§38. Elucidation of Mass Transport on Tungsten Plasma Facing Material by Surface Analyses

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Tungsten (W) will be planned to be used as the armor material of the first wall/blanket which is made of low activation materials such as reduced-activation ferritic/martensitic steel (RAF/M) of the fusion reactor because of its low erosion yield and good thermal properties. It is well known that the armor material is eroded by the ion sputtering and re-deposited layer is formed on the surface in the fusion plasma experimental devices. The re-deposited layer has complicated composition and structure which includes with oxygen. These influence hydrogen isotope retention, diffusion and permeation of the blanket, and the life time of the armor/low activation material. It is necessary that behavior of the surface of the armor material is investigated. In the present works, behavior of the surface of W and other materials which were installed on vacuum chamber at LHD (NIFS) and QUEST (RIAM, Kyushu University) has been investigated to obtain guideline of development of the armor materials of the blanket.

W, SUS316L and Au/SUS316L have been fixed on the vacuum wall of QUEST. After the plasma experiments (the 1st cycle(2008/9-2009/1)、the 2nd cycle(2009/5-2009/8), the 3rd cycle(2009/11-2010/3)), the samples have been removed from the vacuum chamber of QUEST and have been observed using an SEM/TEM. In addition, surface composition has been analyzed using XPS. Chemical composition including in hydrogen has been examined by Rutherford Backscattering Spectrometry (RBS) and Elastic Recoil Detection(ERD) using probe beam of 2.8MeV He^{2+}.

Figure 1 shows the depth compositional profile calculated using the XPS results of Au/SUS316L, which was fixed at horizontal location. Surface was covered by carbon and oxygen. Figures 2 show the sputter time which composition of carbon become to be same one of Au. In the case of the1st cycle, depth of carbon layers were almost same between the sample of upward(45^o) and downward(-45^o) location. On the other hand, in the case of the 2nd cycle, asymmetric between upward and downward can be seen. Amount of C of 1st cycle is larger than that of 2nd cycle. It is considered that hydrocarbon, CO_2 and etc. are dissociated and C is deposited on surface of Au/SUS316L. Deposition rate will be evaluated in view of plasma edge and location from plasma center. Figure 3 shows RBS results of SUS316L fixed on vacuum chamber at the 3rd cycle. Quantitative evaluation indicates that less than $1x10^{15}$ W/cm^2 is deposited on the surface. The W is considered to originate from W divertor plate and center solenoid in QUEST. In addition, ERD analyses show hydrogen is detected in the re-deposited layer.

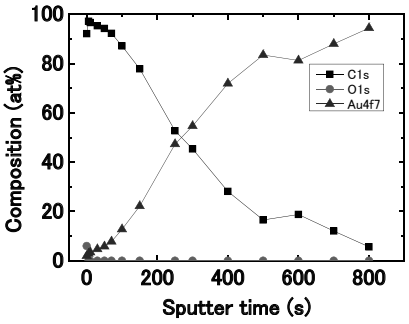

Fig.1 Depth profile of composition calculated using XPS analyses. Sample location is horizontal at the 1st cycle

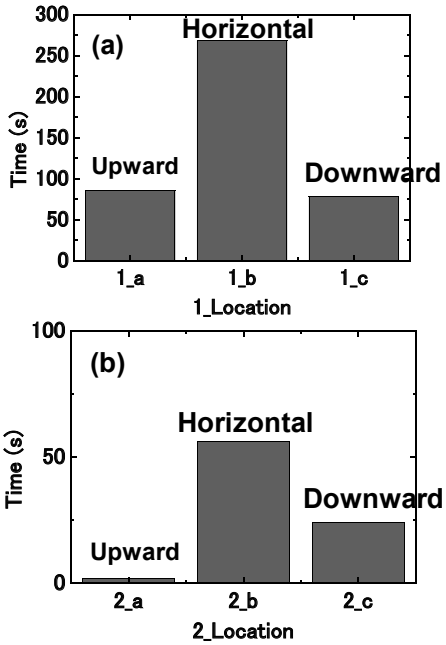

Fig.2 Sputter time which content of carbon become to be same composition of that of Au of (a)1st cycle (b)2nd cycle

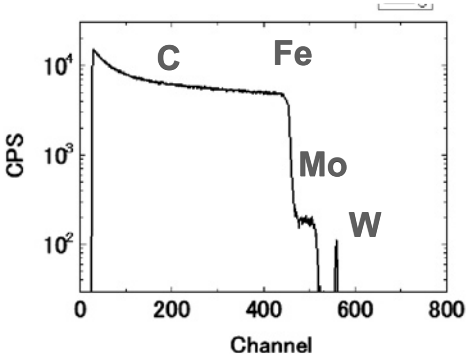

Fig.3 RBS spectrum of SUS316L fixed at the 3rd cycle.