Post mortem analysis of graphite tiles extracted from NSTX-U

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The National Spherical Torus eXperiment Upgrade (NSTX-U) used boronization as its main plasma facing component (PFC) conditioning technique during the 2015-2016 experimental campaign. Boronization was applied by using deuterated trimethylboron (d-TMB, B(CH\textsubscript{3})\textsubscript{3}) in a He glow discharge. It has been shown that boronization increases plasma performance and reduces core impurity concentration [1]. After the end of the experimental campaign, four ATJ graphite tiles were removed from various regions in NSTX-U: the center stack shoulder, the lower inner divertor, the lower outer divertor, and the upper divertor. Several samples were cored from each of these tiles and transported to UIUC in order to be analyzed.

Several analyses were performed. Depth-profile X-ray Photoelectron Spectroscopy (XPS) was performed on at least one sample from each of the tiles to a depth of about \textasciitilde 5 nm. XPS is able to give quantitative information on the chemical composition of materials. The analysis performed showed that the concentrations of boron and oxygen between tiles and between different positions within the same tile varied significantly: from 8-10\% B at the strike point locations in the center stack shoulder and lower outer divertor, to 12-25\% B in the private flux region in the lower inner divertor. Time of flight secondary ion mass spectrometry (TOF-SIMS), Rutherford backscattering (RBS) and optical profilometry were also performed. Results from depth-profile XPS were also compared to day-to-day data taken with the Materials Analysis and Particle Probe (MAPP), a PFC material characterization facility in NSTX-U.

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