Dependence Of Impurity Accumulation On I_p And The Outer Gap In The Presence Of Lithium Deposition In NSTX*

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Lithium coatings have been routinely applied by evaporation onto the carbon surfaces of the lower divertor and other plasma-facing components in NSTX [1]. Shortly after commencing evaporation, a reduction in the frequency of ELMs is observed, with the ELMs eventually being suppressed altogether for periods up to about 1 second as deposition is continued [2]. Despite the absence of ELMs, the plasma remains in the H-mode and confinement remained good [3,4]. Co-incident with ELM suppression, the effective ion charge increases as a result of a buildup in carbon, though lithium itself remains at a low level away from the edge. Radiated power steadily increases as medium-Z metallic impurities, principally iron, accumulate in the core of the plasma [5].

This phenomenon is thought to occur in these NBI-heated, deuterium H-mode plasmas because the lithium coating modifies the recycling of hydrogenic species, affecting the plasma's edge. Another possibility includes the role of sputtering from metal surfaces by fast ions from NBI heating, introduced as a result of the changes in the plasma edge and scrape-off layer. An experiment was performed to investigate the dependence of impurity generation by changing the quantity of fast beam ion loss, modeling of which shows a strong dependence on plasma current and tangency radius of beam. At high plasma current, the smaller width of the banana orbits of trapped beam-ions is expected to minimize the intersecting of the orbits with the plasma facing components. Similarly, a smaller tangency radius of the injected heating beam is predicted to reduce the interaction.

The experiment consisted of scanning several operational parameters of lower-single-null diverted plasmas with 4 MW of NBI. The scans included (1) plasma current (.7 MA and 1.2 MA), (2) neutral beam tangency radius and, (3) the gap between the plasma boundary and outer limiter used to protect the RF antenna (10 cm to 20 cm). A large outer gap is similarly expected to reduce the intersecting of the trapped ion orbits with the plasma facing components.

Results from bolometry and XUV spectroscopy show that increasing the plasma current makes the largest difference in reducing the accumulation of core impurities. The modeled central iron concentration is reduced from .045% to .025%. No observable reduction in impurity accumulation was observed when the neutral beam injection was varied -- either the geometry or the time of injection. At high current, no difference in metals or carbon accumulation is observed when the outer gap is varied. At low plasma current, the Zeff from carbon is reduced by 12-20% at the largest value (20 cm) of the outer gap.

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