Pedestal, SOL And Divertor Plasmas Properties in DIII-D RMP ELM Suppressed Discharges at ITER Relevant Edge Collisionality*

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Large Type-I edge localized modes (ELMs) were completely suppressed by applying edge resonant magnetic perturbations (RMPs) in DIII-D plasmas with the same low pedestal collisionality ($\nu_e^* \sim 0.1$) as in ITER. This may be a promising control technique to eliminate the large ELM induced heat and particle impulses that could increase the erosion rates and reduce the lifetime of the plasma facing components in the main chamber and divertor of ITER. In the discharges with low ITER-like pedestal collisionality the RMP produced significant changes to the pedestal density profile (gradient reduced) and temperature profile (gradient increased somewhat), unlike the high collisionality ($\nu_e^* \sim 1.0$) plasmas reported previously [1], which showed little change in the pedestal profiles during ELM suppression. Density at the pedestal top was reduced due to increased coupling to the divertor pump during the RMP, but the pedestal temperature increased and the total pedestal pressure decreased only slightly. Linear stability calculations indicate that the ELM suppressed operating point was near the kink/peeling stability boundary and that by increasing the RMP amplitude, it could be pushed farther into the stable region. Suppression was obtained in plasmas with a range of RMP amplitudes above a threshold ($\delta b/b_T > 1.8 \times 10^{-4}$), input beam power above a threshold ($P_{inj} > 4.2$ MW), and pedestal density below a threshold ($n_{e,ped} < 2 \times 10^{19}$ m^{-3}) – results of scans of these parameters will be presented. Complete suppression occured for a well-defined resonant window in edge safety factor.

The changes in the pedestal led to significant changes in the scrape-off layer (SOL) and divertor conditions during the ELM suppressed phase. Field line tracing indicates that with the RMP, a large fraction (~50% on average) of field lines originating in the pedestal had connection length to the targets that was comparable to the electron collisional mean free path. During the ELM suppressed phase, pedestal density fluctuations increased but magnetic fluctuations were comparable to the levels between ELMs without the RMP. Changes in the SOL radial transport will also be described. Emission profiles in the divertor showed substantial increases in D_α and carbon ion emission in local regions near gaps between tiles. Carbon emission was also significantly increased throughout both divertor legs and near the X-point although this emission could be reduced by increasing the density with gas injection. SOL and divertor simulations will investigate several aspects of the ELM suppressed regime, including whether the divertor makes a transition from a high recycling regime during the ELMing phase to a sheath limited regime when the ELMs are suppressed.

[1] T.E. Evans, J. Nucl. Mater. **337-339**, 691 (2005)

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