficient from R~0.98 to R~0.9. The change in recycling is not sufficient to account for the change in edge density profiles, however. Further interpretive modeling indicates a widening of the transport barrier inside the separatrix and a reduction in radial particle transport in the scrape-off layer.

When ELM pacing [4] is added to the lithium-enhanced discharges, the secular increase in the density and radiated power is reduced. With the combination of ELM pacing and improved fuelling using a super-sonic gas injector [5], the line-averaged electron density can be made quasi-stationary. This is the result of the edge density decreasing in time, while the density on axis increases: these two dependences yield a line-averaged density that is steady in time. Both the global particle balance during these discharges, including inter-ELM and ELMy transport, and detailed modeling of the edge with SOLPS will be presented.

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