§7. Erosion Properties of Tungsten at Elevated Temperature

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Enhanced erosion of low-*Z* metals such as beryllium and lithium due to the formation of loosely bound surface adatoms has been observed at elevated temperatures under high-flux plasma bombardment in the linear divertor plasma simulator PISCES-B[1]. On the other hand, the existence of enhanced erosion of high-*Z* metals such as tungsten (W) and molybdenum (Mo) at elevated temperatures is not confirmed yet; two contradictory experimental results have been reported[2, 3]. The purpose of this study is to clarify erosion properties of W at elevated temperatures, since W is a promising candidate material for plasma-facing material in future fusion reactors.

Using the material probe system located at the 10.5L port, a castellated W target (80 mm x 30 mm x 1.5 mm) was exposed to divertor plasmas (the working gas was helium) in the Large Helical Device (LHD). The height of the W target was adjusted based on the experiments carried out in the last campaign. As shown in Fig. 1 (a), it was successfully avoided to expose the Mo bolts to the plasma in this campaign. The time evolution of erosion and the surface temperature was measured with two small spectrometers (Avantes) placed at the 10.5U port. In addition, two-dimensional measurements of the target temperature were performed with an infrared camera from the 10.5U port.

Fig. 2 shows a spectrum taken with the spectrometer in Shot #127491 (t = 4950-5000 ms). Neutral W atomic lines (W I) were not observed. Note that the W I 400.8 nm and 429.4 nm lines are the strongest lines in the visible range. This means that W erosion including physical sputtering and evaporation did not occur. It is thought that the incident energy of helium ions is below the threshold of the physical sputtering (~110 eV). In addition, the surface temperature, measured with the infrared camera to be around 2970 K (3590 K) at the assumed emissivity of 0.4 (0.3), was not high enough for evaporation.

While no erosion occurred, the enlargement of grains due to recrystallization was observed even with eyes, as shown in Fig. 1 (b). Detailed surface observations with a secondary electron microscope will be performed.

It was found from the experiments in the last campaigns that the heat flux is not high enough to study erosion properties of W at elevated temperature. Mo is thought to be a good replacement, since both the melting point (2896 K) and the threshold of physical sputtering by He (~46 eV) are lower than those of W.

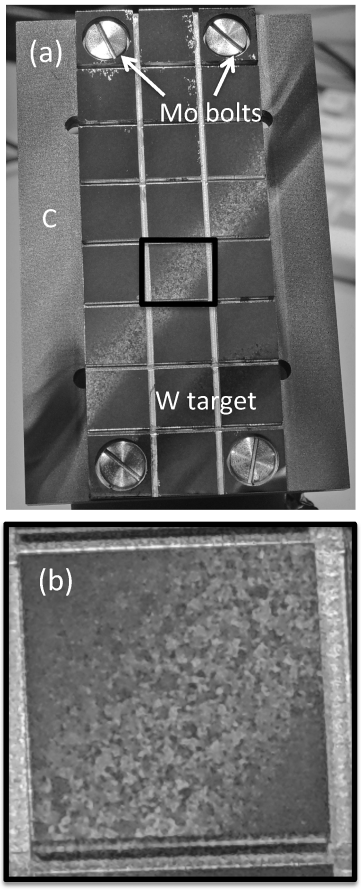

Fig. 1. (a) Photo of the W target exposed to LHD divertor plasmas. (b) Enlarged image of the square region in (a).

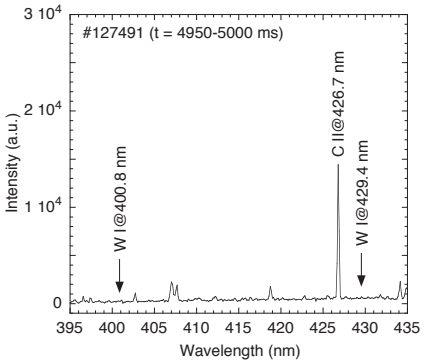

Fig. 2. Spectrum taken in Shot #127491 (t = 4950-5000 ms).

1) Doerner, R.P. et al.: J. Appl. Phys. **95** (2004) 4471.
2) Sergienko, G. et al.: presented at EPS 2005.
3) De Temmerman, G. et al.: presented at PSI 2012.