Comprehensive Measurements and Modeling of SOL, and Core Plasma Fueling and Carbon Sources in DIII-D*

M. Groth,[1] G.D. Porter,[1] J.A. Boedo,[2] S. Brezinsek,[3] N.H. Brooks,[4] M.E. Fenstermacher,[1] R.J. Groebner,[4] E.M. Hollmann,[2] C.J. Lasnier,[1] A.G. McLean,[5] W.M. Meyer,[1] R.A. Moyer,[2] M.E. Rensink,[1] D.L. Rudakov,[2] G. Wang,[6] J.G. Watkins,[7] L. Zeng[6]

[1]*Lawrence Livermore National Laboratory, Livermore, California, USA*
[2]*University of California, San Diego, California, USA*
[3]*Institut für Plasmaphysik, Forschungszentrum Jülich, Germany*
[4]*General Atomics, San Diego, California, USA*
[5]*University of Toronto (UTIAS), Toronto, Canada*
[6]*University of California, Los Angeles, California, USA*
[7]*Sandia National Laboratory, Albuquerque, California, USA*

A comprehensive set of boundary-region diagnostic data was obtained during L-mode and ELMy H-mode plasmas, and simulated using the UEDGE/DEGAS2 codes, to determine the poloidal distribution of the core plasma sources. These measurements included density and temperature at the outer midplane, particle and heat flux to the target plates, and line-integrated and two-dimensional emission profiles of deuterium and carbon in the divertor and main SOL region. Analyses of the emission profiles in the divertor were expanded to include a range of spectral lines: neutral deuterium (D_α and D_γ), neutral carbon (CI 909 nm), and low charge-state carbon (CII 514 nm, CIII 465 nm). In the main chamber, the D_α and CIII (465 nm) emissions were measured at the inner and outer midplane, and at the top of the plasma. The emission of all measured spectral lines peaked in the divertor region, and decreased poloidally toward the midplane by orders of magnitude.

Using a purely diffusive model for the radial plasma transport in the pedestal and SOL region, including the drifts due to **E**x**B** and **B**x∇B, the simulations are consistent with the measured profiles of particle flux and line emissions. The measured midplane D_α emission profiles were well-reproduced by neutral leakage from the divertor region into the main chamber. The simulations show that neutrals penetrate more easily into the SOL on the high-field side of the core plasma than on the low-field side, due to the in-out asymmetric divertor temperature distribution. This greater penetration results in significantly stronger fuelling from the inner main SOL. Carbon produced by chemical sputtering at the inner divertor target and adjacent wall area dominates the carbon content of the inner main SOL. Because of the long neutral mean free path of deuterium neutrals in the inner divertor, the high recycling zone associated with the inner leg can extend as much as 20 cm poloidally from the inner divertor target, defining an extended region of the divertor wall.

*Work supported by the US Department of Energy under W-7405-ENG-48, DE-FG02-04ER54758, DE-FC02-04ER54698, DE-FG03-01ER54615, and DE-AC04-94AL85000.