Effects of impurity seeding in DIII–D radiating mantle discharges

G.L. Jackson, M. Murakami,[a] G.R. McKee,[b] D.R. Baker, J.A. Boedo,[c] R.J. La Haye, C.J. Lasnier,[d] A.W. Leonard, A.M. Messiaen,[e] J. Ongena,[e] G.M. Staebler, B. Unterberg,[f] M.R. Wade,[a] J.G. Watkins,[g] and W.P. West

General Atomics, P.O. Box 85608, San Diego, California 92186-5608

[a]Oak Ridge National Laboratory, Oak Ridge, Tennessee.

[b]University of Wisconsin, Madison, Wisconsin.

[c]University of California, San Diego, California.

[d]Lawrence Livermore National Laboratory, Livermore, California.

[e]Plasma Physics Laboratory, Association EURATOM, Ecoloe Royal Militaire, Brussels, Belgium.

[f]Forschungszentrum Julich GmbH, EURATOM Association, Jülich, Germany.

[g]Sandia National Laboratories, Albuquerque, New Mexico.

(Received

Abstract. Impurity injection, with neon, argon, or krypton, has been used in DIII-D to increase radiation in the mantle region, with confinement enhancements above the ITERL-89P L–mode scaling relation in both diverted and limited discharges. For discharges with an L–mode edge (both limited and diverted), impurity injection produces a prompt increase in confinement (solid line) and a more gradual increase in density. These changes occur at densities and radiated power fractions significantly lower than observed in the TEXTOR tokamak device. ELMing H–mode discharges with active pumping and high deuterium gas feed (puff and pump) exhibit an increase in density with no decrease in energy confinement after impurity injection, increasing to near the Greenwald density limit following a spontaneous transition several hundred milliseconds after

impurity injection. The highest density phase of these discharges is usually terminated after the onset of n=2 MHD activity, identified as an m/n = 3/2 neoclassical tearing mode. High performance discharges at lower density have also been achieved, with a reduction the edge electron pressure and the edge electron pressure gradient and longer ELM-free periods than in comparable discharges without impurity seeding. A reduction in density fluctuations after impurity injection in the mantle region has been measured by beam emission spectroscopy (BES) in L–mode discharges. A reduction in ion temperature driven (ITG) modes is calculated for these discharges, consistent with the observed BES measurements and is the leading candidate to explain the observed confinement improvements.