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プラズマ曝露によってタングステン材料中に注入されたトリチウムの挙動
Behavior of plasma-loaded tritium in tungsten materials

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Introduction

Behavior of energetic tritium (T) implanted in plasma-facing metals is very important to understand surface modification and T retention. Recently, we have applied tritium imaging plate technique (TIPT) to measure T surface and depth profile in pure tungsten (W) after T loading by plasma at various temperatures and found that T was highly localized in near surface region within sub-mm in depth [1]. In the present study, the effect of surface modification by helium (He) irradiation on retention behavior of plasma-loaded T was examined by TIPT.

Experimental

The as received sample used was stress-relieved polycrystalline pure W. The mirror-finished surface of the as-received sample was irradiated by He with energy and flux of 18.7 keV and ~10^{21} m^{-2} s^{-1} in DATS at JAEA, Japan (Hereinafter referred as He-irradiated surface). Total fluence was 10^{24} m^{-2}.

T was loaded on the He-irradiated surface and the mirror-finished surface as a reference at 473 K for 90 min by deuterium plasma including T in a linear plasma device (TPE) located at Idaho National Laboratory (INL), USA. T concentration was 0.5 at%. After the loading, T distribution on the plasma-loaded surface was measured by TIPT. Subsequently, the sample was bisected perpendicular to the plasma-loaded surface to appear a cross-section for a depth profiling of T by TIPT.

Results and Discussion

Figure 1 shows distribution of plasma-loaded T at (a) the He-irradiated surface and (b) the mirror-finished surface for comparison. In the figure, surface T concentration becomes higher as the color changes from blue, green and yellow to red. The plasma-loaded area is clearly distinguished as a circle with ϕ3 mm. The surface T concentration at the He-irradiated surface is much higher than that at the mirror-finished surface. As

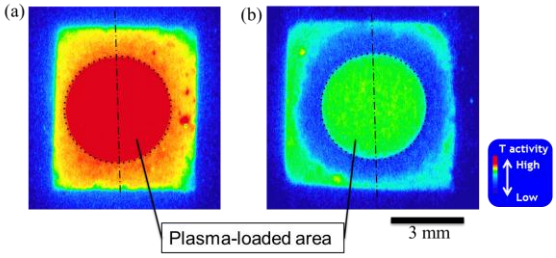

Figure 1 TIP results on (a) the He-irradiated surface and (b) the mirror-finished surface.

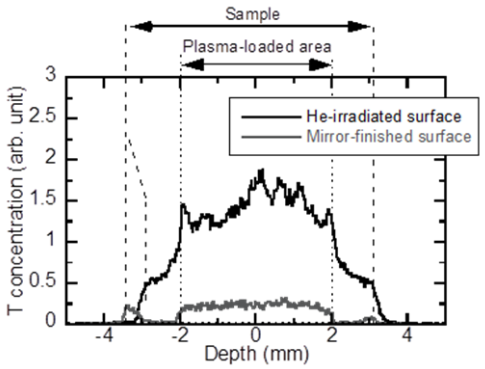

Figure 2 Surface T profile on the He-irradiated surface and the mirror-finished surface.

shown in Fig. 2, surface T profile along chain line in Fig. 1 indicates that T concentration at the He-irradiated surface is not homogeneous. Averaged surface T concentration in the plasma-loaded area at the He-irradiated surface (2293 PSL mm^{-2}) is ~7 times higher than that at the mirror-finished surface (338 PSL mm^{-2}). The causes are attributed to larger surface area due to erosion and/or increase of hydrogen trapping site at near the surface region due to He injection. Analyzing T depth profile in the bulk of W, the effect of He irradiation on retention behavior of plasma-loaded T will be discussed.

References

[1] T. Otsuka, T. Tanabe, *et al.*, *J. Nucl. Mater.*, 415, S769–S772 (2011)