§24. Dependence of Deposition Mitigation Effect of Fin Structure on Main/glow Discharges

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Most of laser diagnostics and spectroscopic measurement on fusion devices require invessel mirrors. The reflectivity of the mirrors is one of parameters which determines the signal to noise ratio. However, an invessel condition is harsh for the mirrors: strong sputtering by plasma particles and charge-exchange particles, impurity (carbon and metal) depositions. They cause surface modification which leads to the degradation of the reflectivity. Since the mirrors will not be replaced frequently in future fusion reactors, methods to maintain the reflectivity should be established.

Although the protective cylinder of the mirror can reduce plasma and impurity flux, it also plays as a source of impurity. The fin structure inside the cylinder can reduce transport of the impurity to the mirror position. The effectiveness had already proven in LHD [1]. Processes of the surface modification during main discharges and glow discharges are expected to be different because the energy and flux of incoming particles are different: charge-exchange particles and accelerated ions, respectively. In 15th experimental campaign, we examined the difference of the effectiveness of the fin structure between main and glow discharges.

Figure 1 (a) shows two sets of protective cylinders with fins and without fins. Mo TEM specimens were placed on the bottom of the cylinders. They were put on the material prove and were exposed to the main and glow discharges separately by using a shutter at the position of inner wall. Each set was exposed to hydrogen main discharges with an averaged electron density of about 3×10^{19} m^{-3} for one day and hydrogen glow discharge for thee hours.

As shown in the blight-field images of in Fig. 2(a), the density and size of dislocation loop of the cylinder with fins (B) are reduced by 2/3 and 1/3, respectively, compared with that without fins in the H main discharge. While the fin structure was originally developed to mitigate the deposition, it is found that the fins prevent the elastic-collision high energy particles at the inner wall of the cylinder going to the bottom. The thickness of the impurity deposition during the main discharges was very small, less than 10 nm. Hence, it was difficult to conclude clearly differences between cylinders with and without fins. Figure 2 (b) shows edges of Mo specimens which were exposed to hydrogen glow discharges. Due to low energy of hydrogen, irradiation defects such as dislocation loops are not seen. The impurity deposition was clearly suppressed by the cylinder with fins.

The irradiation defect and the impurity deposition were seen during the main discharges and the glow discharges, respectively. The cylinder with fins is found to be able to reduce the sputtering in the main discharges and impurity deposition during the glow discharges.

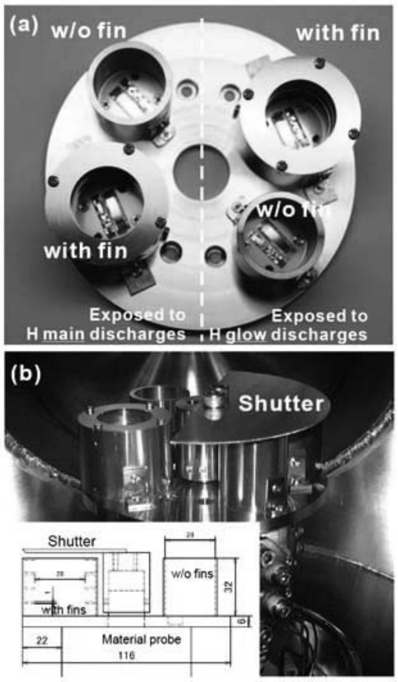

Fig. 1: (a) two sets of cylinders with and without fins. (b) Cylinders put on the material probe

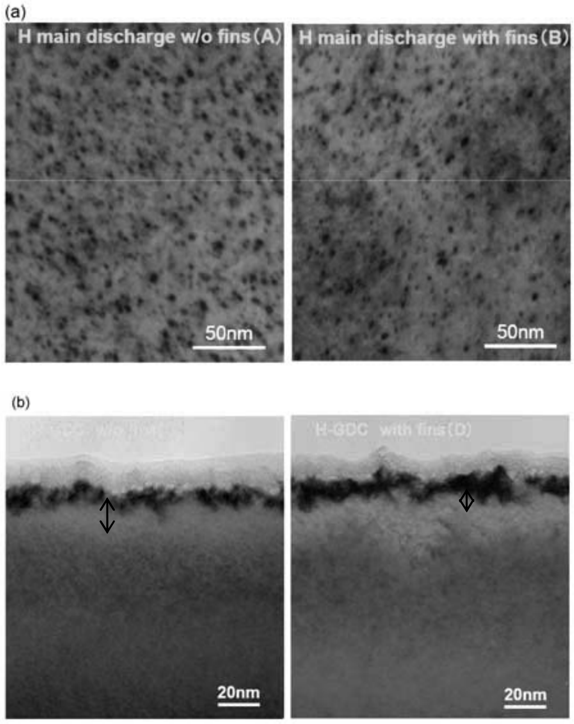

Fig. 2: (a) Blight-field images of specimens at the bottom of the cylinder (A) w/o and (B) with fins exposed to hydrogen main discharges. (b) Thickness of the impurity deposition (shown with arrows) (C) w/o and (D) with fins exposed to hydrogen during glow discharges.

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