The Effects of Increasing Lithium Deposition on the Power Exhaust Channel in NSTX

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Previous measurements on the National Spherical Torus Experiment (NSTX) demonstrated peak, perpendicular heat fluxes, $q_{dep,\ pk} \leq 15$ MW/m^2 with an inter-ELM integral heat flux width, $\lambda_{q,\ int} \sim 3$—7 mm during high performance, high power operation (plasma current, I_p = 1.2 MA and injected neutral beam power, P_{NBI} = 6 MW) when magnetically mapped to the outer midplane. Analysis indicates that $\lambda_{q,\ int}$ scales approximately as I_p^{-1}[1]. The extrapolation of the divertor heat flux and λ_q for NSTX-U are predicted to be upwards of 24 MW/m^2 and 3 mm respectively assuming a high magnetic flux expansion, $f_{exp} \sim 30$, P_{NBI} = 10 MW, balance double null operation and boronized wall conditioning.

While the divertor heat flux has been shown to be mitigated through increased magnetic flux expansion[1], impurity gas puffing[2], and innovative divertor configurations[3] on NSTX, the application of evaporative lithium coatings in NSTX has shown reduced peak heat flux from 5 to 2 MW/m^2 during similar operation with 150 and 300 mg of pre-discharge lithium evaporation respectively. Measurement of divertor surface temperatures in lithiated NSTX discharges is achieved with a unique dual-band IR thermography system[4,5] to mitigate the variable surface emissivity introduced by evaporative lithium coatings. This results in a relative increase divertor radiation as measured by the divertor bolometry system. SOLPS[6] modeling of heavy lithium evaporation discharges will be presented to elucidate divertor operation in this scenario. While the measure divertor heat flux is reduced with heavy lithium evaporation, λ_q contracts to 3—6 mm at low I_p but remains constant as I_p is increased to 1.2 MA yielding λ_q's comparable to no lithium discharges at high I_p. Implications for NSTX-U operation with heavy lithium coatings in the divertor will be discussed.

[1] T.K. Gray, et al., J. Nucl. Mater. **415** (2011) S360-S364
[2] V.A. Soukhanovskii, et al., Phys. Plasmas **16** (2009) 022501
[3] V.A. Soukhanovskii, et al., Nucl. Fusion **51** (2010) 012001
[4] J-W. Ahn, et. al., *Rev. Sci. Instrum.* **81** (2010) 023501
[5] A.G. McLean, et al., submitted to Rev. Sci. Instrum. (2011)
[6] J.M. Canik, et al., Phys. Plasmas **18** (2011) 056118

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