§25. Dependence of Effectiveness of Fin Structure on Main/glow Discharges

Akiyama, T., Yoshida, N. (Kyushu Univ.),
Tokitani, M., Kawahata, K.

A retroreflector is useful for laser diagnostics because the reflected light is parallel to the incident one. However, the thick impurity (carbon and metal) deposition layer tends to be formed at the central region of the reflector installed in a vacuum vessel and the reflectivity degrades [1, 2]. Glow and main discharges are expected to affect the mirror surface differently because the flux and energy of incident plasma and neutral particles are different. Since the energy of the ions and chemical sputtering process depend on the gas species, the surface modification is also related to the gas. In order to identify what condition degrades the reflectivity most, the reflected power by the retroreflector was monitored in the 15th experimental campaign.

Figure 1 shows the retroreflector (stainless steel 316) with a diameter of 50 mm installed in LHD. The temporal evolution of the returned power of He-Ne laser light (633 nm) during the glow discharge cleaning before the experimental campaign is shown in Figure 2 (a). To prevent the window being coated by the impurity, the shutter was opened only at the timing of the measurement. Regardless of high energy of neon ions (strong sputtering), the decrease of the reflectivity is only 3% for 6 hours (0.5%/hour). On the other hand, the reflectivity decreased by 80% for 20 hours (4%/hour) during a hydrogen glow discharge. Although the returned power sometimes fluctuated, the reflectivity was almost determined by the hydrogen glow discharge shown in Fig. 2(a). Figure 2 (b) shows the mirror parts of the reflectors after the 15th experimental campaign. Interference pattern caused by the impurity deposition is seen on one of the mirror surface. The reflectivity around the interference pattern decreased to 10-20% (originally 90%) for He-Ne laser light. The composition of the deposition layer was analyzed with glow discharge optical emission spectroscopy (GD-OES) as shown in Fig. 3 (a) and (b). The intensity and time correspond to the amount of the composition and thickness, respectively. The deposition layer mainly consists of carbon. The boron is detected at just surface of the deposition layer. Since the boronization was done just before the start of the main plasma discharge, the thick carbon deposition layer was formed during the glow discharge cleaning before the experiment. The reason why the reflectivity was significantly degraded during the hydrogen glow discharge was the deposition of carbon, which was released from the divertor plate as hydrocarbon due to the chemical sputtering.

In conclusion, the reflectivity of the retroreflector in metal and carbon devices seems to be determined by the hydrogen glow discharge. Contributions of the main discharges and the glow ones with other gases were small. Close of the shutter during only the hydrogen glow discharge would be effective to maintain the reflectivity if possible.

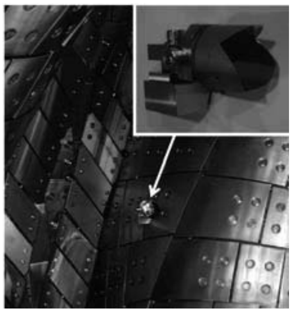

Fig. 1: The retroreflector installed in LHD

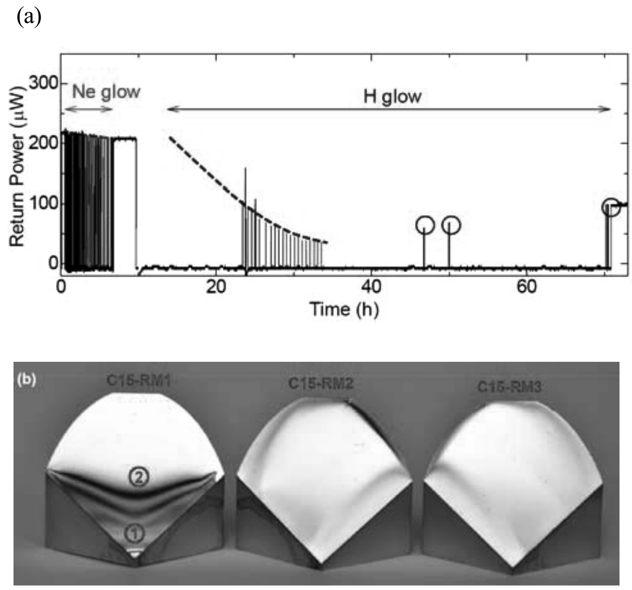

Fig. 2: (a) Temporal evolution of the power of the returned beam during Ne and H glow discharges cleaning. (b) Three mirror parts of the retroreflector after the 15th experimental campaign.

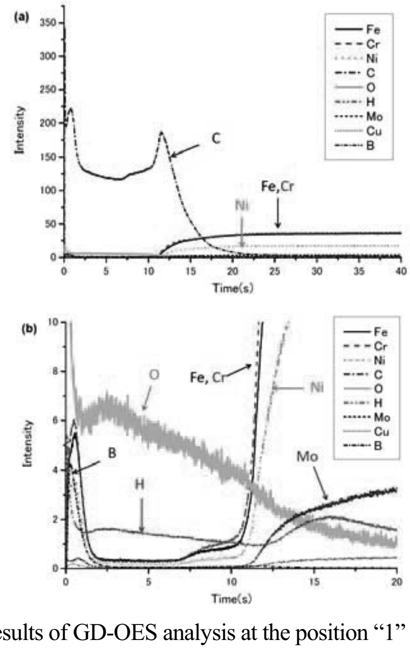

Fig. 3: (a) Results of GD-OES analysis at the position “1” of C15-RM1 in Fig. 2(b). (b) The vertical axis of Fig. 3(a) is expanded.

1) Akiyama T., et al.: Rev. Sci. Instrum. **78**, 103501 (2007).

2) Akiyama T., et al.: Nucl. Fusion **52**, 063014 (2012).