§42-2 Influence and Effect of Nanostructured Tungsten in Fusion Reactors

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In fusion devices, tungsten (W) is likely to be the most plausible material for plasma facing components including first wall and divertor tiles, because of its high durability for erosion by plasma bombardment and low tritium retention property. One of the issues arising from the usage of W is an influence of reflection of light on optical diagnostics, so-called stray light problem.

One of the ways to mitigate the stray light problem is a usage of an optical viewing dump with dark material. From plasma material interaction researches, it has been found that the irradiation of helium (He) particles to W leads to nanostructure formation [1]; it has been revealed that the material is the darkest man made metal and can be used for light absorber from ultra-violet and near infrared wavelength range [2]. In this study, the nanostructured W samples are fabricated in the linear plasma device NAGDIS (Nagoya Divertor Simulator)-II and installed in the large helical device (LHD), and the morphology changes by the exposure in LHD are investigated.

W samples (Nilaco. co.) were exposed to the helium (He) plasma in NAGDIS-II to fabricate nanostructures on the surface. The irradiation of the He plasma was conducted at the surface temperature of 1300 K and the incident ion energy of ~50 eV. A movable sample holder was used to see the influence in distinct exposure times. Two samples can be mounted on the holder: one is electrically connected to and the other is electrically isolated from the vacuum vessel. Two samples were installed during the LHD glow discharge phase and another two samples were installed during the main discharges.

Figure 1 shows TEM micrograph of the sample exposed to glow discharges at the isolated potential. It was found that the nanostructures are fully remained. On the top of the nanostructure, shown in Fig. 1 (c), however, deposition layer with the thickness over 70 nm probably by carbon based material is observed. In deeper region, deposition was also identified with the thickness >10 nm. During glow discharges, ions bombarded the sample that was at the ground potential, while ions could not bombard the sample that was at the floating potential.

The usage of nanostructured material for viewing damp has an advantage that it can decrease significantly the extinction ratio of stray light, which may pose serious issue for optical diagnostics in full metallic devices. However, from this study, it was revealed that the absorptive property of nanostructures is deteriorated by the deposition and erosion by sputtering significantly.

To mitigate the deposition, it is necessary to equip a mechanical shutter. It would be beneficial for decreasing the influence of erosion by sputtering as well. A side cover that shields the deposition by directional particle flow would also be effective to mitigate the deposition.

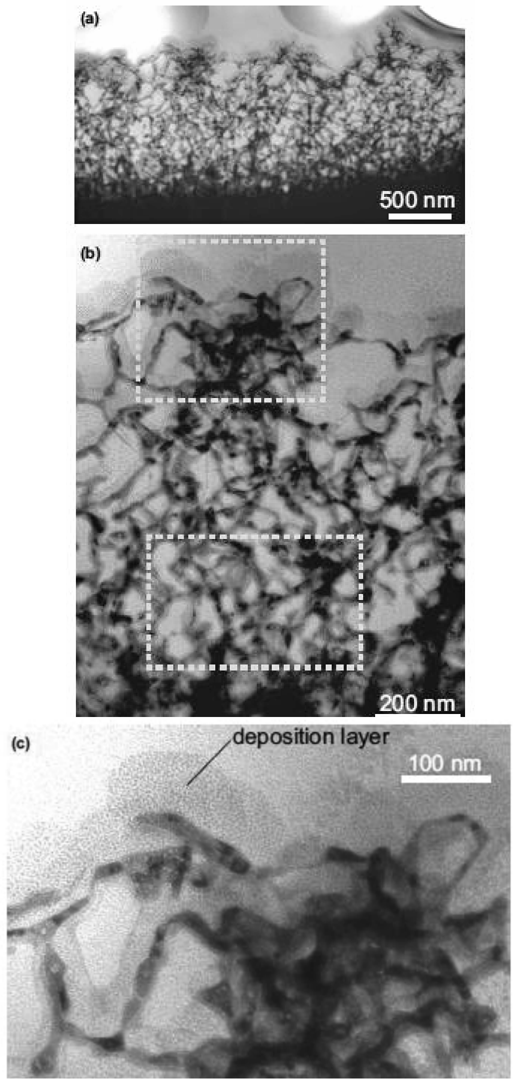

Figure 1: TEM micrographs of nanostructured W exposed to glow discharges in LHD in different scales. (c) is the top part of the structure.

1) S. Takamura, N. Ohno, Dai Nishijima, and S. Kajita, Plasma Fusion Res. **1**, 51 (2006).
2) S. Kajita, T. Saeki, N. Yoshida, *et al.*, Appl. Phys. Express **3** (2010) 085204.
3) S. Kajita, T. Akiyama, N. Yoshida, M. Tokitani, *et al.*, submitted to Fusion Engineering and Design.