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Deuterium Retention in Advanced Tungsten Materials
先進タングステン系材料の水素同位体挙動

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TFGR W (Toughened, Fine-Grained, Recrystallized W) specimens were exposed with a low energy (1 keV) and high irradiation flux (10^{20} $m^{-2}s^{-1}$) of D ion beam at 200-400°C. The amounts of retained D of TFGR W specimens were measured by thermal desorption spectroscopy (TDS) and the result was compared with pure W specimens under the same experimental conditions. The retention amount of D in TFGR W was higher than that of pure W.

1. Introduction

Tungsten (W) is a candidate of plasma-facing materials in future fusion reactors and will be used in divertor of the ITER. At present, a variety of advanced W materials with neutron irradiation resistance have been developed, including TFGR W (Toughened, Fine-Grained Recrystallized W) developed by Kurishita in Tohoku Univ. [1]. TFGR W is the W material that has the average grain size of ~1μm with a small amount of TiC (~1wt%). The fabrication procedure of TFGR W is shown in Ref. [1]. This TFGR W has enhanced toughness compared to other W materials. It is expected that TFGR W will improve the poor irradiation brittleness in W. However, TFGR W has limited data on the applicability as wall-materials in the environment of the fusion reactor, especially for low deuterium (D) retention. In this study, we show the influences of the crystalline structure of W and the addition of TiC into W to the behavior of hydrogen isotopes in W.

2. Experiment

In this study, TFGR W-1.1wt%TiC samples of 10 x 10 x 1 mm size were used. The D implantation into TFGR W specimens was conducted with High-Flux ion beam Irradiation Test device (HiFIT) in Osaka University [2], where the incident energy is 1keV, and the flux density is ~1 x 10^{20} $m^{-2}s^{-1}$. The TFGR W specimens were implanted to a fluence of 1 x 10^{24} m^{-2} at irradiation temperatures of 200-400°C. After the implantation, D retention in TFGR W specimens were measured by thermal desorption spectroscopy (TDS). For comparison, the experiments were also made with pure W samples under the same conditions. The pure W samples were fabricated by A.L.M.T Corp. and annealed at 1300°C in vacuum after mechanical polishing.

3. Results and Discussion

From the experimental results of previous studies, there were fluence dependence and irradiation temperature dependence of D retention in pure W. D retention in pure W also changed with the incident irradiation energy and the annealing temperature of W. We will investigate the trend of D retention in pure W with respect to irradiation temperature, fluence, incident energy and annealing temperature.

D retention in TFGR W specimens was higher than that of pure W specimens irradiated both at 200 °C and 400 °C. The D retention in pure W decreased rapidly with temperature, while decrease in D retention in TFGR W is rather slowly. This suggests that TFGR W has trapping sites with higher trapping energies than those in pure W. The TFGR W specimens have C in form of TiC. Since the chemical affinity is stronger between hydrogen isotopes and carbon than tungsten, D retention in TFGR W at elevated temperatures could be high compared with pure W. More studies are necessary to understand trapping mechanisms of TFGR W.

In this presentation, we will show the difference in D retention between pure W and TFGR W, and discuss the influence of irradiation temperature on D retention.

Referance

[1] H. Kurishita et al., J. Nucl. Mater. **398** (2010) 87-92.
[2] Y. Ueda et al., Fusion Eng. Design **62** (2002) 255-261.