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Edge transport and turbulence reduction, and formation of ultra-wide pedestals with lithium coated PFCs in NSTX[1]

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The coating of plasma facing components (PFCs) with lithium improves energy confinement [1] and eliminates ELMs in the National Spherical Torus Experiment (NSTX), the latter due to a relaxation of the density and pressure profiles that reduces the drive for peeling-ballooning modes [2]. Here we show that both a reduction in recycling (due to lithium pumping) and cross-field transport is needed to reproduce the measured profile changes. Furthermore we document a concomitant density fluctuation reduction measured in the steep gradient region. The experimental transport coefficients are obtained via data-constrained modeling using the SOLPS code [3], which couples a 2D fluid treatment of the edge plasma transport to a Monte Carlo neutrals calculation. First, a reduction in the PFC recycling coefficient from R$\sim$0.98 to R$\sim$0.90 is required to match the drop in Dα emission with lithium coatings. Furthermore, a $\sim$75% drop of the D and χe from $0.8 < \psi N < 0.93$ are needed to match the profile relaxation with lithium coatings; indeed, the region of low transport in the H-mode simply extends to the innermost domain of the simulation. Transport is similar with and without lithium coatings outside of $\psi N \sim 0.93$, with D/χe $\sim$ 0.2/1.0 m2/s. Turbulence measurements using an edge reflectometry system [4] show a decrease in broadband density fluctuations with lithium coatings, primarily at frequencies <10 kHz. These transport changes allow the realization of very wide pedestals, with a $\sim$100% width increase relative to the reference discharges.

[1] H. W. Kugel et al, Phys. Plas. 15 (2008) 056118.
[2] R. Maingi et al, Phys. Rev. Lett. 103 (2009) 075001.
[3] R. Schneider et al, Contr. Plas. Phys. 46 (2006) 3.
[4] S Kubota et al, Bull. Am. Phys. Soc. 53 (2008) 188.

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