§42-5 Optimization of a Cylinder with Fins for Mitigation of Depositions on First Mirrors

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Laser diagnostics and spectroscopy often need to install mirrors in a vacuum vessel. One of problems of invessel mirror is reduction of the reflectivity due to impurity deposition on the mirror surface. There are two ways to prevent the reflectivity degradation. One is a passive way such as a protection structure to the mirror to reduce the number of incoming particles. The other is active method: cleaning of the mirror with a plasma. So far a collaboration group of Kyushu Univ. and NIFS has conducted development of the protective cylinder. While a simple cylinder can reduce incoming impurity by limiting the solid angle, the inner wall of the cylinder becomes impurity source and deposit impurities at the entrance of the cylinder are transported to the bottom (mirror position) by sputtering. Hence we proposed the fin structure inside the cylinder and proved the reduction of the impurity deposition at the bottom and impurity depositions were reduced successfully [1]. However, the fin parameters such as the ratio of diameter of the entrance and cylinder length have not been optimized yet.

Kotov calculated how much impurities are attenuated with fins by Monte Carlo simulation [1]. One example is shown in Fig. 1. For validation of this simulation and optimization of fin structures, we fabricated cylinder with fins based on the Kotov's design and exposed to a plasma in LHD. As shown in Fig. 2, three cylinders with the different cylinder length L divided by the diameter D (L/D=2, 5, 10). Together with cylinders without fins, cylinders were exposed Ne glow discharge. The reason why Ne glow discharges were selected is as follows. H glow discharge creates hydrocarbon by chemical sputtering and the hydrocarbon penetrates into the cylinder as gas. Thickness of the deposition on Si specimens at the bottom is analyzed with TEM.

Figure 3 shows a summary of the thickness of the deposition. The longer the cylinder is, the thinner the deposition layer is. This tendency agrees with Kotov's simulation. However, we found the thicker deposition (mainly carbon) in the cylinder with fins. This is opposite results. Since the top of the cylinder was wider in the case of cylinders with fins, the impurities deposited on the top fins once and the impurities might fall down to the bottom. It is necessary to improve the shape of the fins. If the top fin is a main source of impurities, modification is necessary: A narrow fin at the top and wider at bottom, tilted fins to make the incident angle shallow.

Otherwise, the glow discharge came into the cylinder and sputtered the fins. This may imply that cylinder with fins is not effective for glow discharge. Similar results (thicker deposition in cylinder with fins) were also reported from TEXTOR.

1) T. Akiyama *et. al.*, Nucl. Fusion 52 (2012) 063014.
2) Kotov. K *et. al.*, Phys. Scr. T145 (2011) 014071.

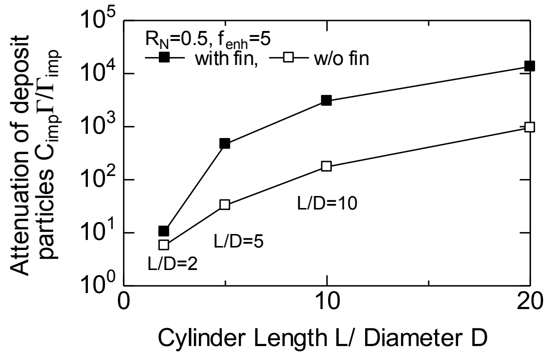

Fig. 1: Attenuations of impurity particles at the bottom of the cylinders with and without fins.

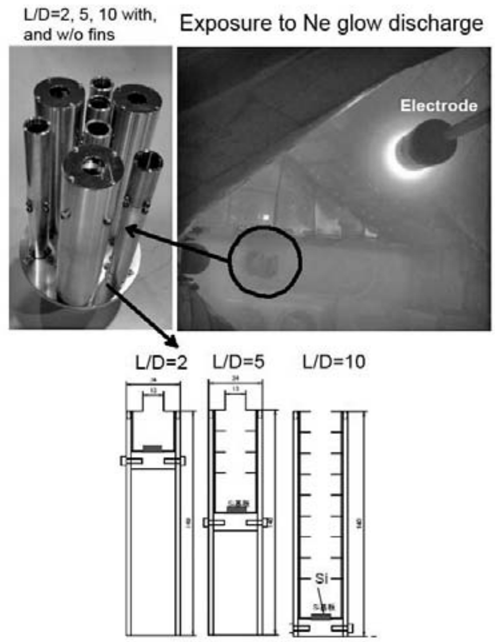

Fig. 2: Structure of cylinder with and without fins [2] (b) Attenuations of impurity particles at the bottom of the cylinders.

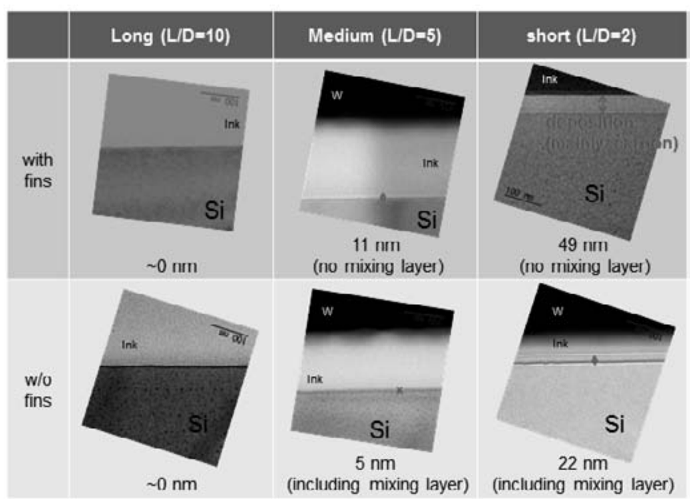

Fig. 3: Cross sectional views of Si specimens at the bottoms of cylinders.