NSTX Liquid Lithium Divertor analysis shows promising predictions for future high-power operation

Purdue University researchers, led by Jeff Brooks and J.P. Allain, analyzed lithium sputtering, evaporation, and transport for the National Spherical Torus Experiment (NSTX) Liquid Lithium Divertor (LLD) for planned high heating power plasma conditions. A temperature-dependent, data-calibrated, surface response model was used to specify sputter yield, velocity distributions, and sputtered Li ion fraction for the liquid lithium divertor surface with D, Li, and trace C impingement. Using the surface response model, and supplied UEDGE code edge plasma parameters and LLD surface temperature profile [1] for a typical 2 MW heating, two-second, low deuterium recycle shot, the REDEP/WBC code package computes lithium erosion/redeposition. The results are encouraging showing negligible Li evaporation, moderate sputter erosion, acceptable Li transport in the edge plasma (~7% Li/D density), and low core plasma (~1% Li/D) contamination potential. A 2% carbon plasma content (from wall sputtering) does not significantly affect the LLD surface response. For fixed plasma conditions, but with hypothetically higher surface temperatures than the reference 281°C peak, an increase to ~350°C appears acceptable, thus implying a significant operating temperature margin. These results add to the confidence that high-power, high-quality plasma shots can be obtained in NSTX with the LLD.