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Observation of Dust in DIII-D Divertor and SOL by Visible Imaging*

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Dust is commonly found in fusion devices. Though generally of no concern in the present day machines, dust may pose serious safety and operational concerns for ITER. Micron-size dust usually dominates the samples collected from tokamaks. During a plasma discharge micron-size dust particles can become highly mobile and travel over distances of a few meters. Once inside the plasma, dust particles heat up to over 3000 K and emit thermal radiation that can be detected by visible imaging techniques. Observations of naturally occurring and artificially introduced dusts have been performed in DIII-D divertor and scrape-off layer (SOL) using standard frame rate CMOS cameras, a gated-intensified CID camera, and a fast-framing CMOS camera. In the first 2-3 plasma discharges after a vent with personnel entry inside the vacuum vessel ("dirty vent") dust levels were quite high with thousands of particles observed in each discharge. Individual particles moving at velocities of up to a few hundred m/s and breakup of larger particles into pieces were observed. After about 15 discharges dust was virtually gone during the stationary portion of a discharge, and appeared at much reduced levels during the plasma initiation and termination phases. After a few days of plasma operations (about 70 discharges) dust levels were further reduced to just a few observed events per discharge except in discharges with current disruptions that produced significant amounts of dust. An injection of a few milligram of micron-size (6 micron median diameter) carbon dust into a high-power lower single-null ELMing H-mode discharge with strike points swept across the lower divertor floor was performed. A significant increase of the core carbon radiation was observed for about 250 ms after the injection, as the total radiated power increased twofold. Dust particles from the injection were observed by the fast framing camera in the outboard SOL near the midplane. The amount of dust observed by the fast camera immediately after the injection was comparable to that in the very first plasma discharges following the dirty vent.

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