§94. Evaluation of Chemical Composition and Retained H and He at Plasma facing Surfaces of LHD and QUEST

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In case of long pules discharges of high temperature plasmas, understanding the plasma-induced modification of the plasma facing surfaces is very important. Especially, influence on the chemical composition at/near the surface is essential, because they affect mechanical property and behaviors of H and He near the surface. In the present work, chemical composition in the sub-surface region of coupons (SUS316L and W), which had been exposed to LHD plasmas during cycle 18, were examined at University of Toyama by means of GD-OES. Positions of the coupons, numbered from 3 to 12, are illustrated in Fig.1. The strongest plasma-wall interaction occurred at the saddle area of the protection wall in the inner-board region (5, 3, 4), where the main plasma is very close. An example of the nanoscopic surface damage and depth distribution of the elements measured by TEM and GD-OES respectively are shown in Fig. 2(a). Most of the impurity atoms, mainly C, O and Fe, deposited on the surface are sputtered away quickly due to heavy bombardment of energetic plasma particles. Some of the impurity atoms, however, penetrated into the subsurface region due to radiation induced migration and formed a very brittle mixing layer at the surface. Under long-pulse discharges using He as working gas in LHD, formation of He bubbles in this area resulted in the exfoliation of very thin flakes (blisters), about 20-50 nm-diameter and 5-10 nm-thick. It was found that the exfoliated the very small flacks were accumulated on the wall at the bottom of the torus. We should pay more attention to this exfoliation phenomenon from the standpoints of the surface erosion and also plasma contamination.

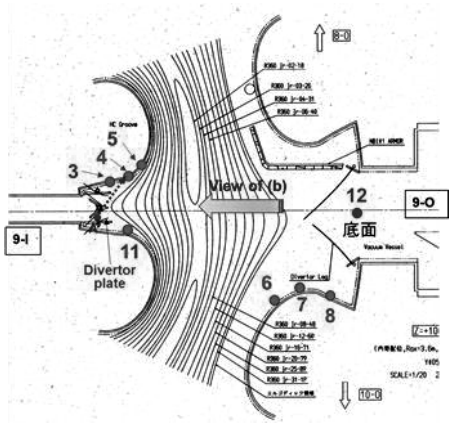

Fig. 1 Position of the coupons from 3 to 13

On the other hand, plasma wall interaction in the outer board region is moderate. The plasma facing surfaces is covered by impurity deposition more or less. GD-OES data in Fig.2(b) shows that a large amount of He, which were injected under the initial He-GDC, are locally retained at the sub-surface of the W coupon (about 10-20 at%), while He in the C rich deposition is less than 1 at%. It was confirmed experimentally that retention of He in the SUS316L coupons was quite similar with that of the W coupons shown in the figure.

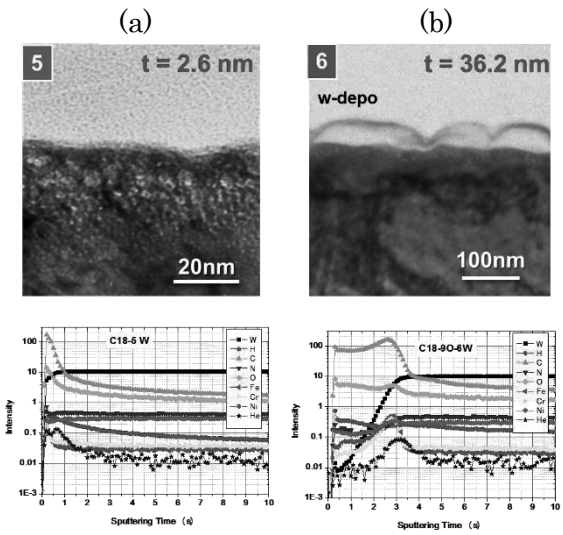

Fig.2 Cross-sectional TEM images of SUS316L and depth distributions of elements in W. (a): Position 5 in erosion dominant area, (b): Position 6 in deposition dominant area.