The effect of lithium conditioning approaches for plasma-facing surfaces on the edge and core temperature and density profiles*

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Experiments on tokamaks at PPPL (NSTX [1], LTX [2], and CDX-U [3]), on the EAST and DIII-D tokamaks [4,5], and on FTU [6] have now investigated the effect of lithium surfaces on the scrape-off layer (SOL) and core plasmas using coatings on varying plasma-facing components (PFCs) including graphite or molybdenum tiles, porous tungsten surfaces, and stainless steel surfaces. These experiments have continued earlier work on lithium wall conditioning performed on T11-M [7], and TFTR [8]. Generally a reduction in the edge density gradient is observed with Li conditioning; however, both flat and peaked temperature profiles have been observed in different experiments [2,7], as well as widening of the H-mode temperature and density pedestal widths [1].

Technically, lithium has been introduced by pellet, granule, or aerosol injection, by direct evaporation, by evaporation into a backfill of helium gas, by between-shots fills of the bulk liquid metal into limiter structures, and by flowing liquid lithium over a limiting surface, during a discharge. A number of the tokamaks used in these experiments were limiter machines (TFTR, T11-M, CDX-U, FTU, and LTX), while others employed a divertor (NSTX, EAST). Background vacuum conditions and fueling have varied as well among the various experiments. While there are clear trends in the effects of lithium and lithium conditioned plasma-facing surfaces on the plasma performance, SOL effects, and (where analysis has been done) the surface science, there are also notable differences. Very recently a flat electron temperature profile with corresponding high edge temperatures was produced with a liquid lithium plasma facing surface in LTX [2], compared to more modest changes seen in NSTX and DIII-D [1,5], or even small decreases in the edge electron temperature seen in the EAST experiments with a flowing liquid lithium limiter plate [4]. The TFTR lithium conditioned discharges [8] had highly peaked temperatures profiles. Here we will show commonality between the various experiments, and attempt to reconcile a number of the disparate observations.

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