NSTX Plasma Response to Lithium Coated Divertor*

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NSTX experiments have explored evaporated lithium coatings on a graphite divertor and other plasma facing components in both L- and H- mode confinement regimes heated by high-power neutral beams [1,2]. Improvements in plasma performance have followed from these lithium depositions, including a reduction and/or elimination of the required HeGDC time between discharges, reduced edge neutral density, reduced plasma density, particularly in the edge and the SOL, increased pedestal electron and ion temperature, improved energy confinement and the suppression of ELMs in the H-mode. However, with improvements in confinement and suppression of ELMs, there was a significant secular increase in the effective ion charge Z_{eff} and the radiated power in H-mode plasmas as a result of increases in the carbon and medium-Z metallic impurities. Lithium itself remained at a very low level in the plasma core, <0.1%. Recently, additional results have been obtained on the behavior of these changes as PFCs surfaces were transitioned from boronized graphite to relatively thin lithium coatings, and finally to thicker lithium coatings. Lithium has also been introduced by injecting a stream of chemically stabilized lithium powder, ~40 μm particle diameter, directly into the scrape-off layer of NBI-heated plasmas. This method of coating produced qualitatively similar effects to the evaporated lithium but at lower total amounts. Recent analysis of the lithium-coated graphite PFCs after plasma exposure have revealed the complex nature of the lithium-hydrogen-graphite interaction. The next phase of this line of research is the installation of a Liquid Lithium Divertor (LLD). The 20 cm-wide LLD located on the lower outer divertor, consists of four, 80° toroidal sections; the sections are separated toroidally by graphite tiles in which diagnostics are mounted. The LLD consists of a 0.16 mm layer of vacuum plasma-sprayed ~45% porous molybdenum facing the plasma, on top of 0.25 mm 316 stainless steel brazed to a 1.9 cm thick copper base. The temperature of the plates can be controlled between ambient and ~400°C and their surfaces will be coated in situ with lithium by evaporation or by applying lithium powder. The LLD is designed to accommodate the desired plasma shapes, the expected power fluxes and MHD forces and to provide pumping capability, and diagnostics for control and characterization of its operation.

[1] H.W. Kugel, *et al.,* Physics of Plasmas 15 (2008) 056118.
[2] M. G. Bell, *et al.*, Plasma Phys. Control. Fusion 51 (2009) 124054.

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