§82. Study on PWI in QUEST equipped with High Temperature All-Metal Wall for Active Particle Control

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Spherical tokamak QUEST in Kyushu University is equipped with heatable plasma facing panels made of APS-W for the upper and lower walls and SUS316L for equator one. In the experimental campaign 2015SM, their surfaces suffered strong plasma wall interactions (PWI) due to frequent long pulse operations exceeding 900s. In the present work, plasma induced changes in the surface properties, such as those for retention and desorption of fueling gas, were examined aiming at active particle control for steady-state operation. In the 2015SM, all plasma discharges were carried out by keeping the wall panels at 473K.

Photos of the inner wall before starting new "W wall campaign" (2014A/W) and after 2015SM campaign are shown in Fig. 1. After the campaign plasma facing surfaces were colored by the deposition of impurities. Chang of color at the upper APS-W panel surface is very unique. Namely, the color viewing from the right hand side (direction along the flow of H^+) keeps original metal gloss, while that from the opposite direction is light brown. A caricature of this surface is illustrated in Fig.2 together with a SEM image. Surfaces facing to H^+ flow keeps metal gloss due to strong sputtering erosion of the deposited impurities (erosion dominant) but impurities can deposit in the shadow of H^+ flow (deposition dominant). Namely the plasma facing surfaces of the top APS-W panel have both characters of erosion dominant and deposition dominant surfaces. On the other hand, the bottom panel is covered by impurities homogeneously and has typical deposition dominant character.

Impurities deposited on the probe coupons (flat Mo plates) placed on the panels were examined by means of TEM, XPS and GD-OES. In case of flat surface, equator line is the clear boundary, namely, erosion dominant at the upper half surface, while deposition dominant at the lower half one. Thickness of the deposition on the lower half surface is 18-150nm depending on the poloidal position. Major deposited impurity is still C in 2015SM. Though the concentration of metallic elements has increased, those of W and Fe were 7at% and 14at%, respectively. We expects that C will decrease quickly by repeating campaign.

In order to discuss the retention and desorption of H in the plasma-exposed coupons, thermal desorption of D gas injected at 473K, were measured. In the W coupon at the erosion dominant condition (2015SM-T W), retention of D is not high but they desorb thermally just above the injection temperature (473K). This result indicates that behavior of H in W at the erosion dominant condition is very temperature-sensitive at and just above the wall temperature (473K). Dynamical retention of H must be active under the discharge. In contrast, retention of D from the coupons in the deposition dominant areas (2015SM-E SUS, 2015SM-B W) is much higher and most of them desorb above 600K. This indicates that H atoms are steadily retained at the deposition dominant area. It is considered that the PWI is strongest at the top wall and the particle balance is mainly controlled by the retention and desorption of H at this area.

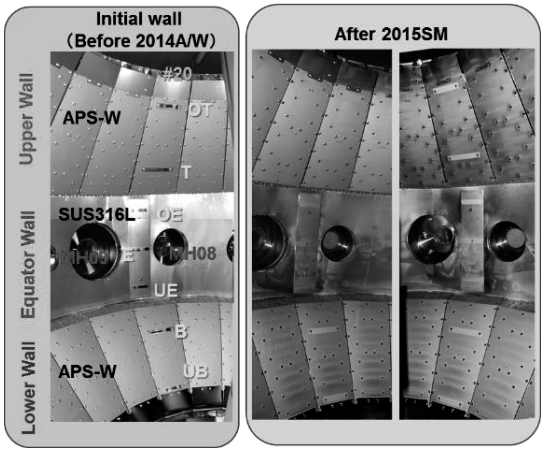

Fig.1 Change of wall surface after ministration of high temperature panels.

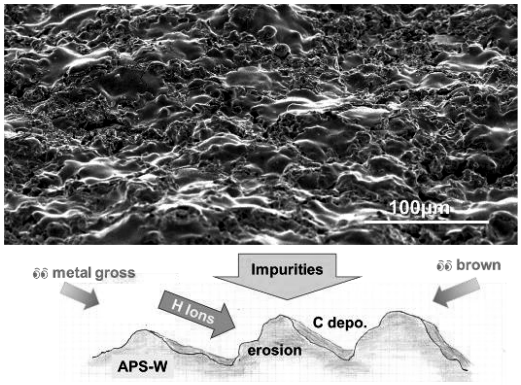

Fig.2 Erosion and deposition of impurities on the APS- W panel at top wall.

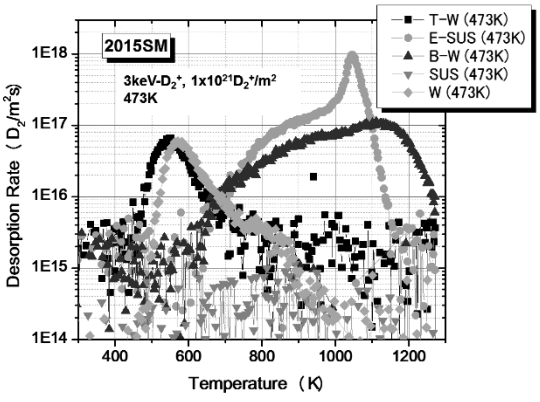

Fig.3 Thermal desorption of D2 from D injected coupons (plasma exposed one and