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NSTX Lithium Technologies and Their Impact on Boundary Control, Core Plasma Performance, and Operations*

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Replenishable liquid lithium PFCs show promise towards resolution of density and impurity control, tritium and dust removal, and long-lifetime walls for diverted high power DT reactors by providing a low-Z, pumping, and self-healing plasma facing surface, and enabling a lithium wall fusion regime. Motivated by this potential, lithium pellet injection (LPI), evaporated lithium, and injected lithium powder have been used in succession to apply lithium coatings to graphite plasma facing components in NSTX high-power divertor plasma experiments. In 2005, following wall conditioning and LPI, discharges exhibited edge density reduction and performance improvements. Since 2006, first one, and now two lithium evaporators have been used routinely to evaporate lithium onto the lower divertor region at total rates of 10-70 mg/min for periods 5-10 min between discharges. Since 2008, prior to each discharge, the evaporators are withdrawn behind shutters. Significant improvements in the performance of NBI heated divertor discharges resulting from these lithium depositions were observed. In 2009, these evaporators were used for more than 80% of NSTX discharges. Improvements in the performance of NBI-heated divertor discharges resulting from these lithium depositions include: reduced edge recycling, edge neutral density and SOL plasma density; improved energy confinement; reduced H-mode threshold power and increased H-mode edge pedestal electron and ion temperatures; suppression of ELMs; and decreases in the inductive flux consumption resulting in longer pulse lengths. The application of lithium has also reduced or eliminated the HeGDC previously required between discharges. Initial work with injecting fine lithium powder into the edge of NBI heated deuterium discharges yielded comparable changes in performance. Several operational issues encountered with lithium wall conditions, and the special procedures needed for vessel entry are discussed. The next step in this work is installation of a Liquid Lithium Divertor surface on the outer part of the lower divertor consisting of a toroidal array of 20 cm wide plates with a 165 micron layer molybdenum with 45% porosity, plasma sprayed on a protective barrier of 0.25 mm stainless steel, bonded to a 1.9 cm thick copper substrate. The design, methods, and application of these lithium technologies, and their impact on boundary control, core plasma performance, and operations will be presented.

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