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Real-time impurity injection for ELM and H-mode pedestal control in EAST

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Impurities are injected into magnetic fusion devices for a number of reasons, e.g. wall conditioning, control of edge-localized modes (ELMs), and power and particle exhaust. A new device designed to inject a wide range of impurity species was developed by staff at the Princeton Plasma Physics Laboratory (PPPL) and is now deployed on the EAST, ASDEX-Upgrade, DIII-D, and KSTAR devices. Both the device and first results will be described.

In EAST, real-time gravitational lithium injection with the first, original dropper design eliminated ELMs in long pulse discharges with the carbon divertor[1], and short pulse discharges with the tungsten divertor[2], while contributing to achievement of 100 s pulse lengths[3]. The original device dropped spherical, non-sticky impurities through an aperture on a vibrating piezoelectric disk driven at resonant frequencies; the injected impurities accelerated via gravity into a drop tube and into the boundary plasma[4]. The new device uses piezoelectric crystals for a horizontal drive off the edge of a surface into a drop tube, and is compatible with a wide range of impurity species and particle sizes, including boron-based compounds[5].

The new dropper allowed injection of large lithium granules of nominal 700μm diameter into ELMy H-mode discharges. ELM elimination within a single discharge was found, correlated with a 90% decrease in the divertor D-alpha emission. There as a progressive conditioning effect: the second discharge with granule injection had lower initial D-alpha emission, more rapid ELM elimination, and final D-alpha level slightly below the first discharge. Overall the results are similar to those with Li powder injection of nominal 50 μm diameter in EAST, except that the fractional D-alpha drop was even larger with granules. These results will be compared with published results with the same apparatus on ASDEX-Upgrade[6], DIII-D[7] and KSTAR[8], in which B, BN, or Li powders were injected for wall conditioning and ELM control. The likely cause of the edge stability modification is pedestal-localized turbulence and/or recycling reduction that results in a density and pressure profile change, mirroring results in EAST[1] and NSTX[9]. Supported in part by U.S. Dept. of Energy under contract DE-AC02-09CH11466.

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