Overview of the Recent DiMES and MiMES Experiments in DIII-D

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Divertor and midplane material evaluation systems (DiMES and MiMES) in the DIII-D tokamak are used to address a variety of plasma-material interaction issues relevant to ITER. Among the topics studied are carbon erosion and re-deposition; hydrogenic retention in the gaps between plasma facing components (PFCs); deterioration of diagnostic mirrors from carbon deposition and techniques to mitigate that deposition; dynamics and transport of dust.

Continuous increase of tritium inventory due to co-deposition with carbon is a critical challenge for ITER. A large fraction of the retained tritium may be accumulated in gaps between PFCs. A decrease of the deuterium (used as a proxy for tritium) retention rate by more than a factor of 10 with an increase in gap wall temperature from 30°C to 200°–300°C has been demonstrated under detached divertor conditions. Effect of the gap entrance geometry on deuterium retention rate was studied by exposing a castellated tungsten sample containing a combination of rectangular and shaped blocks. Carbon erosion/deposition at the outboard chamber wall was studied using MiMES. Net deposition at a rate of ~1 nm/s was measured in high-density, high confinement (H-mode) discharges, while in lower density H-modes a bias towards net erosion was observed. Carbon erosion at a rate of ~9 nm/s was measured in argon-seeded H-mode plasmas under semi-detached conditions in the lower divertor.

Deterioration of diagnostic mirrors from both erosion and deposition processes is a serious concern for ITER. Successful demonstration of carbon deposition mitigation by deuterium gas puff was performed in the lower divertor using DiMES. Mirrors were also exposed in a mid-plane diagnostic port using MiMES. Strong dependence of carbon deposition rate on the mirror orientation has been observed.

Accumulation of radioactive dust and core plasma contamination by impurities resulting from dust transport are potentially problematic for ITER. Studies of dust transport and dynamics have been performed by introducing pre-characterized graphite and diamond dust in the lower divertor using DiMES. The results were used to benchmark Dust3D modelling of the dust transport.

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