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High Performance Discharges in the Lithium Tokamak eXperiment (LTX) with Liquid Lithium Walls[1]

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The possibility of a liquid metal first wall for a fusion reactor has been extensively discussed. Small-area liquid lithium limiters and divertor targets have been installed in tokamaks, but no confinement device has ever operated with a large-area liquid lithium wall. Here we report the first-ever successful operation of a tokamak with a large area (2 m^2, or 40% of the total plasma surface area) liquid lithium wall in the Lithium Tokamak eXperiment (LTX). These results were obtained with a new, electron beam-based lithium evaporation system, which can deposit a lithium coating on the hot (300 C) wall of LTX in a five-minute period. Preliminary analyses of diamagnetic and other data for discharges operated with a liquid lithium wall indicate that confinement times increased by 10$\times$ compared to discharges with helium-dispersed solid lithium coatings. Ohmic confinement times exceeded ITER98P(y,2) scaling by up to a factor of four. LTX lacks auxiliary heating, so these confinement improvements represent changes in electron confinement. Spectroscopic analysis of the discharges using the John Hopkins University transmission grating extreme ultraviolet spectrometer indicates that oxygen levels in the discharges run against liquid walls were significantly reduced compared to discharges operated against solid lithium walls. This differs strongly from earlier trials of molten lithium walls in LTX, which showed evidence for strong oxygen influx from walls operated at similar temperatures. At present, the Thomson scattering system is undergoing upgrades and realignment, after which confinement times obtained with magnetic diagnostics will be compared with kinetic measurements. A second electron beam will be installed to extend liquid lithium wall operation to 4 m^2 coverage, or >80% of the total plasma surface area. Results with expanded liquid lithium wall area will be presented.

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