§76. Comparison and Study of Large Fusion Devices for Optimization of the Boronization Methods

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In the Large Helical Device (LHD), boronization by diborane (B_2H_6) gas has been performed from the 5th campaign. On the other hand, other kinds of boronization methods are adopted in JT-60U and JFT-2M as shown in Table 1. The wall material and temperature of these fusion devices are also different. In order to obtain basic information for designing a boronization system of a next fusion experimental device, investigation of characteristics of boron coating layer such as the thickness distribution in vessel, chemical composition and hydrogen behavior generated under various glow conditions and various number of anodes and gas injection ports has been started.

Table1. The comparison of boronization systems in fusion experimental devices.

	LHD	JT-60U	JFT-2M
Source material	B_2H_6	$B_{10}H(D)_{14}$	$B(CH_3)_3$
Number of anodes	2	3	1
Number of ports	3	12	1
First wall material	S.S.	Graphite	F82H
Wall temp.(℃)	95	300	RT

In this work, samples were installed in the vacuum vessel all the time during the 7th campaign to investigate the long-term effect such as accumulation of impurity and sputtering of boron coating. SS316, Si and CVD-W were selected as long-term samples. In July, samples were installed on the area that thicker boron coating layer was observed after 6th campaign [1]. These kinds of samples were also installed in the JT-60U vacuum vessel in September. Sample installed positions (A-G) in LHD are shown in Fig. 1. Samples were distributed not only the torus direction but the poroidal direction.

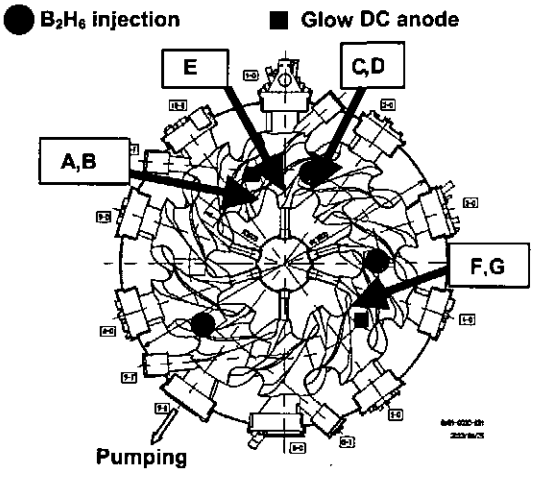

Fig. 1 Sample installed position in LHD.

Short-term samples were also inserted only when boronization on 8th of December. Since Long-term samples can bring out during the ventilation, analysis will be conducted after the 7th campaign. Distribution of boron coating thickness, impurity in/on the boron coating layer, relation between oxygen and hydrogen accumulation and boronization history will be analyzed.

Preliminary investigations were conducted using the past data of LHD, JT-60U and JFT-2M. At first, distance from gas injection port dependence of boron coating thickness was investigated. The thickness showed the tendency to decrease with distance exponentially. Then, depth profiles of boron layer on SS316 (LHD), Fe (JT-60U) and F82H (JFT-2M) substrate measured by XPS were compared as shown in Fig. 2. The JFT-2M sample showed the high carbon concentration of 85%, because trimethylboron $B(CH_3)_3$ contains carbon (C/(B+C)=0.75). On the other hand, the JT-60U sample contains 10% of carbon in spite of the decaborane ($B_{10}D_{14}$) indicating that the first wall made by carbon was sputtered during the boronization and deposited in the boron layer. Hydrogen release temperature must be different between JFT-2M and JT-60U because the peaks of TDS spectra for D_2 and CD_4 from Sput-B/C films are sensitive to the carbon concentration [2]. Carbon concentration of LHD sample was same level as JT-60U. However, oxygen concentration was relatively high. Oxygen was contained not only the interface between Fe and B but the boron layer in constant. Oxygen probably came from the un-coating area of vacuum vessel. More precise study is required by analyzing samples installed in LHD and JT-60U considering the glow discharge condition and partial pressure of oxygen, hydrogen and so on.

Reference

1) Ashikawa, N. *et al.*: Ann. Rep. NIFS (2002-2003) 40
2) Yamaki, T. *et al.*: J. Nucl. Mat. **217** (1994) 154

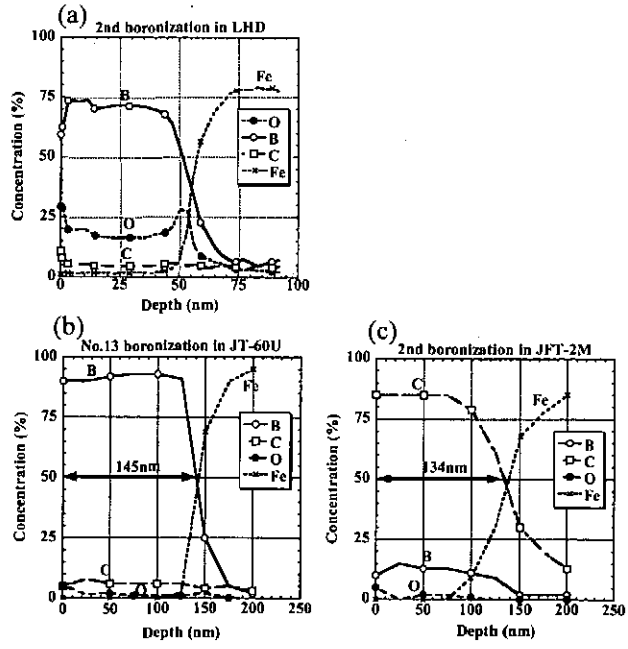

Fig. 2 Depth profiles of boron coating sample in (a) LHD, (b) JT-60U and (c) JFT-2M.