Dust studies in DIII-D and TEXTOR

D.L. Rudakov,[a] A. Litnovsky,[b] W.P. West,[c] J.H. Yu,[a] J.A. Boedo,[a] B.D. Bray,[c] S. Brezinsek,[b] N.H. Brooks,[c] M.E. Fenstermacher,[d] M. Groth,[d] E.M. Hollmann,[a] A. Huber,[b] A.W. Hyatt,[c] S.I. Krasheninnikov,[a] C.J. Lasnier,[d] R.A. Moyer,[a] A.Yu. Pigarov,[a] V. Philipps,[b] A. Pospieszczyk,[b] R.D. Smirnov,[a] J.P. Sharpe,[e] W.M. Solomon,[f] J.G. Watkins,[g] and C.P.C. Wong[c]

[a]University of California, San Diego, La Jolla, California 92093-0417, USA
[b]Institut für Energieforschung-Plasmaphysik, Forschungszentrum Jülich, Association EURATOM-FZJ, 52425 Germany
[c]General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA
[d]Lawrence Livermore National Laboratory, Livermore, California 94551, USA
[e]Idaho National Engineering and Environmental Laboratory, Fusion Safety Program, Idaho Falls, Idaho 83415, USA
[f]Princeton Plasma Physics Laboratory, Princeton, New Jersey, USA
[g]Sandia National Laboratories, Albuquerque, New Mexico 87185, USA
e-mail contact of main author: rudkov@fusion.gat.com

Abstract. Studies of naturally occurring and artificially introduced carbon dust are conducted in DIII-D and TEXTOR. In DIII-D, dust does not present operational concerns except immediately after entry vents. Submicron sized dust is routinely observed using Mie scattering from a Nd:Yag laser. The source is strongly correlated with the presence of Type I edge localized modes (ELMs). Larger size (0.005–1 mm diameter) dust is observed by optical imaging, showing elevated dust levels after entry vents. Inverse dependence of the dust velocity on the inferred dust size is found from the imaging data. Heating of the dust particles by the neutral beam injection (NBI) and acceleration of dust particles by the plasma flows are observed. Energetic plasma disruptions produce significant amounts of dust; on the other hand, large flakes or debris falling into the plasma may induce a disruption. Migration of pre-characterized carbon dust is studied in DIII-D and TEXTOR by introducing micron-size particles into plasma discharges. In DIII-D, a sample holder filled with 30–40 mg of dust is inserted in the lower divertor and exposed, via sweeping of the strike points, to the diverted plasma flux of high-power ELMing H-mode discharges. After a brief dwell (~0.1 s) of the outer strike point on the sample holder, part of the dust penetrates into the core plasma, raising the core carbon density by a factor of 2–3 and resulting in a twofold increase of the radiated power. In TEXTOR, instrumented dust holders with 1–45 mg of dust are exposed in the scrape-off layer 0–2 cm radially outside of the last closed flux surface in discharges heated with 1.4 MW of neutral beam injection (NBI). Launched in this configuration, the dust perturbed the edge plasma, as evidenced by a moderate increase in the edge carbon content, but did not penetrate into the core plasma.