

Hydrogen concentration of co-deposited films formed in Large Helical Device

大型ヘリカル装置における炭素-水素共堆積膜中の水素濃度

Kensuke Fukayama^a, Naoko Ashikawa^b, Yuji Nobuta^c, Yuji Yamauchi^c, Tomoaki Hino^c, Suguru Masuzaki^b,

Kiyohiko Nishimura^b, Akio Sagara^b, LHD Experimental group^b

深山健介^a、芦川直子^b、信太祐二^c、山内有二^c、日野友明^c、増崎貴^b、西村清彦^b、
相良明男^b、LHD 実験グループ^b

^a*Graduate School of Engineering Hokkaido University*

Kita-13, Nishi-8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan

北海道大学大学院工学院 〒060-8628 北海道札幌市北区北 13 条西 8 丁目

^b*National Institute for Fusion Science*

322-6, Oroshi-cho, 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

^c*Faculty of Engineering Hokkaido University*

Kita-13, Nishi-8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan

北海道大学大学院工学研究院 〒060-8628 北海道札幌市北区北 13 条西 8 丁目

Hydrogen amount in co-deposit formed in fusion reactors depends on the structure of carbon. So the deposition process, the relation of the co-deposits with the retention behavior and characteristics must be clarified to evaluate the reactor safety. In the present study, we installed multifaceted holders with material probes on the wall near the graphite divertor in 13th campaign of the LHD. We prepared different characteristic types of co-deposits, then the deposition thickness, the retained amount, deposition amount, and hydrogen concentration of the co-deposits were evaluated. The amount of retained hydrogen and deposited particles and thickness for the co-deposits which directly faced to the divertor were large. Hydrogen concentrations in the co-deposits which did not face to the divertor became large.

1.Introduction

For the safety operation associated with the limitation of in-vessel tritium inventory in fusion reactor, the retention behavior of hydrogen isotope and the characteristic of co-deposits must be clarified, such as the relation of the depositing position with hydrogen retention and concentration. In the present study, we prepared different

characteristic types of co-deposits, and then the deposition thickness, the retained amount, deposition amount, and hydrogen concentration of the co-deposits were evaluated.

2.Experiments

To prepare the co-deposits with different incoming particles during the deposition, we installed a

multifaceted sample holder in the LHD 13th experimental campaign as shown in Fig.1. The SS and Si probes were fixed on the holder. S1 and S2 directly faced the divertor plates. Opening angle of S2 was larger than that of S1. S3 and S4 did not face the divertor plates.

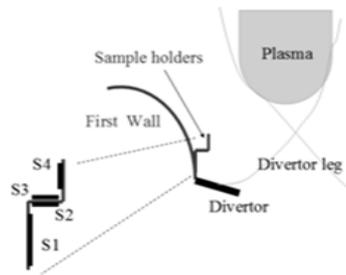


Fig.1. Diagram of multifaceted holders and the position

During the experiment, surrounding probe temperature and neutral particle pressures were the same. The amounts of retained hydrogen and deposited particles were evaluated by thermal desorption spectroscopy and Auger electron spectroscopy, respectively. Then, hydrogen concentrations of the co-deposit were evaluated.

3.Results and discussion

The deposited amounts of carbon, boron, and iron on the probes are shown in Table I.

Table I. Amount of deposition[10¹⁷ atoms/cm²]

	Carbon	Boron	Iron
S1	1.10	1.37	5.07
S2	45.17	7.73	41.78
S3	2.00	0.73	4.33
S4	2.47	2.66	4.73

The deposition amounts S2 were larger than S1. For S3 and S4, the deposition amounts were almost the same. Atomic concentration of carbon for S2 was the highest among the probes.

Amount of desorbed H₂ and CH₄ are shown in Fig.2. The desorbed amounts, namely the amounts of retained hydrogen, S1 and S2, which directly faced the divertor plates, were larger than that of S3 and S4. The amount for S4 was less than the detection limit of our measurement.

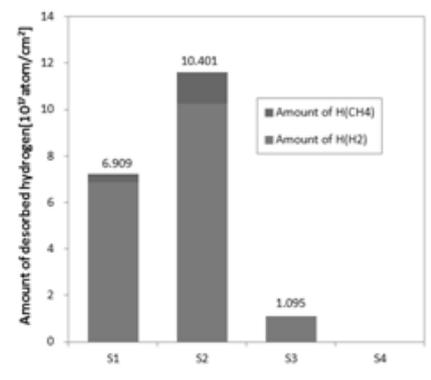


Fig.2. Amount of desorbed hydrogen

Most of deposition on S1 and S2 might be carbon atoms resulted from sputtering on divertor plates. Carbon atoms have high sticking coefficient, so it can easily form the co-deposit. Therefore, desorbed amount of S1 and S2 became high.

The estimated hydrogen concentrations are shown in Fig .3.

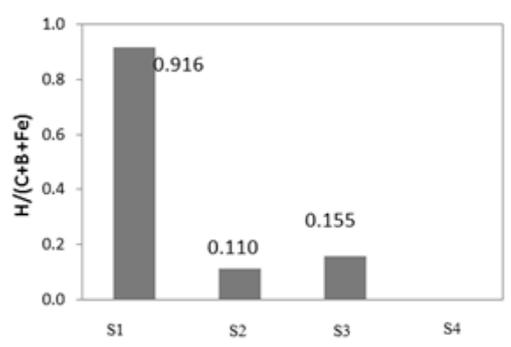


Fig.3. Hydrogen concentration

Hydrogen concentration of S1 was extremely high. The concentrations of S3 was little larger than that of S2. For S2, the main incoming species might be carbon, so the hydrogen concentration became very low. The higher concentration for S3 might be owing to the deposition of hydrocarbon radicals.