Investigation of Tritium Retention and surface properties on the First Wall of LHD

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To understand the mechanism of tritium (T) retention in the first wall of the Large Helical Device (LHD), relationships between surface morphology and microstructure, and properties of T retention and desorption on material probes which were located on typical positions in the LHD vacuum vessel are investigated.

In LHD, deuterium (D) plasma experiment has been conducted since 2017. A result of T balance between generation and evacuation showed that approximately 60 % of generated tritium remained in the vacuum vessel after the first D plasma experiment campaign. To evaluate T distribution on the first wall which consists of stainless steel (SUS316L) panels, long-term material probes made of SUS316L were installed on the first wall before the D plasma campaign in 2017. Material probes were retrieved after the campaign and analyzed. As results of the analysis, the position dependences of the relationship between surface properties such as morphology and microstructure and T retention and desorption properties were revealed.

The microstructures near the probe surfaces, and the thickness of the deposition layers on the probes, were investigated with transmission electron microscopy (TEM). To conduct the analysis, the probes were fabricated with the focused ion beam (FIB), in order to make the cross-sectional lamella specimens with 50-100 nm thickness. The T retention on surfaces of the probes was analyzed by tritium imaging plate (IP) technique. And all T retention and desorption characteristics of the probes were investigated with thermal desorption spectroscopy (TDS). In the TDS analysis, the probes were heated continuously from room temperature to 1173 K at the heating rate of 0.5 Ks\textsuperscript{-1}.

The thickness of the deposition layer, and the size and density of the He bubbles were revealed to depend on the probe positions on the first wall. On the probes located beside divertor tiles, deposition layers were much thicker than those on the other probes. From IP and TDS analyses, the T retention in probes increased clearly with increasing the thickness of the deposition layer. In addition, the TDS spectrum broadened toward high temperature region as deposition layer formed. These observations suggest that T was strongly trapped in deposition layer which consists mainly carbon. The detail information such as depth profiles of T and full combustion method, which can be fully burnt the deposition layer and release T, will be reported in the presentation.