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欠陥導入タングステン–10%レニウム合金における重水素滞留挙動に及ぼす照射温度影響
Influence of irradiation temperature on D retention behavior in damaged W-10%Re alloy

猪爪菜央[1]、小池彩華[2]、山﨑翔太[2]、和田拓郎[2]、芦沢京祐[2]、孫飛[1]、吉田直亮[3]、檜木達也[4]、大矢恭久[1]
INOZUME Nao[1], KOIKE Ayaka[2], YAMAZAKI Shota[2], WADA Takuro[2], ASHIZAWA Kyosuke[2], SUN Fei[1], YOSHIDA Naoaki[3], HINOKI Tatsuya[4], OYA Yasuhisa[1]

[1]静岡大理、[2]静岡大院総合科学技術、[3]九大応力研、[4]京大エネ研
[1]Faculty of Science, Shizuoka University,
[2]Graduate School of Integrated Science and Technology, Shizuoka University,
[3] Research Institute for Applied Mechanics, Kyushu University, [4]Institute of Advanced Energy, Kyoto University

1. Introduction

Tungsten (W) is a candidate material for plasma facing materials (PFMs) in the fusion reactors due to its higher melting point and lower sputtering yield. During the operation, W will be irradiated by energetic particles, like deuterium (D) tritium (T) and neutrons, which would introduce irradiation defects, leading to the enhancement of hydrogen isotope retention. In addition, since W will be irradiated by 14MeV neutrons (n), rhenium (Re) could be generated by nuclear transmutation. Therefore, it is important to investigate the hydrogen isotope retention behavior of W-Re alloys.

2. Experiment

The polycrystalline W-10%Re samples (6mm$^{\varphi}$, 0.5mm^{t}) purchased from A.L.M.T. Co. Ltd were used. These samples were annealed in vacuum at 1173 K for 30 minutes to remove residual defects and hydrogen. Thereafter, 6.4 MeV Fe^{3+} was irradiated to these samples at room temperature (R.T.) and 573 K with damage level of 1 dpa by DuET (Dual-Beam Facility for Energy Science and Technology, Kyoto University). 1.0 keV D_2^+ irradiation was performed with the ion flux of 1.0×10^{18} D^+ m^{-2} s^{-1} up to the ion fluence of 1.0×10^{22} D^+ m^{-2} at R.T.. After that, TDS measurement was performed from R.T. up to 1173 K with the heating rate of 0.5 K s^{-1}.

3. Results and Discussion

Fig. 1 shows the D_2 TDS spectra for W-10%Re (undamaged and Fe^{3+} damaged) samples and W (damaged at R.T.) sample[2]. The highest D retention was found for W-10%Re sample irradiated at R.T.. Large D desorption was found at higher temperature side, namely 600 K and 850 K, indicating that stable D trapping sites would be formed by Fe^{3+} irradiation at R.T.. For the samples irradiated at R.T., the value of the D retention in the W-10%Re sample was reached to be 4.2×10^{20} D/m^2 while that of W was 2.4×10^{20} D/m^2. From the results, it was found that the presence of Re affects the D retention.

On the other hand, W-10%Re sample irradiated at 573 K had no D desorption at higher temperature side, indicating that the defects in W-10%Re sample were recovered by annealing during Fe^{3+} irradiation at 573 K, considering that Re atoms would be precipitated around trapping sites such as vacancies and voids[1], due to higher mobility of Re atoms compared to that of W atoms at 573 K, and Re atoms would be occupied at the irradiation defects.

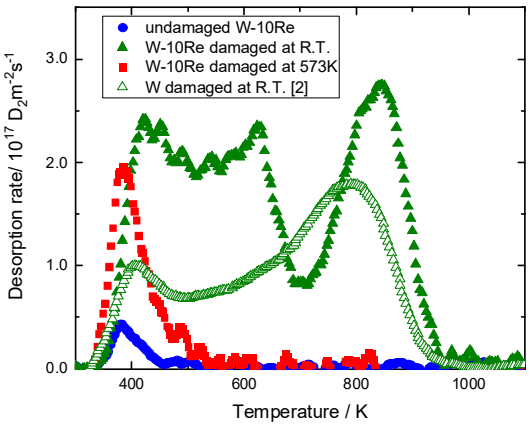

Fig. 1. D_2 TDS spectra of W and W-10%Re samples damaged at various temperature

4. References

[1] T.Hwang et al., J. Nucl. Mater., 507 (2018) 78-86.
[2] Y.Oya et al., J. Nucl. Mater., 461 (2015) 336-340.