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Study of the impact of pre- and real-time deposition of lithium on plasma performance on NSTX

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Experiments in many machines have shown improvements on plasma confinement and edge stability with increasing levels of lithium (Li) conditioning. Different methods were used in these experiments to deposit lithium into the plasma, such as a laser-based injection of Li aerosol, injection by movable probe, use of a rotatable Li-coated limiter and use of a movable porous capillary Li limiter. During NSTX experiments with Li conditioning, three methods of Li injection were used. In this paper, the efficiency to improve plasma performance, in terms of the Li inventory, of two of these three methods of Li injection are compared The first method evaporates Li over the lower divertor targets using a device that consists of a reservoir oven with an output duct that is inserted into a gap of the NSTX upper divertor –the "LITER". Typical evaporation rates obtained with the LITER are in the range 1 to 40 mg/min. In this method, the Li thin-film is deposited on the divertor targets before the discharge where the amount of injected Li depends on the amount of time that LITER is in operation. The second method uses a device that injects a Li aerosol into the plasma during the discharge by simply dropping spherical Li powder in a controllable manner using a vibrating piezoelectric disk with a central aperture –the "Li dropper". Controllable real-time injection of Li aerosol offers some advantages over the thin-film pre-deposition method, such as the real-time replacement of the Li thin-film removed from the divertor targets by the plasma-wall interaction. Typical evaporation rates obtained with the Li dropper are significantly larger than with the LITER and range between 1 to 120 mg/s. However, considering that the LITER evaporates Li during several minutes before the discharge, and that the Li dropper does not operate for more than 1-2 seconds, the total amount of Li injected with these two methods are comparable. The results show that the Li dropper is more efficient than the LITER, as it requires lower amounts of Li to cause the same performance improvements obtained with the LITER. However, the results using the Li dropper show that, above an evaporation rate of about 80 mg/s, no significant incremental change in plasma performance is observed. The effect of the Li evaporation rate on recycling and kinetic profiles for these two methods of Li injection will also be discussed and compared with those in discharges where the plasma facing components were conditioned by helium glow discharge cleaning and boronization. This research was supported by the General Atomics Postdoctoral Research Participation Program administered by ORAU and is part of the General Atomics Collaboration on Plasma Boundary Interfaces and Macroscopic Stability at NSTX-U. This work has been supported by the US Department of Energy, Office of Science, Office of Fusion Energy Science under DOE award DE-SC0012706.

Eligible for student paper award?

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