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Quantification of Chemical Erosion in the DIII-D Divertor[1]

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Chemical erosion (CE) yield at the graphite divertor target in DIII-D was measured to be substantially lower in cold near-detached plasma conditions compared to well-attached ones, with major implications for ITER. Current estimates of tritium retention by co-deposition with hydrocarbons (HCs) in ITER place potentially severe restrictions on operation. However, calculations done to date have been based on excessively conservative assumptions, due to limited understanding of cold divertor plasmas (1-5eV) which bridge energy thresholds for complex atomic and molecular processes not present in attached conditions. Hydrocarbon injection through a unique porous graphite plate which realistically simulates secondary reactions of HCs with a graphite surface has been used to measure CE *in-situ*. For the first time in a divertor, measurements were made at extrinsic CH_4 injection rates comparable to the expected intrinsic CE rate of C, with the resulting spectroscopic emissions separated from those of the intrinsic sources. Under cold plasma conditions the contribution of CE-produced C relative to total C sources in the divertor declined dramatically from $\sim$50% to $<$15%. Photon efficiencies for products from the breakup of injected CH_4 were greater than previous measurements at higher puff rates, indicating the importance of minimizing perturbation to the local plasma. At 350K, the measured CE yield near the outer strike point was $\sim$2.6% in attachment dropping to only $\sim$0.5% in cold plasma; results are consistent with some theoretical predications and lab studies. Under full detachment, near total extinction of the CD band occurred, consistent with suppression of net C erosion. These findings have potentially major impact on projected target lifetime and tritium retention in future reactors, and for the PFC choice in ITER.

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