Measurement of C I Kinetic Temperature in Methane Puffing Experiments on DIII-D and Implications for Spectroscopically Distinguishing Carbon Sputtering*

N.H. Brooks,[1] R.C. Isler,[2] A.G. McLean,[3] and P.C. Stangeby[3]

[1]*General Atomics, San Diego, California 92186-5608, USA*
[2]*Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA*
[3]*University of Toronto Institute for Aerospace Studies, Toronto, Canada, M3H 5T6*

Previous analysis of neutral carbon emission from the graphite-armored, DIII-D divertor has relied on decomposition of the often asymmetric C I line shapes into thermal (Gaussian) and Thompson velocity distributions, associated with chemical and physical sputtering mechanisms, respectively [1]. However, up to now, there has been no independent measurement in a tokamak of the neutral carbon velocity distribution resulting from plasma fragmentation of the volatile hydrocarbons characteristic of chemical sputtering. In CH_4 puffing experiments in the DIII-D divertor employing a porous plug [2], the measured C I line shape is found to be well fitted by a single Gaussian function with a half width corresponding to a kinetic temperature $T_{kin} \sim$ 0.6 eV. Similarly low values of T_{kin} are observed when methane is puffed in a toroidally symmetric fashion into the crown of the core plasma. These T_{kin} measurements provide benchmarks for code modeling of the multi-step, chemical breakup process leading to free carbon atoms [3].

The methane puffing measurements strongly suggest that the cold, symmetric C I line profiles observed under near-detached divertor conditions in DIII-D arise from plasma breakup of hydrocarbon molecules. Analysis of atomic and molecular fluxes had previously indicated this to be the case. Under the attached divertor conditions of the porous plug experiment, the measured C I profile from plasma interaction with the graphite divertor target far from the puff location is discernibly asymmetric. Spectral decomposition of the C I profile into thermal and Thomson components for this low power, L-mode plasma will be presented, as well as for a variety of other attached plasmas with increasingly higher input powers. From this body of C I line profile data, the relative contributions of physical and chemical sputtering to the neutral carbon influx will be related to divertor parameters.

[1] R.C. Isler, *et al.*, J. Nucl. Mater. **313–316**, 873 (2003).
[2] A.G. McLean, *et al.,* this conference.
[3] A.G. McLean, J.D. Elder, *et al.,* this conference.

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