§13. Influence and Effect of Nanostructured Tungsten in Fusion Reactors

Kajita, S., Kato, J., Yajima, M., Ohno, N. (Nagoya Univ.), Akiyama, T., Tokitani, M.

In nuclear fusion reactor, it has been recognized that nanostructured tungsten can be formed by the interaction with helium particles formed by the nuclear fusion reaction. When the nanostructures were formed on the surface, the surface properties were drastically changed. For e.g., it was found that the thermal diffusivity decreased[1)], the optical reflectivity decreased[2)], and that the particle reflection coefficient also decreased[3)]. Previously, it was suggested that the thermal conductivity significantly decreased and an anomalous temperature increase occurred in response to transients when the nanostructures were formed on the surface. Moreover, unipolar arcing was initiated in LHD[4)]. In this study, using the property that the nanostructured tungsten decreases the optical property, the nanostructured tungsten was installed in LHD as a viewing dump for optical diagnostics.

The nanostructured tungsten was prepared in the linear plasma divertor simulator NAGID-II. The size of the tungsten sample was $30\times30\times0.2$ mm^3. The sample was exposed to the helium plasma at the surface temperature of 1200 K up to the helium fluence of 1.0×10^{26} m^{-2}. Six samples were prepared, and they were equipped to the LHD vacuum vessel at the position where the spectroscopic view cords see. The signal intensities with and without the viewing dump were compared at the wavelength of 486.1 nm. Also, nanostructured samples with the size of $15\times15\times0.2$ mm^3 were prepared and introduced to LHD. They were exposed to the glow discharges and main discharges at the floating and vacuum vessel potential. The surface of the samples was analyzed SEM (scanning electron microscope). In addition, the optical reflectance of the surface was measured with an integrating sphere and a laser[2)].

Figure 1 and 2 show the SEM micrographs of before and after the exposure to the glow discharge. Before the exposure, the surface had nanostructures. However, the surface became rough without nanostructures after the exposure. It is likely that the deposition occurred and nanostructures were covered with the deposited materials. Or, sputtering dissipated the nanostructures. The surface optical reflectance measurement at 633 nm shows that slight decrease in the absorptance after the exposure. Before the exposure, the optical reflectance was 99.5%, while it decreased to 96.3% for the sample at the vaccum vessel potential and to 98.7% for the sample at the floating potential. It was found that the influence of the glow discharge on the optical reflectance was less for the sample at the floating potential.

Spectral intensity at 486.1 nm showed that there was no significant differece betweent the view cords with and without the viewing dumps. The results suggested that the influence of the reflectance was not significant for the viewing cords. Or, the degradation of the viewing dump might have occurred by the exposure to the plasmas. It is of importance to consider the degradation of the performance of viewing dump by the sputtering or deposition.

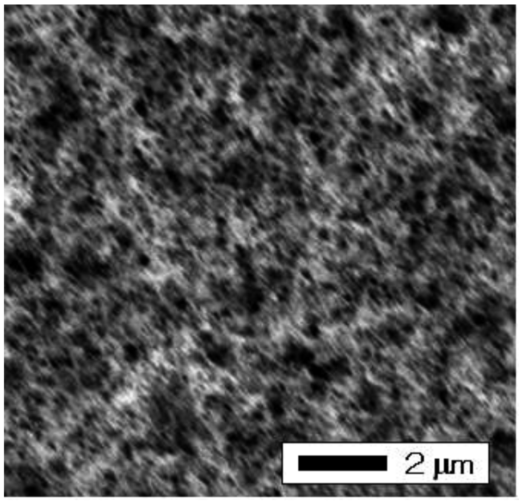

Fig. 1 A SEM micrograph of helium irradiated tungsten surface before the exposure to the glow discharge in LHD.

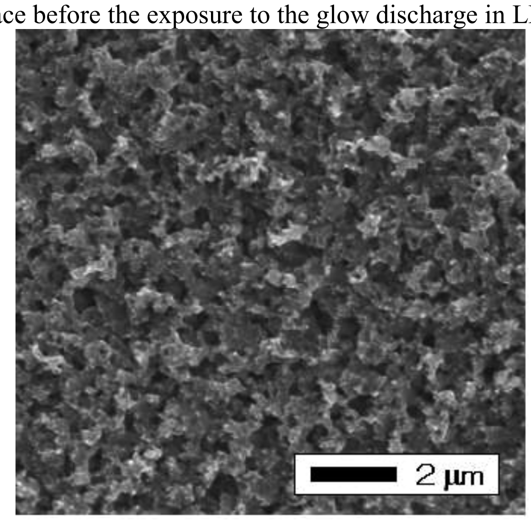

Fig. 2 A SEM micrograph of helium irradiated tungsten surface after the exposure to the glow discharge in LHD..

1) S. Kajita, S. Takamura, N. Ohno, Dai Nishijima, H. Iwakiri and N. Yoshida, Nucl. Fusion **47**, 1358 (2007).

2) S. Kajita, T. Saeki, N. Yoshida, *et al.*, Appl. Phys. Express **3** (2010) 085204.

3) S. Takamura, T. Miyamoto, N. Ohno, Fusion Science and Technology *(in press)*.

4) M. Tokitani, S. Kajita, S. Masuzaki, Y. Hirahata, N. Ohno, T. Tanabe, and LHD Experiment Group, Nuclear Fusion **51** (2011) 102001.