Topic: EX-D

The role of lithium conditioning in achieving high performance, long pulse H-mode discharges in the NSTX and EAST devices

R. Maingi[1], D.K. Mansfield[1], X.Z. Gong[2], Z. Sun[2], M.G. Bell[1], Y.M. Duan[2], H.Y. Guo[2], J.S. Hu[2], R. Kaita[1], S.M. Kaye[1], H.W. Kugel[1], J.G. Li[2], V.A. Soukhanovskii[3], B.N. Wan[2], G.S. Xu[2], and the EAST and NSTX teams

Email: rmaingi@pppl.gov
[1] *Princeton Plasma Physics Laboratory, Receiving 3, Route 1 North, Princeton, NJ 08543 USA*
[2] *Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031 China*
[3] *Lawrence Livermore National Laboratory, 7000 East Ave, P.O. Box 808, Livermore CA 94551, USA*

The role lithium wall conditioning on the achievement of high performance, long pulse discharges in the National Spherical Torus Experiment (NSTX) and the Experimental Advanced Superconducting Tokamak (EAST) is documented. Common observations include a reduction in hydrogenic recycling, confinement enhancement, and the elimination of ELMs. The plasma confinement and pulse length in both devices improve with increasing lithium conditioning. In NSTX, the impurity accumulation which occurred when natural ELMs were suppressed by lithium conditioning, was ameliorated by triggering controlled ELMs, e.g. with pulsed 3D fields. In EAST, active lithium conditioning during discharges has overcome this problem, producing an ELM-free H-mode with controlled density and impurities.

In NSTX, analysis has been extended to dedicated lithium conditioning scans with high δ and κ, more prototypical of the shapes envisioned for NSTX-U. Indeed, the improvements in pulse length, reduction in recycling, and elimination of ELMs in these highly shaped discharges reflect those with lower shaping, confirming that the performance improvements are not strongly shape dependent. The edge density and pressure gradients were reduced in the outermost 5% of the profile in both the high and intermediate shapes, which is critical for the edge stability improvement. However, while the pressure gradient was reduced, the pedestal broadened, increasing the pressure at the pedestal top and overall performance.

In EAST, the extensive lithium wall conditioning routinely applied via evaporators prior to a run day has been integral to the achievement of its record long H-mode pulse lengths in excess of 30 sec. However, during the course of a run day, the efficacy of the lithium coating can decline, and thus active conditioning during a discharge by injecting lithium powder into the edge plasma has been investigated. As in NSTX, large ELMs were eliminated, in this case with real time lithium conditioning. Although the radiated power and edge soft X-ray emission were moderately higher in the discharge with active conditioning, these and the line-averaged electron density remained relatively constant in time, in contrast to the NSTX observations which showed secular rises in all of these quantities with large lithium doses.

In summary, the results from both devices demonstrate several common benefits of lithium conditioning. The new observation on EAST of a quasi-steady discharge devoid of large ELMs improves the prospects for the applicability of lithium conditioning for future devices, removing one of the obstacles to progress in NSTX experiments.