Comparisons of Physical and Chemical Sputtering in High Density Divertor Plasmas with the Monte Carlo Impurity (MCI) Transport Model*

T.E. Evans, D.F. Finkenthal◊, M.E. Fenstermacher‡, G.D. Porter‡, W.P. West, and Y.S. Loh§
General Atomics, P.O. Box 85608, San Diego, California 92186-5608 USA

The DIII–D Monte Carlo Impurity[1] (MCI) code is designed to accurately model the effects of realistic walls and surface physics on the production and transport of impurities in highly radiating divertor and SOL plasmas. MCI carbon transport simulations[2] are compared with multi-fluid UEDGE[3] carbon density distributions on the UEDGE nonorthogonal grid using a fixed hydrogen background plasma. The two codes agree well in total carbon inventory and in their cell-to-cell carbon concentrations. A kinetic particle tracking algorithm is used in MCI to identify statistically significant impurity transport pathways. This alogrithm has been used to identify a multi-charge state, spatially circulatory, transport process near the inner leg of a detached inner strike point plasma. This process results in relatively long carbon lifetimes in the divertor under certain conditions. Time dependent UEDGE runs are carried out in order to better understand the role of local plasma parameters just above the inner strike point on this inner leg multi-stage circulatory transport process.

Two dimensional CIII radiation distributions calculated with MCI are compared to CIII images from the DIII–D tangential TV[4] in order to benchmark the physics models in the code[1,2]. Initial comparisons with experimental data are qualitatively quite good using only a simple physical sputtering model for the carbon neutral source. We are in the process of implementing a chemical sputtering model and a more sophisticated physical sputtering model. Preliminary comparisons of DIII–D divertor carbon distributions predicted by MCI, for cases with and without chemical sputtering, are presented. Each of these cases are then compared with CIII radiation patterns from the DIII–D tangential TV in order to help determine the significance of chemical versus physical sputtering in detached and partially detached plasmas. The chemical and physical sputtering models used in MCI are discussed along with the role of surface and kinetic effects. Plans for future enhancements in MCI's surface sputtering, reflection, and redeposition models are also discussed.

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◊Palomar College, San Diego, CA.
‡Lawrence Livermore National Laboratory, Livermore, CA.
§Harvard University, Cambridge, MA.
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