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核融合装置内壁のチタン蒸着膜における重水素吸蔵状態の評価
An evaluation of absorbed deuterium in Ti-Deposited layer in fusion plasma devices

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1. Introduction

The authors developed a cylindrical glow discharge fusion device which can generate 2.45 MeV neutrons by D-D fusion reactions on the surface of the cylindrical electrode with titanium-coating[1], based on the consideration that deuteron collision on the surface enhances neutron yield (Fig.1). Titanium is widely used for plasma device because of its deuterium storage capacity. However, the state of deuterium inside titanium deposited layer is not understood sufficiently. To evaluate the effect of the amount of deuterium and its distribution, the authors analyzed a depth profile of deuterium by using glow discharge optical emission.

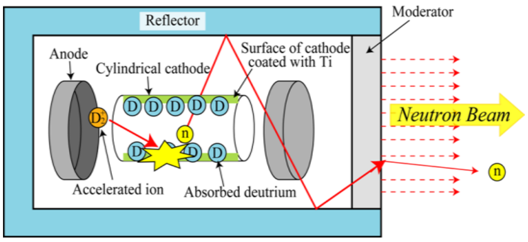

Fig. 1 Concept of a cylindrical glow discharge fusion device.

2. Method

2.1 Samples

Cylindrical electrodes for the discharge source were coated with titanium and exposed to D_2 gas, and after that the electrode was used for glow discharge with deuterium for neutron generation experiments. The electrodes were cut and extended by applying pressure in order to shape into 2.5 x 1.5 cm square size for characterization of Ti coating and its deuterated surface.

2.2 Depth profile

GD-Profiler2 (HORIBA) was used for deuterium depth profile analysis. Argon gas pressure was 515 Pa, and the depth profile was measured down to approximately 9.5 µm from the surface. Sputtering depth was measured by surface roughness tester SJ-210 (Mitutoyo).

3. Results and Discussion

An example of the depth profile of titanium-coated electrode is shown in Fig. 1. Deuterium was detected in titanium coating and mostly existed 0.4 µm down from the surface. The status of the deuterium existing in the Ti coating layer are considered to be possible for the following three processes. (I) is captured deuterium during the titanium coating process, (ii) is internally diffused process after the adsorption, and (iii) is deuterium ion penetration while glow discharging mainly driven by implantation. As seen in the Fig.2 left, plateau of the deuterium corresponding to the Ti layer seems suggesting a possible formation of the titanium deuteraide (TiD2).

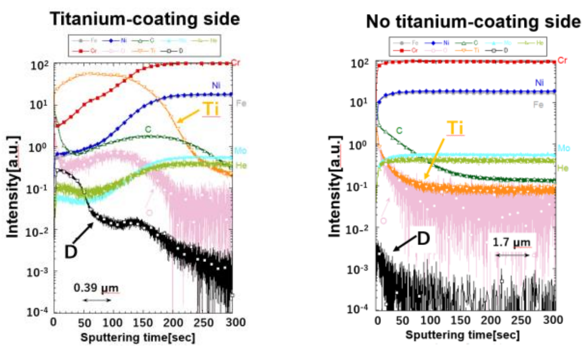

Fig. 2 Depth profile of an electrode.
Left is titanium-coating side.
Right is no titanium-coating side.

4. Reference

[1] K. Noborio *et al.*, “Neutron production rate of inertial electrostatic confinement fusion device with fusion reaction on surface of electrodes”, Fusion Science and Technology, 52(4), 1105-1109, 2007