§16. Plasma Exposure of Cylinder with Fins for Comparison with Simulation

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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 protection structure to the mirror to reduce the number of incoming particles. The other is cleaning of the mirror with a plasma. 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 end 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 [1].

Figure 1(b) shows attenuation of the deposit particles at the bottom of the cylinder (parameters are shown in Fig. 1(a)) simulated by K. Kotov [2]. The vertical axis is the attenuation, which is defined as the ratio of the number of incoming particles to that of particles which reach to the bottom. Here, the reflection of the incident particles at the inner wall R_N and the enhancement factor of the numbers of sputtered particles f_{enh} are supposed to be 0.5 and 5, respectively. The attenuation by the cylinder with fin is about ten larger than that of cylinder without fins.

In order to examine the simulation results, cylinders with fin with three different size parameters (L/D) were exposed to a glow discharge in LHD. Since the simulation in Ref [2] supposes that the impurities come into the cylinder as particles, neon was selected as a gas of the glow discharge. This is because a hydrogen glow discharge produces hydrocarbon at the surface of the divertor plates and it can come to the bottom of the cylinder as a gas and the carbon deposit on the mirror surface. On the other hand, neon does not produce the hydrocarbon and is expected to be similar to the Kotov's simulation condition. Figure 2 shows photograph of the plasma exposure of the cylinders with and without fins. L/D are 2, 5, 10 for cylinders with and without fins, respectively. In addition to that, "Fuzz", which is nano-structure tungsten and has the large sticking parameter for incoming particles, is attached at the end of the cylinder inner wall instead of fins. These cylinders were exposed to the glow discharge plasma for three hours. The amount of the impurity on the Si plate at the bottom will be analyzed with Rutherford Backscattering Spectroscopy (RBS) which was installed in NIFS in 2014. The attenuation by Fuss and fins will be also compared.

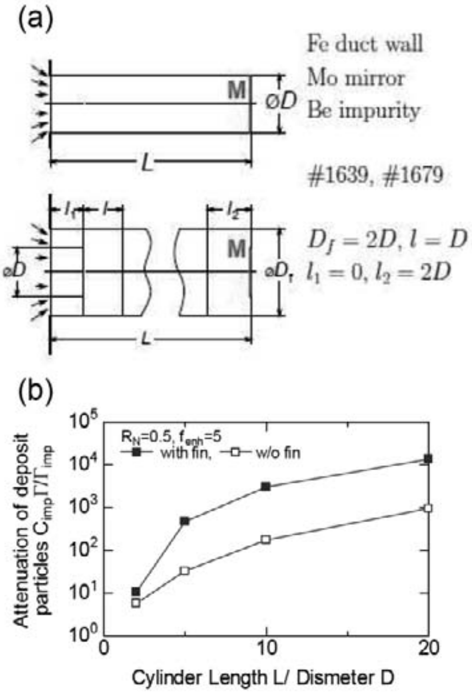

Fig. 1: (a) Structure of cylinder with and without fins [2] (b) Attenuations of impurity particles at the bottom of the cylinders.

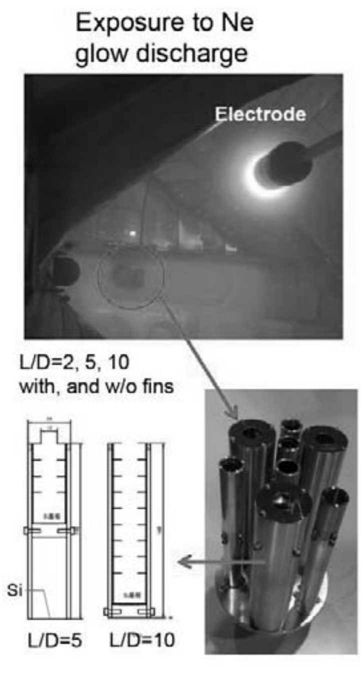

Fig. 2: Photographs of plasma exposure and cylinder with and without fins

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