Post-mortem surface chemistry and passivation measurements of lithium-coated ATJ graphite NSTX divertor tiles*

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Lithium has been used as a plasma-facing surface in multiple fusion reactors such as the National Spherical Torus Experiment (NSTX), in order to enhance plasma performance and reduce deuterium recycling. Lithiumization of ATJ graphite tiles is achieved by use of two lithium evaporators (LiTER) [1]. Lithium deposition is found predominantly at the inner and outer lower divertor floor tiles. Tiles extracted along a radial line from the center stack across the lower inner divertor floor were delivered to Purdue University for post-mortem analysis. Tiles are passivated immediately after exposure to ambient air during transit. Sampels were cored from extracted tiles into ~1-cm diameter disks along radial and toroidal locations. Analysis included X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), and thermal desorption spectroscopy (TDS). The binding state of lithium in ATJ graphite after NSTX plasma discharges and exposure to ambient air is not clearly understood, due to lithium's complex oxide and carbidic states [3]. Understanding passivated layer evolution of lithiated graphite tiles after NSTX plasma exposure is critical to unraveling the archaeology of the lithium-deuterium interactions that develop during D-plasma irradiation. Post-mortem XPS analysis shows prominent photoelectron peaks at 533 eV and 291 eV, indicative of Li-O-D and Li-C-D functionalities, respectively, as detailed by Taylor *et al*. [4]. XPS depth profiling was conducted via Ar sputtering and the thickness for freshly passivated samples (assuming equal Li-C surface concentrations) was found to be ~6Å. Experiments show that for tiles exposed to ambient air over long periods of time, a passivation layer of less than 1-5 nm can be removed, thus revealing the preserved chemical state of lithium on the tile prior to removal from NSTX. Post-mortem analysis indicates a radial dependence of surface chemistry from the inner center stack region outboard to the last tile of the inner divertor. Inner divertor locations near the center stack exhibit disordered, broad XPS spectra, characteristic of amorphous-like surface chemistry. Outboard of the PFR, amorphous behavior is not observed. TDS investigates D retention and erosion mechanisms as a function of radial and toroidal locations along divertor tiles.

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