§86. Study on PWI of QUEST with High Temperature All-Metal Wall for Active Particle Control

Watanabe, H. (RIAM, Kyushu Univ.)

In the spring/summer campaign of 2014 (denoted as 2014SS) of QUEST, long-pule operations have been carried out frequently. Remarkable change of the wall color indicates that PWI in the campaign was unprecedentedly strong. In the present work, modification of the plasma facing surface by the strong PWI and its influence on the behaviors of hydrogen in the wall were examined for deeper understanding of the recycling process of fueling particles in QUEST.

The wall of QUEST is made of SUS316L and its temperature under operation of 2014SS campaign was about 370K. Divertor plates, limiters and plasma facing surface of the center stack are made of W.

In 2014SS campaign, many probe samples were mounted on several representative points at the plasma facing wall before starting the campaign. After exposing to the plasmas through the campaign, they were examined by means of TEM, SEM, XPS, GD-OES and TDS to clarified chemical and physical properties of the plasma facing surfaces. In addition, color of the plasma facing surfaces, which reflects their properties sensitively, was quantified by using a handy color analyzer (CA) released in recently. In order to evaluate the behavior of H in the plasma-exposed samples, thermal desorption of D_2 was measured after injection of 1keV-D_2^+ at room temperature up to $3x10^{21} D_2^+/m^2$.

A photo of internal wall of the torus after 2014SS and its color (RGB (red, green, blue), 1024 gradation) measured at 30 points are shown in Fig.1. Generally speaking, color of the wall changes along the poloidal direction and can be classified into three areas. Namely, top part of upper wall (area A), between middle part of the upper wall and the equator (area B) and below the equator (area C). Ports along the equator affected the color at their periphery. RGB level of areas A and C falls to 330~410 and 420-570, respectively, due to deposition of impurity atoms. In the area B, on the other hand, RGB keeps quite high level above 600 due to strong sputtering erosion by strong directional flow of H particles. Cross-sectional structure of the plasma facing surface at area C, for example, is shown in Fig.2. Clear layer structure of the deposition indicate that chemical components changed from campaign to campaign. In case of area B, on the other hand, the surface is covered with a very thin deposition about 11±6 nm-thick due to strong sputtering erosion.

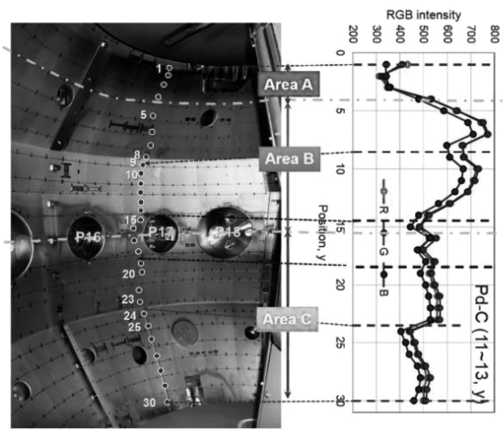

Fig.1 Photo of wall after 2014SS and RGB measured at 30 points marked on the photo.

According to the XPS analysis, major elements of the deposition formed at the surface during 2014SS is metallic ones (W, Fe, Cr). This result indicates that PWI in 2014SS became stronger due to improvement of the plasma performance.

Fig. 3 shows TDS of the injected D. It is clear that retention of D in the virgin SUS316L is suppressed very much by exposing to the plasmas. Due to strong sputtering erosion and coating with thin impurity deposition, retention of D in the area B reduced drastically. This is very favorable for particles control. TDS spectra of area C are typical ones of thick impurity deposition. Judging from the wide distribution of the spectrum between 330K and 700K, some part of the retained H will became unstable thermally due to slight elevation of the wall temperature. It is likely that the additional desorption of H due to the temperature elevation will disturb the particle balance.

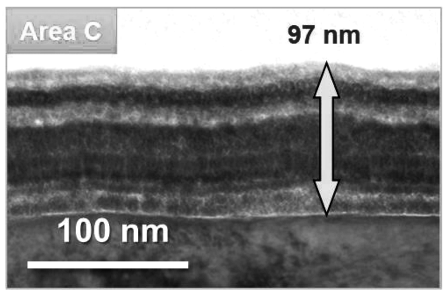

Fig. 2 Cross-sectional TEM images of the SUS316L wall in areas A, B and C

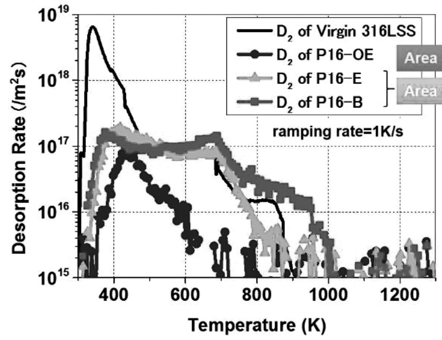

Fig. 3 Thermal desorption of D_2 form D_2^+ injected SUS316L probe samples of areas B and C.