2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Reduction of H content and particle recycling with mixed graphite and tungsten divertors for long-pulse and high performance plasma in EAST

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Reductions of H content and particle recycling are important for the improvement of ICRF minority heating efficiency and the enhancement of plasma performance of the EAST superconducting tokamak. In EAST, the amount of hydrogen released from plasma-facing components has been shown to depend strongly on both their composition and their temperature. As measured by thermal desorption spectroscopy, the hydrogen inventory in graphite - used in EAST as lower divertor material - has been determined to be >25 times larger than that of tungsten which comprises the upper divertor. This difference in hydrogen inventory is attributed mostly to the intrinsically porous nature of bulk graphite. Thus the main source of hydrogen release into EAST discharges was identified as the graphite tiles used in the lower divertor. The hydrogen content in EAST plasmas were clearly reduced by first employing a high-temperature vacuum baking of all graphite tiles and then renewing a 100–200 μm thick SiC coating before an EAST experimental run campaign. Subsequent active surface conditioning of all wall components with elemental silicon and then with elemental lithium (Li) were seem to again reduce the plasma hydrogen content significantly - with lithium proving to be more effective than silicon. Combining these several techniques, H/ (H+D) levels as low as ~3% have been achieved in EAST discharges.

In addition, real-time lithium injection is proven to be an effective method to reduce particle recycling, as evidenced by Dα emission, observed during the lithium injection, qualitatively like that observed in other experiments using pre-discharge lithium deposition. Modeling with the SOLPS plasma/neutrals transport code indicates a relative reduction in the divertor recycling coefficient of ~20% (e.g., R=0.99 to 0.8) with lithium injection. These results show the potential for lithium injection to provide real-time control of recycling and particle removal via surface pumping and possible lithium edge radiative shielding. Other impurities like B and C will be used to real time inject into plasma in a follow-up experiment in EAST, the effect of impurity injection on controlling particle recycling will also be presented.

Furthermore, for long-pulse and high parameter plasma, some other new technologies has been successfully investigated. An operational maneuver whereby a diverted plasma is repetitively switched from an upper single null configuration to a lower single null configuration is presented. This switching maneuver has been shown to suppress hydrogen influx into a 35s-long EAST discharge by alternately mitigating the rise in divertor temperature. It is also noted that effective particle exhausts with strike point closing to the pumping slot. With the help of these control technologies of H content and particle recycling, it has been successfully achieved larger than 100s H mode plasma with good particle recycling control.

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