Reduction of Divertor Carbon Sources in DIII–D and the Effect on Core Plasma Carbon Content*

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The evolution of carbon release from the graphite covered DIII–D tokamak over the last seven years is studied. In-situ atomic and molecular spectroscopy are used to measure divertor sputtering yields and core carbon concentration. Corraborating carbon erosion yield measurements are obtained from the exposure of DIII–D divertor tile sections in the linear plasma device PISCES (Plasma Interaction with Surface Components Station). Several surprising results are obtained.

The carbon chemical erosion yield in the DIII–D lower divertor has been substantially reduced over the last seven years from ~2% in 1993 to ~0.1% in 1999. Circumstantial evidence points to the cumulative effect of >30 wall-conditioning boronizations in DIII–D and 10^5 seconds of plasma exposure as the cause of this reduction. This result indicates that a substantial reduction in carbon's chemical erosion can be obtained by in-situ wall conditioning techniques.

The total effective sputtering yield and hence the carbon source amplitude of the DIII–D lower divertor has also decreased, by at least a factor of 4. This is most likely caused by the reduction in chemical erosion yield. A direct comparison of nearly identical plasmas (ELMy H–mode, attached divertor) between 1993 and 1997 show a large reduction (~10) in the singly ionized carbon influx at the outer strikepoint.

There has been no change in the typical core plasma carbon contamination with the decreasing lower divertor carbon source. Two possible explanations for this observation are being explored. First, the wall surrounding the main plasma may be a more important source for core plasma contamination than the divertor. This is supported by the observation (from spectroscopy) that the influx of carbon at the midplane has remained large and constant, unlike the divertor region. Second, a combination of parallel impurity transport and plasma "adjustment" to changing wall impurity source rates make the core carbon contamination less than linearly dependent on the wall source rate. This behavior has been simulated with the UEDGE multi-fluid code.

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