# §30. Influence and Effect of Nanostructured Tungsten in Fusion Reactors

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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. 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[3)]. In this study, detailed analysis of the sample installed in LHD in the year 2012 was conducted. The properties of the erosion and deposition are revealed.

The samples were prepared by being exposed to the helium plasma in the divertor simulator NAGDIS-II. The sample temperature was 1200 K, the fluence was $1.0 \times 10^{26}$ $m^{-2}$, and the incident ion energy was 50 eV. The optical reflectance, which was measured with a laser and an integrating sphere was 0.5%, indicating that the sample was more or less total optical absorber. Figure 1 shows the scanning electron microscope (SEM) of the sample exposed to the LHD main discharge. The sample was exposed to the plasma at the floating potential, by electrically disconnected from the vacuum vessel; the position of the sample was the shadowy part of the divertor. After the exposure, the optical reflectance was recovered to 6.5 %.

Figure 2 shows a transmission electron microscope (TEM) micrograph of the sample shown in Fig. 1. The sample was fabricated with focused ion beam (FIB) milling process, and the thickness of the sample was roughly 100 nm. Usually, the top part of the nanostructure directed to upward; however, after being exposed the main plasma, the top parts of the nanostructures were destroyed, and consequently, the optical reflectance was recovered to ~6%. Inside the nanostructures, many bubbles exist. By the exposure to the main discharge, additional bubbles might have been formed, especially He glow discharge or He main discharge. It is interesting to note that the structures were deformed even though the sample temperature should be significantly lower than the fabricated temperature of 1200 K. It is likely that the top part of the structures were sputtered and the sputtered particles are trapped on the bottom part of the structures.

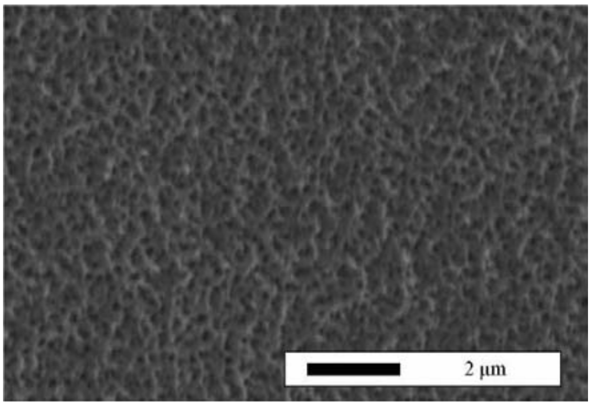

Fig. 1 A SEM micrograph of helium irradiated tungsten surface after being exposed to the LHD main discharges.

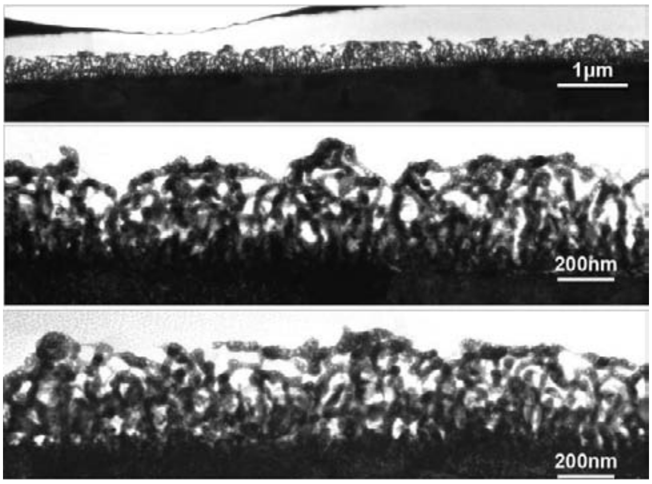

Fig. 2 TEM micrographs of the sample shown in Fig. 1.

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