## §15. Estimation of Physical Property for Tungsten Possessing Nano-structure for Fusion Devices

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Tungsten and its composite material have widely used for plasma face component for fusion device, i.e. divertor, due to hits low sputtering ratio and high melting point. It has well known that the physical property is suitable for divertor and first wall in fusion devices. Therefore, the surface condition of the tungsten has been required to realize not only its surface physics but also condition in high temperature plasma for keeping high temperature of plasma.

Here, tungsten has characteristic property for superconducting transition temperature. Although its general temperature is nearly 0.01 K, it strongly varied to be several K if the impurity like hydrogen is contained inside of the tungsten.[1)] We have tried to investigate new method whether its physical property can be detected by using the superconducting transition temperature, especially the tungsten possessing Nano-structure by plasma damage.

The thin poly-crystal tungsten disks (diameter: 30mm, thickness: 0.2 mm) irradiated by He plasma for 30 and 60 min were prepared. Figure 1 shows scanning electron microscope (SEM) images after bombardment. It realized the Fuzz structure reported before has observed at the surface of the tungsten disk. The roughness depended on the bombardment time. It shows the structure of the crystal was broken by high-energy helium ion bombardment that is much higher bonding energy of tungsten lattice. By using the tungsten possessing the nano-structure, the resistance measurement with 4-probe method was done and its temperature dependence is shown in Fig.2. Due to its thickness, the estimated resistance value at 300 K was approximately 60 μΩ, and its value was decreased with decreasing the temperature; however, the measurement was quite difficult due to low voltage less than several μV even if lock-in amplifier was utilized. It should be noticed the thickness of the Fuzz structure is less than several μm. On the other hand, the thickness of poly-crystal tungsten is 0.2 mm. Therefore; major influence of the resistance was come from the base tungsten. To identify the influence of the Fuzz structure, information of several μm thicknesses is required. As a next step, very thin tungsten film, less than 1 μm, was deposited by sputtering method on the quartz and alumina substrates that are sorts of insulator. The tungsten film was irradiated by He plasma to obtain the Fuzz structure. After checking XRD and SEM observation, the resistance measurement will be done.

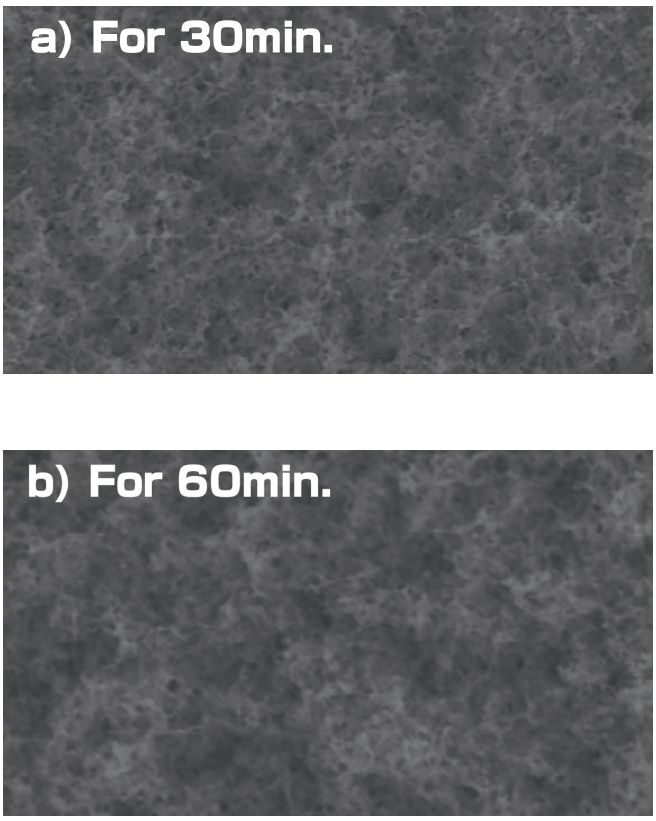


Fig.1 SEM observation of the surface of the tungsten plates after He plasma bombardment for a) 30 min and b) 60 min.

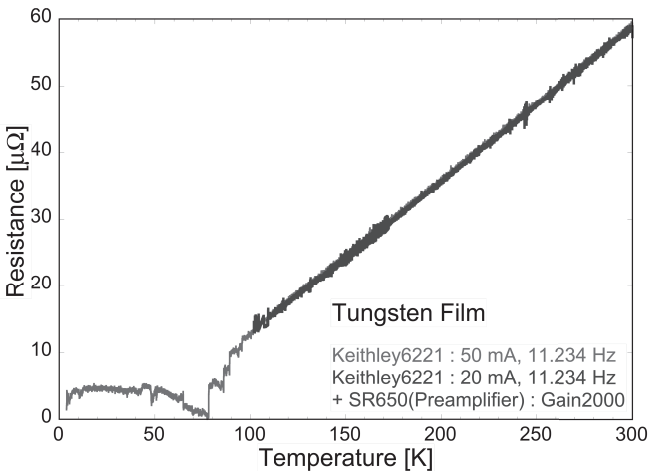


Fig. 2 Temperature dependence of measurement resistance of the tungsten disk prepared by using lock-in amplifier and preamplifier. The current oscillation was driven by Keithley 6221 model.

1) Sadki. E. S., *Appl. Phys. Let.* 85, 6206 (2004)