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**A study of hydrogenic retention in a tokamak with reactor-like plasma-facing surfaces; Alcator C-Mod**

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Tritium retention is an important safety concern for ITER; Operation for 1000 discharges without a major stoppage will require the fraction of ion fluence to Plasma Facing Components (PFCs) that is retained, R, to be $< 0.001\%$. One year operation of a reactor, where tungsten (W) PFCs are envisioned, requires R to be 100x smaller! Co-deposition of H with carbon projects to unacceptably high T retention in ITER. We present the results of the first in-depth study of fuel retention for high-Z PFCs with ITER divertor $n_e$, $T_e$, particle and heat fluxes. We utilize molybdenum (Mo, with a small fraction of W), which is very similar to tungsten in terms of hydrogenic retention. The retention observed in a series of disruption-free C-Mod discharges is high, R$\sim$1%, 1000x than expected from inherent Mo properties. These retention characteristics are exhibited regardless if the Mo surfaces are bare or partially covered by B films; D co-deposition with B is not contributing significantly to retention. Retention appears linear in fluence up to the limit of the discharge sequence, $\sim$20s, approaching one ITER discharge. Comparison of He- and D-fueled discharges gives support to a model of retention site creation in the lattice ('traps') due to D neutral buildup and accompanying lattice distortion driven by recombination-limited release (D->$D_2$) from the front surface. Disruptions can be used to rapidly heat surfaces, releasing the H/D for recovery, potentially applicable to ITER. Naturally-occurring disruptions appear to balance single-discharge retention reducing the campaign-integrated retention by at least 100. Comparisons to laboratory-based retention studies indicate that the tokamak environment leads to additional enhancements of retention. This work is supported by U.S. Dept. of Energy Coop. Agreement DE-FC02-99ER54512.