Simulations of Diffusive Lithium Evaporation onto the NSTX Vessel Walls[1]

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NSTX is exploring and developing lithium (Li) conditioning of plasma facing surfaces. In the principal technique used thus far, Li is evaporated from the top of the vessel into a vacuum in the period between discharges and is primarily deposited on the lower divertor surfaces. Lithium coatings have reduced D recycling, improved confinement and suppressed ELMs [1]. However, in the plasmas with suppressed ELMs, the core carbon and medium-Z metallic impurity concentrations increase in the latter part of a discharge. To the extent that these impurities are the result of sputtering from the graphite tiles and other surfaces, increased coverage of the plasma facing surfaces with Li should reduce the impurity sources.

In this paper, we describe 3-D DEGAS 2 neutral transport modeling of Li evaporation into a helium filled vessel. With this technique, the Li diffuses throughout the vessel, coating a larger fraction of the graphite tiles. The mean free path of the Li atoms scales inversely with the helium pressure, so lower pressures coat the bottom of the vessel most effectively and higher pressures lead to thicker coatings at the top. A series of DEGAS 2 simulations is used to construct a sequence of evaporations at three pressures (corresponding to Li mean free paths of 0.5, 1.0, and 3.1 m) that provide a specified minimum Li coating at all locations in the vessel.

The data taken during the experimental implementation of this prescription will be used to validate the DEGAS 2 based model for Li evaporation and deposition, accounting for the effects of outgassing of molecular hydrogen (H_2, HD, and D_2) and other technical details. The corresponding DEGAS 2 simulations will utilize the measured vessel pressures and Li evaporation amounts and will be compared with quartz micro-balance (QMB) measurements of the actual deposition. Preliminary analysis of the QMB data indicates that the deposition rates do exhibit the expected qualitative variation with helium pressure.

[1] R. Maingi et al., Phys. Rev. Lett. **103**, 075001 (2009).

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