Boundary Mass Transport Research on DIII-D*

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The DIII-D boundary research plan is focussed on understanding the physics of mass transport in the scrape-off layer (SOL) and divertor and developing techniques to affect and control the flow of particles around the boundary of divertor tokamaks. The transport of deuterium fuel in the boundary is responsible for plasma recycling from material surfaces, fueling of the pedestal and core plasma, and impurity generation and transport. Understanding these coupled processes will be key to designing the boundary of future fusion devices, and particularly the power and particle handling of high power density and high triangularity discharges. Recent experiments have measured the 2-D recycling and fueling profiles with camera images in the divertor and main chamber and these have been compared with calculation from fluid and neutrals codes such as UEDGE, DIVIMP, DEGAS and OEDGE. Density and fueling control in advanced tokamak regimes has been found to place requirements on pumping geometry and the secondary separatrix. The radial and parallel transport of particles and impurities due to edge localized modes (ELMs) and bursty transport have been measured with a variety of high time resolution diagnostics. Control of the ELM flux has been demonstrated in initial experiments by applying non-axisymmetric magnetic fields to produce a stochastic boundary. For impurity generation molecular spectroscopy and CI lineshape studies in D and He plasmas are being used to determine the relative importance of chemical versus physical sputtering. Carbon transport was investigated by toroidally symmetric injection of $^{13}CH_4$ into the main chamber during 22 identical discharges. Afterward, a poloidal row of graphite tiles was removed for surface analysis. The poloidal profile of ^{13}C deposition coupled with extensive plasma documentation will allow for the modeling of carbon trasnport and redeposition. To improve boundary measurements a number of additional and upgraded diagnostics are planned for DIII-D and include Langmuir probes to characterize main chamber particle fluxes, microbalances to measure carbon erosion and redeposition and boundary charge-exchange recombination spectroscopy for impurity flow measurements. A new lower divertor geometry is also planned to provide better particle control for DIII-D advanced tokamak operation, which optimizes in a high triangularity balanced double-null shape.

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