Glow Discharge Boronization and Plasma Fueling Boronization

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PPPL
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Boronization of NSTX Using Deuterated Trimethylboron (TMB) Has Significantly Improved Plasma Performance

- TMB has been applied 9 times using HeGDC (90%He,10%TMB), about every 2-3 operating weeks. Reference D_2 discharges following TMB showed:
  - 15x reduction in O luminosity
  - Factor of 2 decrease in C luminosity
  - The D_2 density limit increased from about 60% of the Greenwald limit density to about 75%-80% after boronization
  - He density limit increased from 75% to 100% of the Greenwald limit
  - Access to H-mode plasmas occurred following the 3rd boronization, and the 4th boronization
  - The energy confinement time during NBI heating exceeded 100 ms and the toroidally averaged Beta > 22%.

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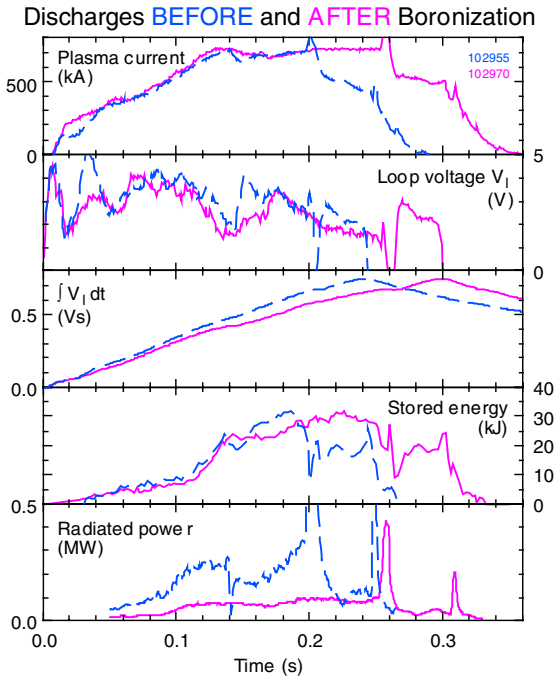
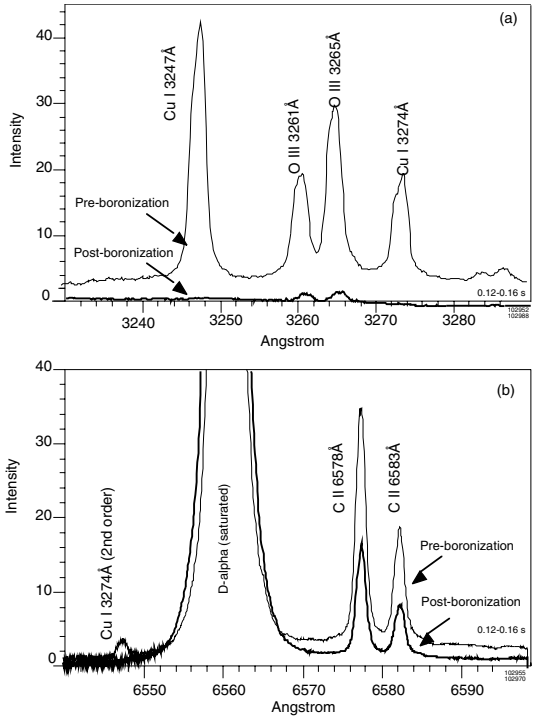
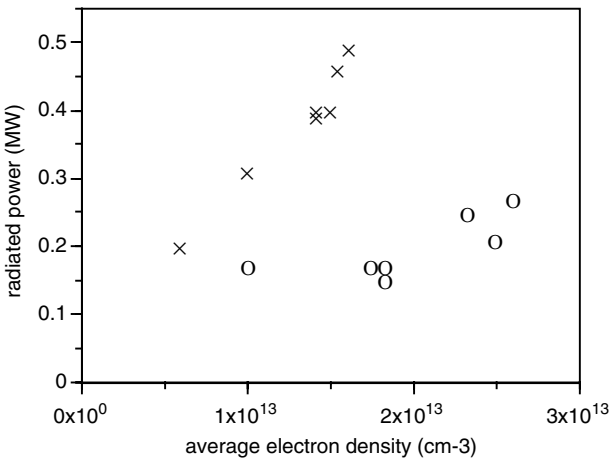
Plasma Performance After Boronization Improved Significantly







- Waveforms before (solid) and after (dashed) bornonization
- Impurity emission before and after boronization.
- Radiated power before (×), and after (O) boronization.

TMB Injected into Plasma Edge Reboronizes Plasma-Wetted Surfaces

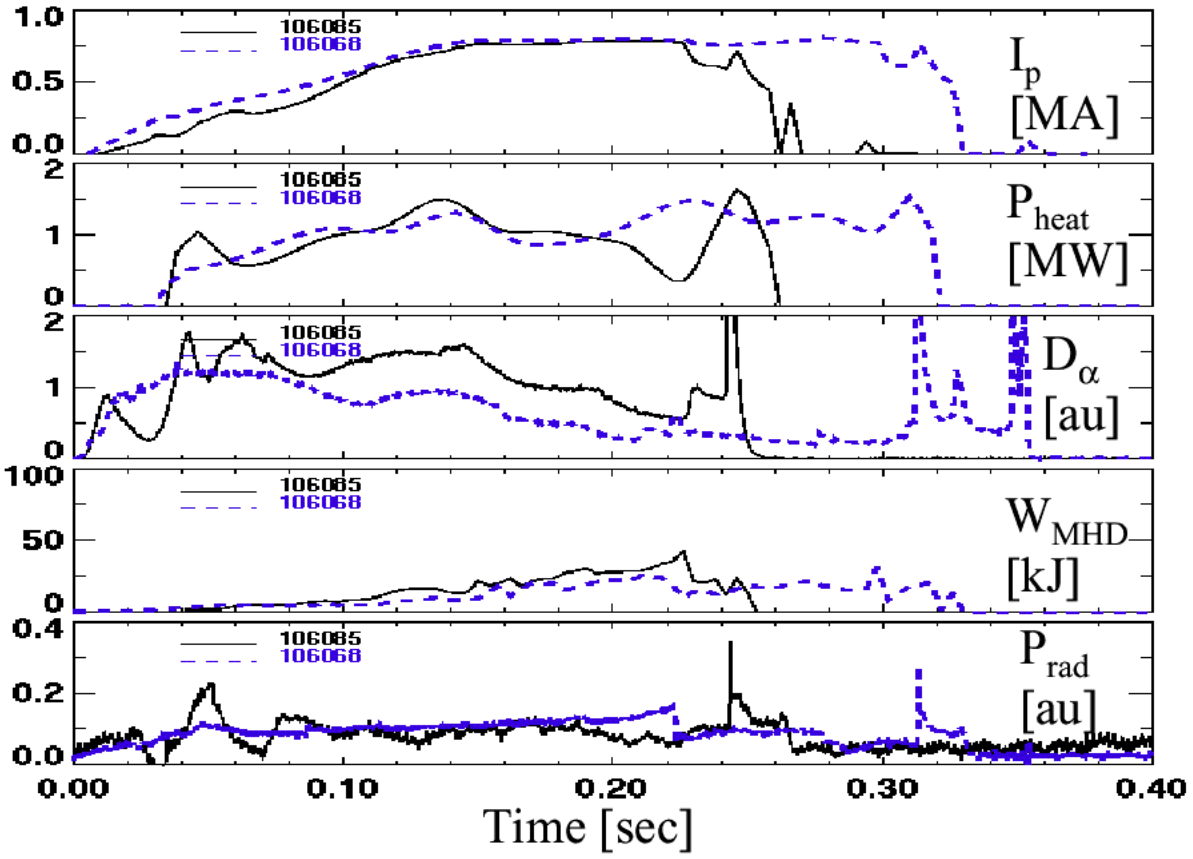
- HeGDC is used to deposit boron film over the vessel interior (100 nm)

- Subsequent erosion of this deposited film occurs preferentially on plasma wetted surfaces, e.g., Center Column and Divertor strike points.

- On TEXTOR (Esser et al.) and TdeV (Boucher, et al.) tested plasma fueling with boron gases, and obtained interesting results and improved performance.

- On PISCES, the injection of carborane into the plasma resulted in very high boron film deposition rates (~1000 nm/min) on the target samples. This was attributed to good transport of the injected carborane to the plasma wetted surface.

NSTX Plasma Boronization (Black) Lead to Lower Radiated Power and Better Ohmic Performance



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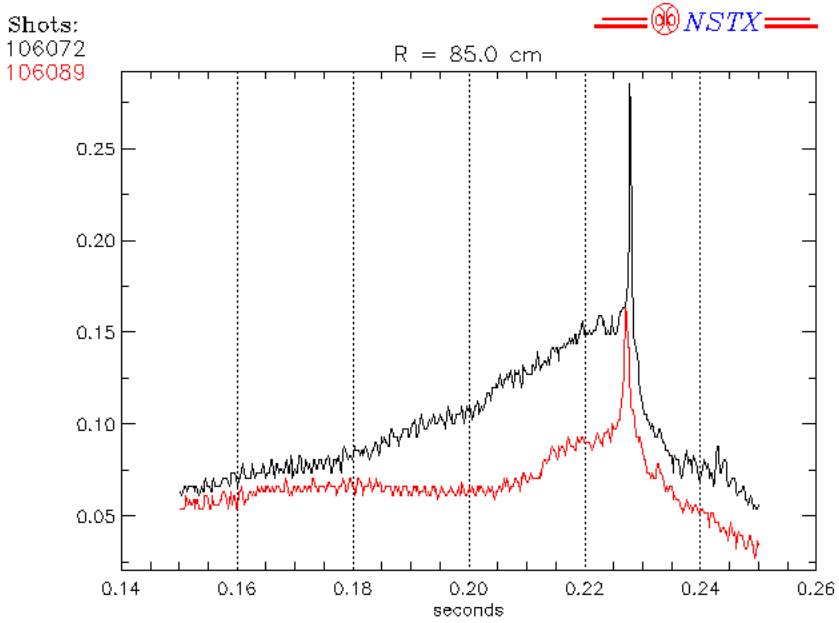
NSTX Plasma Boronization Lead to Lower Radiated Power and Better NBI Performance

- A comparison of Center Stack Limited (CSL), 1 MA,1.5 MW, NBI fiducial discharges before and after He/TMB fueling, showed x2 decrease in central radiation after TMB.



Rad. Pwr.(MW) before (upper) and after (lower) He/TMB

Test of Direct Injection of 90% Helium and 10% TMB into Lower Single Null 800 kA, 150 ms flattop into Edge Plasma Yields Promising Results

- Fueling to 16 Torr-liters reduced I_p from 88 KA to 500 kA with a 75 ms flattop due to high radiative power losses and the effect of He recycling.

- TMB fueling was then reduced to 6 Torr-liters for next 6 TMB fueled discharges (12 discharges total) : yields x2 decrease in central radiation after TMB.

- The edge O and C luminosities were comparable within the limited statistics.

- Density profile for the post-TMB CSL discharge exhibited an outboard shoulder.

- The subsequent post-TMB, LSN, 900 kA, 1.5 MW, NBI fiducial discharge exhibited a transition into the H-mode.

- Future experiments with pure TMB fueling being planned.