24P081-P

Deuterium Behavior in Tungsten Coatings Irradiated with Mixed Ion Beam
混合イオンビームを照射したタングステンコーティング材料中の重水素挙動

Kazuhiro Uekita[1], Oya Makoto[1], Ohtsuka Yuusuke[1], Ueda Yoshio[1], Kasada Ryuta[2], Kimura Akihiko[2] and Nagasaka Takuya[3]
上北 一博[1], 大宅 諒[1], 大塚 裕介[1], 上田 良夫[1], 笠田 竜太[2], 木村 晃彦[2], 長坂 琢也[3]

[1]*Graduate School of Engineering, Osaka University, 2-1 Yamadaoka, Suita, Osaka, 565-0871, Japan*
大阪大学大学院工学研究科 〒565-0871 大阪府吹田市山田丘2-1
[2]*Institute of Advanced Energy, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan*
京都大学エネルギー理工学研究所 〒611-0011 京都府宇治市五ヶ庄
[3] *National Institute for Fusion Science, 322-6 Oroshi, Toki, Gifu 509-5292, Japan*
核融合科学研究所 〒509-5292 岐阜県土岐市下石町322-6

W coatings on low activation materials such as ferritic steel (F82H), oxide dispersion strengthened (ODS) steel, and vanadium alloy NIFS-HEAT2 (NH2) were exposed to low energy (1 keV) and high irradiation flux (10^{20} D/m^{2}s) of pure D ion beam and D/He mixed ion beam. The D retention properties of W coatings were examined by thermal desorption spectroscopy (TDS). In addition, the surface modification of W coatings was observed with scanning electron microscope (SEM). We discuss the influences of substrate materials on the retention properties of W coating materials and the surface modification due to ion beam irradiation.

1. Introduction

Tungsten (W) is a major candidate material for the first wall in future fusion reactors because of its high melting point and low sputtering yield. However, W is generally heavy in weight and has poor workability as W is a high Z material [1]. One of the ways to overcome these disadvantages is to have W coated on various low activation materials. W coatings on the substrates can be produced by means of vacuum plasma splay (VPS) process [2]. VPS process is useful for coating a large area because of its relatively high coating rate. At present, the study on the retention properties of hydrogen isotopes (hydrogen, deuterium, and tritium) in the W coatings have yet being carried out. Additionally, helium (He) produced in burning deuterium (D) and tritium (T) plasmas results in simultaneous irradiation of hydrogen isotopes and He to the first wall of fusion reactors. In this study, we irradiate W coatings on various materials with pure D ion beam and D/He mixed ion beam. We investigate the D retention properties of W coatings and the surface modification after irradiation.

2. Experimental

Four different W coating samples were investigated. The first three samples were the W coating samples on F82H ferritic steel (F82H: Fe-8Cr-2W-0.1C), oxide dispersion strengthened ferritic steel (ODS: Fe-19Cr-0.3Ti-0.3Y_2O_3) and NIFS-HEAT2 vanadium alloy (NH2: V-4Cr-4Ti). The fourth sample was the pure W coating peeled from the substrate after coating on a bulk W. In comparison with W coating samples, bulk W sample was investigated with the same experimental conditions. The dimensions of the samples are as shown in Table I.

The irradiation experiment was performed by using the high flux ion beam test device (HiFIT), where the beam energy is 1 keV and the irradiation flux is ~1 x 10^{20} D/m^{2}s [3]. The irradiation fluence was ~1 x 10^{24} D/m^2. The main experimental parameter varied was sample temperature (473 K and 673 K). He impurity was added to D ion beam by introducing He gas into the plasma source, where the He fraction in the flux was about 5%.

After the irradiation, the D retention properties of the samples were analyzed with thermal desorption spectroscopy (TDS), where the samples were heated from RT to 1273 K with a heating rate of 0.1 K/s. In addition, the surfaces of the samples were observed with scanning electron microscope (SEM) to analyze the surface modification due to ion beam irradiation.

3. Research plan

In this presentation, we show the D retention properties of W coating materials on different substrates and discuss how the substrate materials influence the D retention properties. We characterize the front surface of different W coatings to show the effect of ion beam irradiation on W coating materials. Furthermore, we discuss if the existence of He in irradiation flux influences the properties of W coating materials. Finally, we discuss applicability of various W coating materials as plasma facing materials in future fusion reactors.

Table I. The dimensions of the samples (The area of the irradiation surface is 10 x 10 mm for all samples)

sample number	sample	total thickness [mm]	substrate thickness [mm]	W thickness [mm]
#1	F82H substrate	1.5	0.9	0.6
#2	ODS substrate	1.5	0.7	0.8
#3	NH2 substrate	1.5	0.7	0.8
#4	peeled W	0.8	–	0.8
#5	bulk W	1	–	1

References

[1] K. Tokunaga, R.P. Doerner, R.Seraydarian, N. Noda, N. Yoshida, T.Sogabe, T. Kato and B. Schedler, J. Nucl. Mater. **307-311**(2002)126-129.

[2] T.Nagasaka, R.Kasada, A.Kimura, Y.Ueda and T. Muroga, Fusion Sci. Tech. **56**(2009)1053.

[3] Y. Ueda, T. Shimada and M. Nishikawa, Nucl. Fusion **44**(2004)62.