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Active conditioning of ASDEX-Upgrade tunsgten PFCs through boron particulate injection

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The injection of boron (B) and boron nitride (BN) powders into ASDEX-Upgrade (AUG) H-mode discharges have shown the ability to effectively control tungsten influx in low density/collisionality operational regimes, similar to conventional boronization methods. A newly designed impurity powder dropper was installed onto AUG with 5µm diameter BN powder, and 50 µm B powder (99%+ purity) loaded into separate dropper assemblies. The sub-mm powder particles are gravitationally accelerated into the upper edge of a lower single null H-mode plasma. Discharges with IP = 800 kA, ne = 6x1019 m-3, PNBI = 10 MW , and a conformal boundary shape were used for the conditioning sequences. These were followed by different discharges to evaluate the effects of the conditioning.

The first experiment was performed with five BN conditioning discharges, in which injected B was varied from ~4x1018 atoms/discharge to ~4x1020 atoms/discharge. Visible spectroscopy measurements at the outer limiter showed increases in both boron and nitrogen signal levels, well as elevated boron levels in the divertor and an increase in PRAD by greater than a factor of 2. Globally the BN injection also improved energy confinement by 10-20%, similar to gaseous N2 injection. Discharges with increasing B injection rates were also performed. Injecting, 9.2x1021 atoms of pure B resulted in minimal impact on plasma performance and up to 50% increase in radiated power. To test the conditioning effect of B powder, a sequence of discharges with magnetic perturbations for ELM suppression were conducted afterwards. Historically these discharges are very sensitive to wall conditions. However, following the B conditioning discharges, all three attempts to run low density discharges with ELMs suppressed by magnetic perturbations were successful. These preliminary results suggest that the application of B containing powders can be used to both improve plasma performance in real-time, and improve wall conditions. Furthermore the injection system is capable of injecting a wide number of impurities (B, BN, B4C, Li, C, Sn, Mo, W, …) for a range of studies. Similar systems are being installed on the EAST and DIII-D devices. Results from these and forthcoming studies on AUG, and possibly other devices, will be reported. The U.S. authors supported by U.S. Dept. of Energy contract DE-AC02-09CH11466.

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