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Progress in understanding the role of low-Z impurity in the confinement in JET-ILW and in JET-C plasmas

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The pedestal confinement has significantly decreased in JET with its metallic ITER-like wall with reference to the carbon wall phase of JET (JET-C). In particular, a reduction in pedestal temperature is observed in all scenarios regardless of the level of D-gas injection or value of ☒N 1-3¬. At low gas injection, excessive W radiation is not always the cause for this reduction. Unraveling the mechanism(s) that, in the absence of carbon in the plasma composition and/or as wall material, leads to a decrease in pedestal temperature is critical in predicting the pedestal pressure in ITER. This mechanism(s) is most likely related to the observed increase in pedestal temperature with nitrogen (N) injection in JET-ILW4, and should also explain the lack of pedestal pressure improvement with neon (Ne) injection5. This paper makes a synthesis of experimental observations made with extrinsic impurity injection since the first JET-ILW campaign and reviews our current understanding of the role of low-Z impurity on the pedestal pressure.

The first conjecture advocates that D-implantation and release in the W divertor target has been modified w.r.t to CFC divertor target during ELMy H-mode and could be reducing the pre-ELM pressure by reducing the power at the separatrix, via increased neutral losses or only the ELM-averaged pressure by impairing the pedestal recovery between two ELMs. The second conjecture proposes that improved pedestal stability would be caused by the pressure profile moving inward from the separatrix with impurity injection10, either via a global shift or relative shift of the temperature and density profiles. The third conjecture points towards the recovery of pedestal pressure with N injection to an initial mechanism linked to the change in ELM energy losses which raises modestly the average global ☒ by 10% but allows in return the virtuous cycle of an increased Shafranov shift, higher pedestal pressure allowing increased core pressure. This initial mechanism appear linked to the SOL temperature. It is becoming clear that to understand the mechanisms at play it is important to assess the plasma stability with inclusion of flows and resistivity.

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