Experiments to Measure Hydrogen Isotope Exchange in Graphite Walls During Massive Hydrogen Gas Injection in DIII-D*

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Discharge termination via massive hydrogen injection during the current ramp-down is a possible approach to help in tritium removal from soft co-deposits of carbon in the divertor region of ITER. The use of massive injection of argon for ITER discharge termination and simultaneous tritium removal from radiation flash heating of the walls has been proposed previously [1]. Massive hydrogen injection is a somewhat different approach in that heating of the wall tends to come from conducted heat loads, not from radiation. Because of the known ion energy and surface temperature dependence of chemical erosion [2], the huge plasma fluxes to the wall which occur during hydrogen massive gas injection (MGI) shutdowns are expected to be very effective at removing soft surface layers. Additionally, MGI shutdown wall fluxes are large throughout much of the divertor region, not just at the strike points [3]; thus, wall surfaces which experience net deposition during normal operation become, transiently, regions of large erosion. In DIII-D H_2 MGI experiments, 1000 torr-l of H_2 gas are injected into a H-mode deuterium discharge in a 3 ms pulse, resulting in discharge termination within 10 ms. Huge main chamber average plasma densifications of $20\times$ (from $n_e \approx 5\times10^{13}$ cm^{-3} to $n_e \approx 10^{15}$ cm^{-3}) are observed. At the main chamber wall, densifications of greater than $100\times$ are measured (from $n_e < 10^{12}$ cm^{-3} to $n_e > 10^{14}$ cm^{-3}), resulting in very large main-chamber recycling fluxes. Exposure of an x-point DiMES graphite sample during H_2 MGI indicates that the initially D-saturated graphite is largely (more than 50%) replaced by H in a single H_2 MGI shutdown, thus demonstrating very effective isotope exchange.

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