Control of Plasma Profiles and Transport Barriers by Pellet Injection in DIII–D*

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A key issue for obtaining higher performance in toroidal devices is to determine means to directly reduce the radial transport in these plasmas. One approach is to actively control the radial electric field, E_r, and its radial derivative since E×B flow shear can significantly reduce the level of turbulence in the plasma. In the DIII–D tokamak, the injection of deuterium pellets has been investigated as a means of affecting various plasma quantities, such as the electron density and the toroidal rotation velocity, in an effort to control the radial electric field profile. Therefore, the local pellet deposition coupled with angular momentum conservation provides a means to change gradients in the plasma rotation and E_r.

Solid deuterium pellets of 2.7 mm diameter have been injected from several locations around the plasma cross-section including injection from two locations on the inside wall, vertical injection inside the magnetic axis, and radial injection from the outside midplane of the vessel. Also, 1.5 mm diameter lithium pellets have been injected from the outside midplane. Pellet penetration extended to the plasma axis for deuterium pellets injected from the inside wall. The pellets significantly perturbed the density profiles and, consequently, the toroidal rotation velocity profiles since the toroidal angular momentum is observed to be conserved. Consequently, the E_r profile is also modified, with the degree of modification being dependent on the penetration depth of the pellet.

Lithium pellet injection during plasma current ramp-up and during counter neutral beam injection produced significant increases in the core electron density and an internal transport barrier that lasted for 1 s. Results on pellet induced changes to the n_e, T_e, T_i, v_ϕ, and E_r profiles and subsequent changes to the transport will be presented for single-null and double-null discharges with co- and counter neutral beam injection.

Shallow pellet penetration to $\rho \geq 0.85$ to affect local changes to only the plasma edge have been produced by shattering the 2.7 mm diameter deuterium pellets before entry into the plasma. These shattered pellets can significantly alter the edge pedestal electron density and electron temperature as well as the edge toroidal rotation. The resultant effect on the edge transport barrier in H–mode plasmas varies from inducing ELMs in ELM-free H–mode plasmas to increasing the ELM frequency in ELMing H–mode plasmas. Edge pellet deposition is also being investigated as a means of producing an H–mode transition from otherwise stable L–mode condition and as a means of changing the pedestal conditions and determining the resultant effects on the radial temperature profiles to compare with theories and models of the edge pedestal.

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