Migration of Artificially Introduced Micron Size Carbon Dust in the DIII-D Divertor*

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Micron size dust is commonly found in tokamaks and stellarators. Though generally of no concern in present day machines, dust may pose serious safety and operational concerns for the next generation of fusion devices such as ITER. Dust accumulation inside the vacuum vessel can contribute to increased tritium inventory and cause radiological and explosion hazards [1]. In addition, dust penetrating the core plasma can cause increased impurity concentration and degrade performance.

We studied migration of pre-characterized carbon dust in a tokamak environment by introducing about 30 milligrams of dust flakes 5–10 μm in diameter in the lower divertor of DIII-D using the DiMES sample holder. In two separate experiments dust was exposed to high power ELMing H-mode discharges in lower-single-null magnetic configuration with the strike points swept across the divertor floor. In the initial stage of the discharges the dust holder was located in the private flux zone, and the dust presence did not manifest itself in any way. When the outer strike point (OSP) passed over the dust holder exposing it to high particle and heat fluxes, part of the dust was injected into the plasma. In about 0.1 s following the OSP pass over the dust, 1%-2% of the total dust carbon content ($2\text{–}4\times10^{19}$ carbon atoms, equivalent to a few million dust particles) penetrated the core plasma, raising the core carbon density by a factor of 2-3. When the OSP moved inboard of the dust holder, the dust injection continued at a lower rate. Individual dust particles were observed moving at velocities of 10–100 m/s, predominantly in the toroidal direction for deuteron flow to the outer divertor target, consistent with the ion drag force. The observed behavior of the dust is in qualitative agreement with modeling by the 3D Dust Transport (DustT) code, which calculates trajectories of test dust particles in a realistic plasma environment.

[1] G. Federici *et al.,* Nucl. Fusion **41**, 1967 (2001).

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