Carbon Sources, Scrape-Off Layer Transport, and Deposition in DIII-D*

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Comprehensive studies of carbon production, transport, and deposition in the scrape-off layer (SOL) in DIII-D show that carbon produced in the main chamber is primarily deposited in the divertor on surfaces facing a cold and dense plasma. Controlling the carbon erosion and deposition are critical issues for future fusion devices with carbon PFCs, as tritium will be co-deposited with the carbon layer, potentially leading to an unacceptable tritium inventory. Carbon-13 tracer experiments were carried out in DIII-D L-mode and H-mode plasmas by injecting $^{13}CH_4$ into the main SOL, and analyzing tiles post-mortem for ^{13}C surface deposition. The main and divertor SOL of these plasmas were well characterized, including 2-D measurements of the carbon emission in the divertor and near the $^{13}CH_4$ injection location. In both confinement regimes a high ^{13}C deposition was observed in the inner divertor. However, in H-mode, the deposition extended across the private flux region to the intercept of the outer leg of the separatrix. Multiple diagnostics in the divertor region showed that the inner divertor SOL is partially detached in L- and H-mode, while the outer divertor SOL is attached in the L-mode, but partially detached in the H-mode plasma. Edge-localized modes were observed to modulate the divertor plasma conditions in H-mode, by periodically reattaching the inner and outer divertor plasma. Plasma simulations of the L-mode using the UEDGE code including **E**x**B** and **B**x∇ B drifts predict carbon flow in the main SOL toward the outer target, and ^{13}C carbon deposition along the inner and outer divertor targets. Assuming a deuterium flow of M~0.5 in the main SOL toward the inner divertor, interpretative studies with the OEDGE code are consistent with the main SOL carbon emission distributions and ^{13}C deposition profile.

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