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Study of Transport Characteristics of Multiple Impurities Depending on the Impurity Source Location in LHD

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By injecting tracers into the LHD plasma with a tracer-encapsulated solid pellet (TESPEL) method, we found that the impurity source location is essential for determining the impurity transport property. The impurity transport for three different locations of impurity source are studied by (i) thick-shell-type TESPEL (thickness of ˜240 micron m), (ii) thin-shell-type TESPEL (thickness of ˜75 micron m) and (iii) Ar gas puffing. As a result, a new property of the impurity behavior was revealed owing to the advantage of the direct and local deposition of the multiple tracers (V, Mn, and Co) by TESPEL in the plasma as follows. (1) In the plateau regime (n_e= 3-4×10^{19} m^{-3}), the tracers deposited in the plasma flow away faster than the case of the Pfirsch Schlueter (PS) regime (n_e= 5-7×10^{19} m^{-3}), while the intrinsic impurities can enter easily into the plasma core. (2) In the PS regime, the tracers deposited in the plasma are kept for a long time, while the impurities coming from the outside of the plasma are prevented from entering into the plasma core. This is confirmed with the Ar gas puffing as a simulator for intrinsic impurities. In case (ii), the tracer penetration depth becomes shallower (around roh= ˜0.85) than the case (i) (around roh= ˜0.75). The tracers deposited in this location have still the same feature as the case (i). The Ar Li- and Be-like emissions mainly coming from the plasma periphery are observed in the both regimes. The ratio of the emission intensity of the PS versus the plateau regime is compared with the calculation by the STRAHL code, and it indicates that Ar particles reach up to the region of roh= 0.87 - 0.93 in the PS regime. Thus, the layer discriminating the impurity behavior is identified as the region of roh= ˜0.9. The dominant friction force against the thermal force in the scrape-off layer works as the outflow mechanism of the impurity in case of the PS regime, as the ratio of the friction force versus the thermal force is proportional to $ne^{-2.5}$˜ -3 in the plasma periphery. The method and the present results will contribute to the future impurity transport study in the edge region of the fusion plasma.

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