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Global particle balance investigation using hot wall operation in all-metal plasma facing device, QUEST

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QUEST is a medium-sized spherical tokamak which has parameters of R~0.64m, a~0.4m, BT<0.25T. The plasma facing walls (PFWs) are made of metals such as tungsten, atmospheric sprayed tungsten (APS-W), stainless steel type 316 (SS 316L) and 316L (SS316). A RF heating source is available for long pulse operation (LPO). A hot wall has been installed to regulate PFWs temperature. Taking advantage of the equipment, several times of LPO have been performed up to 6 hours.

In this study, we try to investigate the quantitative wall pumping and/or exhaust capability for various PFWs used in QUEST including plasma-induced deposition layer (DL). Tungsten is the most promising materials for ITER and mono-block tungsten has been used for limiters on QUEST. Its characteristics of hydrogen pumping and/or exhaust capability has been strenuously investigated in various fusion-oriented devices. APS-W is a coating of the hot wall facing to plasmas. SS316L is used for electrode of coaxial helicity injection (CHI) locating on the bottom side. SS316 panels has been installed since 2018 as a protection of the vacuum vessel in the high filed side from plasma bombardments. The SS 316 panels cold be cooled by water. According to the quantitative investigation, it found that the SS316 panels played an essential role in global particle balance during LPOs. Tungsten and APS-W have quite low solubility of hydrogen and their wall pumping capability is significantly limited. But a part of APS-W was covered with plasma induced deposition layer (DL) composed of carbon, tungsten, and stainless-steel materials and has a larger capability of wall pumping capability than original APS-W. The impact of the DL is also clarified quantitatively using the fast ejecting system for targeted sample (FESTA) measurements. The hydrogen desorption from the DL is approximately 10 times larger than SS316L and it means that the DL could play a significant role in global particle balance. Actually, the regulation of the hot wall temperature gave rise to extension of plasma duration from 40 min to more than 3 hours.

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